Part II

A Cyclical Theory of Financial Crises
Chapter 4

A Model of Financial Crises and Endogenous Fluctuations in Industrial Countries

4.1 The Real Side

Consider a large and fully industrialized country whose currency floats freely against other industrial countries, and is used as a nominal anchor, or as an international reserve currency by emerging market and transition economies.

Output is assumed to be determined by the demand side of the economy. The resulting goods market equilibrium condition is formally given by

\[ PY = PY^d(C, I, G, NX), \]

stating that nominal output \( PY \), where \( P \) denotes the domestic price level and \( Y \) real output, is determined positively by real consumption demand \( C \), by real investment demand \( I \), by real government expenditure \( G \) and by real net exports \( NX \). The nominal capital stock \( PK \), where \( K \) denotes the real capital stock, being equal to replacement costs or to the supply price of capital, is used as the numéraire of the model. Dividing both sides of the goods market equilibrium by the numéraire \( PK \), and assuming an additive aggregate demand function yields

\[ u = \frac{Y}{K} = \frac{C}{K} + \frac{I}{K} + \frac{G}{K} + \frac{NX}{K}, \]

where output is transformed into the output/capital ratio or capacity utilization \( u = Y/K \), and real demand components are expressed in terms of the real capital stock. For reasons of simplicity, real consumption demand is excluded from the model, i.e. \( C/K = 0 \). The second demand component \( I/K \) representing the real growth rate of the capital stock \( \dot{K} \) (\( I/K = \dot{K}/K = \dot{K} \)) is assumed to be positively determined by Tobin’s \( q \), being derived in detail below and explained in appendix A, resulting in the “desired” growth rate of the capital stock

\[ \frac{I}{K} = \dot{K} = \eta(q). \]

Government expenditure is assumed to be determined inversely by the real value of public debt being financed by the issuance of government bonds, and by real interest payments on
debt. Accordingly, real government expenditure adjusted for the capital stock $g = G/K$ is assumed to be negatively dependent on the real interest rate on government bonds $i - \hat{p}$, where $i$ denotes the nominal interest rate on bonds, and $\hat{p} = \hat{P}/P$ the growth rate of the domestic price level, formally

$$\frac{G}{K} = g = g(i - \hat{p}).$$

Real net exports adjusted for the capital stock $nx = NX/K$ are assumed to depend positively on the growth rate of the real exchange rate $\hat{s} + \hat{p}^* - \hat{p}$, where $\hat{s} = s/s$ denotes the growth rate of the nominal exchange rate $s$ expressing the price of one unit of foreign currency in domestic currency, and $\hat{p}^* = \hat{P}^*/P^*$ the foreign price level's growth rate which is assumed to be constant at zero, i.e. it holds that $\hat{p}^* = 0$; as a result, real net exports are given by

$$\frac{NX}{K} = nx = nx(\hat{s} - \hat{p}).$$

Furthermore, it is assumed that the Robinson-condition is fulfilled according to reactions of the current account to real exchange rate movements, ruling out abnormal reactions, i.e. a real appreciation of the exchange rate (real depreciation of the home currency) leads to an increase in $nx$, and a real depreciation of the exchange rate (real appreciation of the home currency) leads to a decrease in $nx$. The negative dependence of $nx$ on capacity utilization $u$ by import demand is neglected for reasons of simplicity and does not change the model results significantly. Summing up, goods market equilibrium is given by

$$u = \eta(q) + g(i - \hat{p}) + nx(\hat{s} - \hat{p}). \tag{4.1}$$

Though the impact of $q$, $i$ and $\hat{s}$ on $u$ is unequivocal in equation 4.1, the influence of $\hat{p}$ on $u$ is not clear. On the one hand, an increase in $\hat{p}$ leads to an increase in government expenditure by the reduction of the real interest rate on bonds $i - \hat{p}$, whereas on the other hand, an increase in $\hat{p}$ leads to a deterioration of the current account, i.e. $nx$ decreases. Though a neutral, positive, as well as, negative influence of $\hat{p}$ on $u$ can be justified, it is assumed in the present model that the overall impact of the growth rate of the price level on capacity utilization being denoted as $\partial u / \partial \hat{p}_a$ is positive, where $\partial \hat{p}_a$ reflects both the influence of $\hat{p}$ on $nx(\cdot)$ and the effect of $\hat{p}$ on $g(\cdot)$. As a result, inflation leads to an expansion in output, and deflation to a contraction since the influence of net exports is assumed to be smaller than the influence of government expenditure. Formally, it holds that

$$\frac{\partial u}{\partial \hat{p}_a} = \frac{\partial g}{\partial (i - \hat{p})} \frac{\partial (i - \hat{p})}{\partial \hat{p}} + \frac{\partial nx}{\partial (\hat{s} - \hat{p})} \frac{\partial (\hat{s} - \hat{p})}{\partial \hat{p}} = - \frac{\partial g}{\partial (i - \hat{p})} - \frac{\partial nx}{\partial (\hat{s} - \hat{p})} > 0.$$

Firms' profits and their influence on investment and expectations play a central role in the model. Gross nominal profits $Q_g$ are given formally as

$$Q_g = PY - wN - \delta PK,$$

that is, by earnings $PY$ less labour costs $wN$, where $w$ denotes the nominal wage rate and $N$ labour input, and less depreciation on the capital stock $\delta PK$, where $\delta$ denotes the depreciation rate. Net profits $Q$, or just profits, are determined by gross profits
less external financing costs, i.e. less interest rate costs on the stock of loans \( jL \), where \( j \) denotes the nominal interest rate on bank loans and \( L \) the nominal stock of loans. Formally, net profits are determined as

\[
Q = PY - wN - \delta PK - jL.
\]

The gross and the net profit rate on capital are derived by dividing gross, as well as net profits by the numéraire \( PK \). The gross profit rate \( r_g \) is given by

\[
r_g = \frac{PY}{PK} - \frac{wN}{PK} - \frac{\delta PK}{PK} = u(1 - v) - \delta,
\]

where \( v = wN/(PY) \) denotes the wage share with respect to gross nominal product\(^1\) which is treated as a parameter in the model which increases e.g. if nominal wages rise, or in case of a negative shock to labour productivity \( Y/N \). Furthermore, imperfect competition in goods markets is assumed, i.e. firms possess market power, implying that the wage share is less than gross nominal product; formally, it holds that \( v < 1 \). The net profit rate \( r \), or just the profit rate, is given by

\[
r = \frac{PY}{PK} - \frac{wN}{PK} - \frac{\delta PK}{PK} - \frac{jL}{PK} = u(1 - v) - \delta - j\lambda,
\]

where \( \lambda = L/(PK) \) is the debt-asset ratio relating the stock of loans outstanding to the capital stock valued at replacement costs.

The supply side of the model is represented by a simplified Phillips curve given by

\[
\hat{p} = \psi(u - u^*),
\]

stating that capacity utilization which exceeds the “natural full employment level” of capacity utilization, being defined as \( u^* > 0 \), causes inflation, and a situation \( u < u^* \) deflation. This definition of the price level’s growth rate neglects inflation or deflation expectations since they are incorporated in the expected profit rate on capital being derived in detail below. Furthermore, the direct influence of the exchange rate’s growth rate \( s \) on \( \hat{p} \) is neglected. This assumption can be justified by the fact that industrial countries like the U.S. or the Euro area can be considered as rather closed economies, and that the influence of exchange rate variations via imported inputs can be neglected. However, an indirect influence of \( s \) on \( \hat{p} \) is incorporated in the model by the fact that an increase in \( s \) leads, according to equation 4.1, to an increase in net exports and therefore, to an increase in capacity utilization increasing \( \hat{p} \) according to equation 4.3.

### 4.2 The Financial Side

#### 4.2.1 A Stylized Financial Structure

A simplified and stylized financial structure of an industrialized economy can be described by the economy-wide balance sheets in figure 4.1. There are six types of agents in the

\(^1\)Note that \( \frac{wN}{PK}PY = \frac{wN}{PY}PK = vu. \)
economy: households, firms, government, banks, the central bank and foreign agents. Though there has been a substantial movement towards disintermediation in the last decade, banks still dominate the financial system of industrialized countries regarding the allocation of capital between savers and investors by bank loans.²

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<tr>
<th>Households</th>
<th>Banks</th>
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<tr>
<td>Deposits</td>
<td>Deposits at Central Bank (Required Reserves)</td>
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<td>Domestic Government Bonds</td>
<td>Deposits</td>
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<td>Foreign Government Bonds</td>
<td>Loans to Firms</td>
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<td>Equities</td>
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<td>Net Worth</td>
<td>Domestic Government Bonds</td>
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<th>Firms</th>
<th>Central Bank</th>
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<tr>
<td>Capital Stock</td>
<td>Domestic Credit Component</td>
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<tr>
<td>( P_K K )</td>
<td>( H )</td>
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<tr>
<td>Loans from Banks</td>
<td>Deposits of Commercial Banks (Required Reserves, Interest-Free Bank Reserves)</td>
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<td>( D_{ba} )</td>
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<td>(High-Powered Money)</td>
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<td>Equities</td>
<td>( P_t (E_t + E) )</td>
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<th>Government</th>
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<tr>
<td>Net Worth (Negative)</td>
<td>Domestic Government Bonds</td>
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<tr>
<td>NW_{def}</td>
<td>( P_{so} (B_{so} + B_{on}) )</td>
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**Figure 4.1: Stylized Financial Structure in Industrial Countries**

There are seven sorts of assets being held by economic agents. The first sort are deposits conventionally held by households with banks. The second sort are domestic government bonds which are held by domestic households and banks. Foreign government bonds which constitute asset sort three are held only by households. Domestic and foreign government bonds are imperfect substitutes since domestic bonds are assumed to bear a risk premium reflecting the country’s risk of default. Firms’ capital stock, constituting asset type four, is partly financed by the issuance of equities, being asset sort five, which are held by households and banks. Commercial paper and corporate bond markets are neglected for reasons of simplicity, implying that credit is solely supplied by bank loans to firms, constituting asset type six, in order to finance the remaining part of the capital stock. Asset type seven is high powered money issued by the central bank, and held by commercial banks in the form of required reserves; in order to simplify the model, excess reserves held by banks are neglected. The central bank does not hold foreign reserves due to the flexible exchange rate system.

Assets and debts are priced at their current market or discounted present values, i.e. there is no distinction between book and market values. The real stock of bonds is

²For empirical data, see Mishkin (2000), p. 391.
denoted as $B_{xx}$, where the first subscript denotes whether bonds are Domestic or Foreign, and the second one denotes whether they are held by Households or by Banks. The real stock of equities is denoted as $E_x$, where the subscript denotes whether equities are held by Households or by Banks. The entire real stocks of equities and domestic government bonds are given as $E = E_H + E_B$ and $B = B_{DH} + B_{DB}$. Since bonds and equities are traded in official markets, they are quoted at their market prices $P_{xx}$ denoting the price of one real unit of bonds or equities in domestic or foreign currency, where the first subscript describes whether it concerns the price of Bonds or Equities; the second subscript distinguishes between Domestic or Foreign bond prices. Bond prices are inversely related to their interest rates. Nominal market values of equity and bond holdings are $P_{EH}E_H$ and $P_{EB}B_{xx}$. Foreign bonds are denoted in foreign currency, and stocks are multiplied by the exchange rate $s$.

Households hold their nominal net worth $NW_{HH}$ in the form of deposits $D$, domestic government bonds $P_{DB}B_{DH}$, foreign government bonds $sP_{FB}B_{FH}$ and equities $P_{EE}E_H$.

Firms finance the capital stock by issuing equities $E$ and taking loans $L$ from banks. It is assumed firstly, that equities cannot be traded internationally due to information asymmetries, and secondly, that the stock of equities $E$ does not vary in the short run, implying that new investment is financed internally by retained earnings, and predominantly externally by taking new loans which is highly compatible with the “credit view” of macroeconomic activity. The market value of the capital stock $P_KK$, where $P_K$ denotes the demand price of capital\textsuperscript{3}, is evaluated via the equity market and the amount of bank loans. As a result, the demand price of capital can be simply derived from firms' balance sheet identity as

$$P_K = \frac{L + P_EE}{K}.$$  

This definition assumes a zero net worth of firms, i.e. the equity price adjusts to bring the stock market into equilibrium.\textsuperscript{4}

Banks act as intermediaries between investors and savers. They create deposits as a multiple of the domestic credit component $H$, being equal to high powered money $M$ (monetary base), and supply loans to firms. Since cash is excluded from the model, demand for high powered money by commercial banks, being held as deposits at the central bank $D_{BA}$, stems from a required reserve ratio $\tau$ controlled by monetary authorities, being reflected in the money multiplier $m = 1/\tau$, where it holds that $D_{BA} = H = \frac{1}{m}D$.\textsuperscript{5} In an environment of financial liberalization and deregulation of domestic and international

\textsuperscript{3}For a definition of the demand price of capital, see appendix A.

\textsuperscript{4}This assumption can be found, for example, in Taylor (1985) and in Franke and Semmler (1994), whereas Taylor and O'Connell (1985) explicitly assume nonzero net worth because they argue that large outstanding levels of corporate net worth appear to be characteristic of modern capitalism. Allowing for net worth of firms would call for the introduction of an additional asset market equation, one determining $P_K$ and the other one $P_E$. After having determined the demand price and the equity price, net worth could be determined by the balance sheet identity. However, allowing for firms' net worth in the model would not change the basic results, and is therefore neglected.

\textsuperscript{5}A more sophisticated model which attaches greater weight on the money supply process should endogenize the money multiplier $m$ by the introduction of excess reserves, as for example in Bernanke and Blinder (1988). However, endogenizing $m$ does not change the model results significantly, and is neglected for reasons of simplicity.
capital markets, banks are also assumed to be allowed to hold corporate equities\textsuperscript{6} and government bonds. Though banks are allowed to engage in active asset management, empirical data show that banks' business is dominated by creating deposits and loans.\textsuperscript{7} Banks are assumed not to take loans in foreign currency.\textsuperscript{8} Banks' adding-up constraint

\[(1 - \tau)D + NW_{Ba} - PBEB - PDBBDB = L, \quad \text{where} \quad \tau D = D_{BA} = H,\]

shows that banks' inputs consist of deposits adjusted for required reserves, plus banks' net worth $NW_{Ba}$, less equity and bond holdings, which are used for the creation of loans.

The domestic and the foreign government issue bonds, held by households and banks, to finance their budget deficits. The market value of domestic bonds amounts to $PDBB$, and the market value of foreign bonds, denoted in foreign currency, $sPBFBFH$. The stocks of domestic and foreign government bonds are treated as exogenous in the model. The domestic government does not own any assets, resulting in a negative net worth, i.e. $NW_{Gov} < 0$.

Monetary policy takes the form of controlling the domestic credit component $H$ and the required reserve ratio $\tau$. The central bank does not use the exchange rate as a policy tool, i.e. there are no interventions in the foreign exchange market.

Private domestic wealth $W_P$ (central bank and government excluded), which is determined by consolidating the balance sheets of households, firms and banks in figure 4.1, is given by

\[W_P = NW_{HH} + NW_{BA} = PDBB + sPBFBFH + H + PKK,\]

that is, by the sum of households' and banks' net worth, consisting of domestic government bonds, foreign government bonds, base money and the nominal value of the capital stock since inside debt (loans and deposits) cancels out. Overall domestic wealth $W$, i.e. the sum of households', government's and banks' net worth, being determined by consolidating all entries in figure 4.1, is formally given by

\[W = NW_{HH} + NW_{BA} + NW_{Gov} = sPBFBFH + H + PKK,\]

i.e. by the sum of foreign government bonds, base money, and the nominal value of the capital stock.

### 4.2.2 Financial Market Equilibria

Economic models emphasizing the influence of balance sheet positions on aggregate economic activity generally use a standardized portfolio technique to determine asset prices and their influence on real sector variables. According to this standardized portfolio approach along the lines of Tobin and Brainard (1968), Tobin (1969), Tobin and Buiter\textsuperscript{6}\textsuperscript{6}For example, Japanese banks' portfolios contain large fractions of equities, making them very vulnerable to stock market volatility.

\textsuperscript{7}Empirical data for the U.S. banking system can be found e.g. in Mishkin (2000), p. 422, or in various issues of the Federal Reserve Bulletin.

\textsuperscript{8}Generally, in the wake of global financial deregulation and liberalization, banking sectors of reserve currency countries grant loans in domestic currency to emerging market and transition economies. Problems evolving from foreign debt in emerging market and transition economies are discussed in chapter 5.

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(1980), Taylor (1983, 1991), Franke and Semmler (1994, 1999), Frankel (1995), and Semmler (2003), private wealth, which is only held by households, is determined in a first step by consolidating balance sheets of all sectors except for the government and the central bank in order to eliminate inside debt, as e.g. bank loans or deposits. In a second step, households' asset excess demand functions are specified as a function of households' net worth and asset returns; all asset excess demand functions add up to households' net worth. Finally, in a third step, asset market equilibria, which determine asset returns and the behaviour of real sector variables, are specified by households' asset excess demand functions, and by asset supply stocks which are often assumed to be exogenous.

Though this standardized portfolio approach is a highly sophisticated tool to model the complex financial sphere of an economy, an application to the present financial model structure given in figure 4.1, which is predominantly designed to explain the evolution of financial crises, would be inappropriate for two reasons. Firstly, standardized portfolio approaches, as described above, assume that wealth is entirely held by households. Financial crises however, are characterized in most cases by net worth deficiencies and illiquidity of sectors other than households, which requires to consider not only households' net worth. If one follows the standard theoretical, as well as empirical literature on financial crises, especially net worth positions of the firm and the banking sector are important for the explanation of financial distress which do not exist by definition in a standardized portfolio approach. Secondly, standard approaches do not consider explicitly debt structures of different sectors, as e.g. firms' and banks' debt-asset ratio, since inside debt generally cancels out by consolidating private sector's balance sheets. Accordingly, as to standardized portfolio techniques, an economy's debt structure is assumed to be determined predominantly from households' portfolio decisions and not by the interaction of the firm and the financial sector. Yet, empirical data have shown that especially the debt-structure and the liquidity status of firms and banks, resulting on the one hand from firms' investment decisions, and on the other hand from financial intermediaries' risk perceptions as to the expansion of credit, play a dominant role in the propagation of financial crises. In order to overcome these drawbacks of standard portfolio techniques, the financial structure given in figure 4.1 is transformed into four financial market equilibria equations, containing all seven sorts of assets, as in an extended IS-LM model, where banks' and firms' liquidity and solvency status is explicitly considered. As opposed to standard portfolio techniques, the resulting financial market equilibria equations do not correspond exactly to the financial structure given in figure 4.1, but represent a realistic approximation with special emphasis on liquidity and net worth positions.

The equilibrium condition in the market for deposits normalized by the numéraire $PK$ reads as

$$ mh = d(u, \hat{p}, i - \hat{p}, r + \rho), $$

(4.4)

where the left hand side denotes deposit supply by banks, and the right hand side deposit demand by households. Deposit supply by banks is a multiple of normalized base money $h = H/(PK)$, where $m = 1/\tau$ denotes the money multiplier. The term $1/h = PK/H$ is the "velocity" of base money with respect to the nominal value of the capital stock. Normalized deposit demand $d(\cdot) = D(\cdot)/PK$ by households is assumed to arise from two main sources. Firstly, since cash is excluded from the model, deposit demand stems from transaction purposes depending positively on capacity utilization $u$. Secondly, according to the financial structure given in figure 4.1, deposits are a part of households' net worth.
$NW_{HH}$ which can be split among deposits, equities, domestic and foreign government bonds. Accordingly, as to portfolio considerations, deposit demand varies positively with its own return, and negatively with the returns of other assets. Since deposits are assumed to bear no interest, the real return of holding deposits is negatively dependent on the price level's growth rate $\bar{\rho}$. Hence, ceteris paribus, households flee from deposits in case of inflation and increase deposit demand in case of deflation. The negative dependence of deposit demand $d(\cdot)$ on the real interest rate on domestic government bonds $i - \bar{\rho}$, where $i$ denotes the nominal interest rate on domestic government bonds which is determined by the nominal interest rate on foreign government bonds $i^*$ according to a risk adjusted interest rate parity condition being analyzed below, can be interpreted as the traditional "speculative" demand for money or deposits, respectively. The negative dependence of $d(\cdot)$ on the expected profit rate $r^e = r + \rho$ on capital, being equivalent to the expected return of holding equities, where $\rho$ denotes the "state of confidence" representing the difference between the expected and the actual profit rate, states that households shift their portfolios from deposits into equities in case the expected profit rate increases.

The formation of profit expectations is assumed to cover the entire time horizon of capital goods' life cycle. Consequently, the state of confidence parameter $\rho$ represents the state of long-term profit expectations which can be interpreted as an expected average value over a longer time horizon reflecting investors' "animal spirits" which can vary substantially over the business cycle. In case the state of confidence is positive, i.e. $\rho > 0$, agents expect a higher profit rate in the future than today's actual profit rate, i.e. it holds that $r^e > r$. In case the state of confidence is negative, i.e. $\rho < 0$, agents expect a lower profit rate in the future than today's actual profit rate, i.e. it holds that $r^e < r$. In case the state of confidence is zero, i.e. $\rho = 0$, agents expect the actual profit rate to prevail in the future, i.e. it holds that $r^e = r$. This long-term view on profit expectations explicitly takes into consideration that capital goods are long living and often irreversible, implying that investment is not only exposed to "normal" risk which can be captured by some objective or subjective probability distributions, but is additionally exposed to some "real" risk which cannot be foreseen and which is also very volatile over the business cycle. This kind of uncertainty as to the formation of expectations in the present model implies the invalidity of the rational expectations hypothesis in its strict form at least in the short-run, since the application of the rational expectations in the present case would not allow profit expectations to differ from the actual profit rate except for the case of random, exogenous shocks. However, in order to describe business cycles, as well as financial crises as expectations-driven events, business confidence has to vary

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9 Explaining business cycle fluctuations predominantly by variations of expectations and business confidence has a long tradition in economic theory. The asymmetry of the upswing and the downswing, i.e. steady improving real and financial variables during the upturn, and sudden reversals first in financial, and then in real variables at the beginning of the downturn, is generally explained by the instability of business confidence as emphasized e.g. by Hawtrey (1926) 1950), Keynes (1936), Lavington (1921) and Minsky (1972, 1975, 1977, 1978, 1980b, 1982a, 1982b, 1986). For this overview see also Flaschel, Franke and Semmler (1997), p. 421. For a more general overview of the role of business confidence during different stages of the business cycles, see Boyd and Blatt (1988).

considerably over the business cycle, since otherwise, business cycles and financial crises would be modelled as events induced by random exogenous shocks and not by endogenous mechanisms.\textsuperscript{11} In the following analysis, the state of confidence $\rho$ is going to be one of the main driving forces of business cycles and financial crises, being treated as a parameter in the comparative-static analysis, and as an endogenous variable in the dynamic version of the model.

Though households are assumed to adjust deposit demand $d(\cdot)$ inversely to variations in the price level’s growth rate $\hat{p}$ due to the direct negative influence of the real return on deposits, the overall impact on deposit demand is not clear due to an indirect, but counteracting force by the real interest rate on domestic government bonds $i - \hat{p}$. For example, in case of inflation, households reduce on the one hand deposit demand owing to the direct effect of $\hat{p}$ on $d(\cdot)$, but at the same time increase deposit demand due to the indirect but positive effect of a decreasing real interest rate on government bonds $i - \hat{p}$ on $d(\cdot)$. Though the theoretical as well as the empirical literature is not very clear about the overall influence of the price level’s growth rate on deposit demand, denoted as $\partial d / \partial \hat{p}_a$ in the model, it is assumed that the overall impact of $\hat{p}$ on $u$ is positive, i.e. households reduce their money holdings in case of deflation and increase money holdings in case of inflation. Formally, it holds that

$$\frac{\partial d}{\partial \hat{p}_a} = \frac{\partial d}{\partial \hat{p}} + \frac{\partial d}{\partial (i - \hat{p})} \frac{\partial (i - \hat{p})}{\partial \hat{p}} = \frac{\partial d}{\partial \hat{p}} - \frac{\partial d}{\partial (i - \hat{p})} > 0,$$

stating that the indirect influence of $i - \hat{p}$ on $d(\cdot)$ is larger than the direct influence of $\hat{p}$ on $d(\cdot)$.

The international market for government bonds is characterized by imperfect capital mobility due to the existence of a risk premium $\rho$ on domestic government bonds, implying a divergence from uncovered interest parity (UIP). Assuming the absence of capital controls and instantaneous portfolio adjustments, equilibrium in the international market for government bonds is given by risk adjusted UIP, formally

$$i = i^* + \hat{s e} + \rho,$$

stating that the nominal domestic government bond rate $i$ equals the nominal foreign government bond rate $i^*$, adjusted for expected exchange rate changes $\hat{s e} = \hat{s e} / s$, and for the risk premium $\rho$. The risk premium $\rho$ is assumed to reflect on the one hand domestic government bonds’ risk of default, but, on the other hand, also a general country risk premium since financial distress in the private sector, caused by real or financial disruptions, leads to financial problems (illiquidity or even insolvency) in the government sector. For example, private sector induced financial distress in the government sector can be caused by extraordinary expenditures resulting from bailing out troubled financial intermediaries by capital injections, or from compensating depositors being covered by deposit insurance systems. Furthermore, in case of private sector financial distress, tax revenues are subject to sharp declines leading very quickly to liquidity problems of the government.

\textsuperscript{11}A critical assessment of the model results in comparison with standard business cycle and financial crises theories with special emphasis on the controversy over their exogenous or endogenous nature is outlined in chapters 4.5 and 4.6.
Regarding the determinants of exchange rate expectations and risk premia, standard macroeconomic models often assume them to be exogenous variables or parameters. Yet, financial crises are characterized by sudden and large changes both in the exchange rate’s expected growth rate and in the risk premium, being caused by a sudden revelation of aggregate financial distress stemming from adverse real or financial sector problems. Thus, as opposed to standard models, the explanation of financial crises has to consider both $\hat{s}e$ and $rp$ as endogenous variables depending on real and/or financial sector variables. Owing to the existence of imperfect foresight in the present model, exchange rate expectations and risk assessments are subject to the same uncertainty as profit expectations, since future exchange rate movements or changes in country risk are determined by future real and financial sector developments which cannot be foreseen perfectly. As a result, the formation of exchange rate expectations and risk assessments cannot be modelled according to the rational expectations hypothesis, but have to rely on other determinants. Since rational expectations cannot be applied in the present case, and the theoretical as well as the empirical literature is not very clear about the factors determining exchange rates and risk premia, the model assumes that changes in $\hat{s}e$, as well as in $rp$ are determined by the state of confidence parameter $\rho$ representing a “catch all” variable, providing information for the “strength” or “weakness” of the domestic economy’s financial status. Modelling $\hat{s}e$ and $rp$ as dependent variables of $\rho$ implies that domestic and foreign investors have the same interpretation of $\rho$. If $\rho > 0$, domestic and foreign investors believe in the “strength” of the domestic economy, leading on the one hand to a reduction in the risk premium due to expected improvements in the overall liquidity and solvency status of the private and the government sector, and on the other hand to depreciation expectations of the exchange rate in the long-run due to increasing credibility in the domestic currency, being based on the belief that a high performance country yields either future current account surpluses due to high profitability (which can compensate current current account deficits), or enjoys large capital inflows leading to a future capital account surplus. If on the other hand, $\rho < 0$, domestic and foreign investors are very pessimistic about the performance of the domestic economy, leading to an increase in the risk premium and to devaluation expectations due to lacking credibility in the domestic currency, based on the belief that low profitability leads to future current account deficits and to capital account deficits caused by capital outflows. As a result, risk adjusted UIP can be formulated as

$$i = i^* + \beta(\rho),$$

stating that in case $\rho > 0$, implying $\beta(\rho) < 0$ (lower or even negative risk premium and depreciation expectations of the exchange rate), it holds that $i < i^*$, in case $\rho < 0$, implying $\beta(\rho) > 0$ (higher positive risk premium and appreciation expectations of the exchange rate), it holds that $i > i^*$, and in case $\rho = 0$, implying $\beta(\rho) = 0$, it holds that $i = i^*$.

Equity market equilibrium determining share prices $P_E$ can be formally described by the condition

$$P_EE = Ed(u, \hat{p}, i - \hat{p}, r + \rho),$$

where the right hand side represents the nominal demand for equities $Ed(\cdot)$, and the left hand side the supply or the market value of equities, where the nominal stock of equities $E$ is assumed to be constant. Nominal demand for equities $Ed$ can be assumed to be
predominantly influenced by households’ portfolio choices, i.e. by the same determinants as households’ demand for deposits in equation 4.4. As a result, nominal demand for equities can be modelled as being negatively dependent on capacity utilization, positively dependent on the inflation rate, negatively dependent on the real interest rate on bonds, and positively dependent on the expected profit rate. The level of share prices $P_E$ is of special importance in the model since aggregate investment is assumed to depend on general stock market conditions according to Tobin’s $q$ theory of investment.\footnote{See appendix A for a detailed discussion on Tobin’s $q$-theory of investment.} Tobin’s $q$ in its original version is defined as the ratio of the market value of existing capital goods valued at the demand price of capital $P_K$ to reproduction costs of new capital goods valued at the supply price of capital being equivalent to the general price level $P$, i.e. it holds that $q = P_K / P$. General stock market conditions, i.e. the level of share prices $P_E$, and the level of Tobin’s $q$ are linked by firms’ balance sheet identity according to figure 4.1, defining the demand price of capital as $P_K = (L + P_E E) / K$ under the assumption of zero net worth of firms. According to this definition, the demand price of capital $P_K$ is determined by the stock of loans $L$, by the nominal stock of equities $E$, by the equity price $P_E$, and by the real value of the capital stock $K$. However, since the nominal stock of equities $E$ and the real capital stock $K$ are assumed to be constant, and the nominal stock of loans $L$ is treated as a parameter, the equity price $P_E$ can be implicitly determined by the the demand price of capital $P_K$. Consequently, equity market equilibrium and share prices $P_E$ can be subsumed under the equilibrium condition in the market for real capital determining the demand price of capital $P_K$.\footnote{This procedure, as e.g. applied by Tobin (1969), has been chosen for reasons of simplicity since the explicit consideration of both the market for equities and the market for real capital would have called for an additional asset market equation, and for the explicit consideration of firms' net worth. For an explicit consideration of the equity market equilibrium, see Taylor and O’Connell (1985), Semmler and Franke (1994), and Flaschel, Franke and Semmler (1997).} Formally, the equilibrium condition in the market for real capital can be stated as

$$P_K K = K^d(u, \hat{p}, i - \hat{p}, r + \rho),$$

where the left hand side represents the capital stock valued at the demand price of capital implying thereby a certain market value of equities, and the right hand side the nominal demand for the real capital stock $K^d(\cdot)$ implicitly containing the demand for equities. Since the demand for equities corresponds to the demand for real capital, nominal demand for real capital $K^d(\cdot)$ depends on the same variables as equity demand $E^d(\cdot)$. Dividing both sides of the real capital market equilibrium by the numéraire $P_K$ yields a modified equation determining Tobin’s $q$ as

$$q = \frac{P_K}{P} = \frac{1}{P_K} K^d(u, \hat{p}, i - \hat{p}, r + \rho).$$

This version of Tobin’s $q$ however, is only of limited applicability to the present model owing to additional partial derivatives whose magnitudes in relation to other partial derivatives can be only specified by restrictive assumptions. In contrast to the equilibrium condition in the market for real capital, Tobin’s $q$ can be determined alternatively in a much simpler way along the lines of Tobin’s original version (see appendix A) as the ratio
of the gross profit rate on capital to a risk adjusted real interest rate investors demand for holding capital assets. In the present model, the “gross” version of Tobin’s \( q \) could be expressed as

\[ q_g = \frac{r_g + \rho}{j - \bar{p}}, \]

stating that \( q_g \) is the ratio of the expected gross profit rate to the real interest rate on bank loans (to be determined below) which constitutes the risk adjusted interest rate banks demand for granting loans being invested in capital assets by firms. The correct version of Tobin’s \( q \) would call for the use of the expected real interest rate on bank loans, which would require the introduction of inflation expectations. Still, it can be shown in the dynamic analysis that expectations regarding the change of the price level are already incorporated in the state of confidence parameter \( \rho \). The gross version of Tobin’s \( q \) however, is only of limited interest for the present model since it does not consider firms’ debt-asset structure by neglecting external finance costs, i.e. the liquidity as well as solvency position of firms are assumed not to have any influence on the market valuation of the capital stock. Thus, taking explicitly into consideration firms’ financial structure containing interest payments on debt requires the use of the expected net profit rate \( r + \rho \), transforming the original “gross” version of Tobin’s \( q \) into a “net” version being expressed as

\[ q = \frac{r + \rho}{j - \bar{p}}. \]

For reasons of analytical tractability, this net version of Tobin’s \( q \) can be restated in a much simpler linearized form\(^{14}\), being used in the present model as

\[ q = r + \rho - (j - \bar{p}). \quad (4.6) \]

This net version of Tobin’s \( q \) is both an indicator for the liquidity position and for the solvency position of business firms. The liquidity status of the firm sector is measured via the influence of \( r \) on \( q \). Illiquidity in the present model would mean that earnings fall short of expenses, causing \( r \) to become negative and causing \( q \) to decrease, or even to become negative as well. Liquidity problems can emanate both from negative real sector shocks and from financial market disruptions. Negative real sector shocks, as e.g. a large drop in capacity utilization \( u \) caused by a sudden drop in aggregate demand, lead to a large drop in earnings and in \( r \), causing Tobin’s \( q \) to fall. By way of contrast, negative financial market shocks, indicated by a sharp increase in the loan rate \( j \), lead on the one hand to an indirect reduction in \( q \) via a reduction in \( r \) due to rising debt costs, and on the other hand, to a direct reduction in \( q \) via an increase in \( j \). The solvency status is directly measured by the level of Tobin’s \( q \), i.e. by the level of the demand price of capital \( P_K \) at a given price level \( P \). Solvency difficulties arise from a decreasing demand price of capital \( P_K \) (for a given \( P \)), i.e. from decreasing equity prices. In case the capital stock valued at the demand price of capital falls short of the nominal value of loans \( L \) the firm sector is bankrupt.\(^{15}\) Tobin’s \( q \) also shows that solvency problems, i.e. a fall in \( q \), can arise from liquidity problems, i.e. from a drop in \( r \), from sharp drops

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\(^{14}\)For the use of a linearized version of Tobin’s \( q \), see e.g. Taylor and O’Connell (1985), and Taylor (1991), chapters 5 and 6.

\(^{15}\)According to the financial structure given in figure 4.1, this definition of bankruptcy, i.e. negative net worth, corresponds to a theoretical situation with negative equity prices being not possible in reality.
in long-term expectations $\rho$, and from declines in $\dot{\rho}$ (especially in deflationary periods), all factors causing $q$ to fall. Liquidity problems stemming from solvency problems cannot be directly derived from the definition of Tobin’s $q$ and require an explicit consideration of the transmission mechanisms between the real and financial sphere of the economy. For example, a sudden drop in the state of confidence $\rho$ leading quickly to solvency problems, i.e. to a fall in $q$, lead with a time lag to a fall in aggregate demand via a reduction in investment demand according to equation 4.1, causing liquidity problems by reduced earnings and a declining profit rate $r$, deteriorating solvency problems by a further reduction in $q$. As a result, once solvency and liquidity problems come into being, they tend to reinforce themselves by a cumulative downward process. By way of contrast, improving solvency and liquidity positions lead to a cumulative upward trend with steady increasing stock market valuations and ameliorating liquidity positions. Summing up, liquidity and solvency problems indicated by a drop of Tobin’s $q$ can be caused by a fall in $r$, a fall in $\rho$, an increase in $j$ or by a fall in $\dot{\rho}$. Since changes in $r, \rho, j$ and $\dot{\rho}$ alter the liquidity and the solvency status of the firm sector, Tobin’s $q$ also has a deep influence on credit market conditions. According to the theory of imperfect capital markets, business firms’ access to credit market depends crucially on the collateral value measured by the capital stock valued at the demand price of capital, and on their general liquidity position. Consequently, Tobin’s $q$ is also an important indicator for relaxing or tightening credit market conditions.

Apart from being an indicator for liquidity, solvency, and credit market conditions, Tobin’s $q$, in its form as the sole determinant of the investment function by equation 4.1, also captures the fact that investment decisions in the model both have a medium-run and a long-run perspective. The medium-run perspective may relate e.g. to a time period of up to three years in reality, whereas the long-run perspective refers to the entire lifetime of capital. In the medium-run, investment demand is assumed to be mainly determined by overall goods market demand, because firms attempt to have a “normal” capacity utilization. A positive dependence of investment on capacity utilization calls for an accelerator type investment function which is reflected in the model by the indirect positive effect of capacity utilization on Tobin’s $q$ via a positive effect on the profit rate. That is, higher capacity utilization $u$ leads to an increase in the profit rate $r$ by equation 4.2, inducing a rise in Tobin’s $q$ by equation 4.6, and a further rise in capacity utilization $u$ via an increase in investment demand $\eta(q)$ according to equation 4.1. As a result, this medium-run perspective on the investment function also reflects the fact that the model is subject to self-reinforcing upward and downward processes in the real and in the financial sector. The long-run perspective on investment demand is represented by a positive dependence of investment demand on the “state of confidence” parameter $\rho$ via Tobin’s $q$, reflecting long-run profit expectations which are going to be endogenized in the dynamic version of the model, and leading to endogenous business cycles due to accelerations and

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However, in practice, economic units are often defined as bankrupt in case net worth falls below some positive lower limit which corresponds to positive or zero equity prices being a realistic scenario. In terms of the model, there is no exact definition of bankruptcy in terms of equity prices since the equity market has been subsumed under the market for real capital. One possible definition of bankruptcy which is used in the following, corresponding to negative net worth in reality, is a negative value of the linearized version of Tobin’s $q$ according to equation 4.6 in case the expected profit rate falls short of the real loan rate, i.e. in case it holds that $r + \rho < j - \dot{\rho}$, implying $q < 0$. 

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decelerations of the inherent cumulative processes during different stages of the business cycle.\textsuperscript{16} The explicit consideration of the loan market is consistent with “credit view” of macroeconomic activity. In its strict version, the credit view assumes that monetary policy is able to influence the availability of bank loans directly and instantaneously. Nevertheless, loans are generally designed as medium-term or even long-term contracts which cannot be adjusted instantly.\textsuperscript{17} Taking into consideration that the entire stock of loans can be adjusted only with some time lags, it is assumed that the stock of loans $L$, or in terms of the numéraire, the debt-asset ratio $\lambda = L/(PK)$, is predetermined in the short run. As a result, banks are assumed to satisfy, at least in the short-run, completely loan demand by firms $L^d$ which is equivalent to the current stock of loans $L$, i.e. it holds that $L^d = L$. In terms of the numéraire, firms’ “warranted” or demanded debt-asset ratio $\lambda^d$ is equivalent to the actual debt-asset ratio $\lambda$ which is satisfied by banks, i.e. it holds that $\lambda^d = \lambda$. In terms of the model, the fact that the stock of loans is predetermined in the short-run and can be only adjusted with some time lags, is considered by treating the debt-asset ratio $\lambda$ as a parameter in the comparative-static version of the model, whereas the long-run dynamic analysis allows for changes in the debt-asset ratio by endogenizing $\lambda$, where banks have a strong influence on the stock of loans.

The fact that banks are assumed to satisfy entire demand for loans of firms at least in the short-run does not imply that banks’ loan supply $L^s$ is only dependent on firms’ loan demand. By way of contrast, banks’ supply of loans $L^s$, or in terms of the numéraire, banks’ “warranted” supply of the debt-asset ratio $\lambda^s$, depends on various determinants in the model which are going to be analyzed below. Consequently, the equilibrium condition in the loan market in terms of nominal loan values reads as

$$L = L^s,$$

where the left hand side denotes the current stock of loans $L$, being equivalent to firms’ loan demand $L^d$, and the right hand side the warranted supply of loans by banks $L^s$. Dividing both sides of the equilibrium condition by the numéraire $PK$, and considering explicitly loan supply determinants, yields the loan market equilibrium in terms of the debt-asset ratio as

$$\lambda = \lambda^s(m_h, j - \hat{p}, q, \alpha),$$

where $\lambda^s(\cdot) = L^s(\cdot)/(PK)$ is the “warranted supply of the debt-asset ratio” by banks, and $\lambda$ the actual or demanded debt-asset ratio by firms. According to equilibrium condition 4.7, banks’ warranted supply of the debt-asset ratio $\lambda^s(\cdot)$ is assumed to depend on four determinants. Firstly, according to money multiplier theory, $\lambda^s(\cdot)$ is positively dependent on the the amount of normalized deposits $m_h$.\textsuperscript{18} Secondly, normalized loan supply $\lambda^s(\cdot)$ is positively dependent on the real interest rate on bank loans $j - \hat{p}$ because a higher loan rate on an existing level of loans increases banks’ profits. Thirdly, normalized loan

\textsuperscript{16}For a similar type of investment function, see Flaschel, Franke and Semmler (1997), chapter 12.

\textsuperscript{17}Even credit lines which can be adjusted each day as stipulated, can be viewed as a, at least, medium-term financial agreement.

\textsuperscript{18}The influence of the deposit amount on the loan amount, as well as its theoretical foundation can be found in almost every textbook on monetary macroeconomics. See e.g. Bofinger, Reichle, Schächter (1996), or Jarchow (1998), chapters III.2 and III.3.
supply depends positively on Tobin’s $q$, reflecting firms’ liquidity and collateral position and being an indicator for firms’ risk of default. Furthermore, Tobin’s $q$ is also used as an indicator for banks’ solvency and liquidity position which are important determinants for overall loan supply according to national and international regulation standards, as e.g. the Basel II agreement which requires each bank to assess the risk of each individual debt and asset contract, obliging it to provide sufficient collateral in the form of net worth depending on the degree of risk. Thus, deteriorating liquidity and solvency positions among firms require a higher net worth of banks which, in times of recessions, can be only achieved by withdrawing risky loans, leading very often to illiquidity and insolvency of debtors, and further deteriorating the aggregate liquidity and solvency status. As a result, the liquidity and solvency dependent availability of credit tends to accelerate upswings as well as downswings by a procyclical variation in the amount of credit, being designated as the financial accelerator mechanism which has been described in section 2.2.2.2. Approximating banks’ liquidity and solvency position by firms’ Tobin’s $q$ can be justified by the fact that the liquidity and solvency position of firms, which is heavily influenced by the interest rate on loans $j$, determine the amount of non-performing loans, and thereby banks’ profits, liquidity and solvency. Furthermore, since banks are allowed, in the wake of global financial liberalization, to hold more risky assets like e.g. equities, gains and losses in the market for real capital influencing banks’ net worth can be captured by Tobin’s $q$. Summing up, a rising Tobin’s $q$ coincides with rising net worth and liquidity positions of banks, leading to an increase in the supply of loans. Fourthly, the intensity of financial market regulation (interest rate caps or quotas on the loan supply, etc.) determines the amount of loans supply which is captured by a negative dependence of $\lambda^*(\cdot)$ on parameter $\alpha$, i.e. deeper financial market regulation is indicated by an increase in $\alpha$ lowering normalized loan supply $\lambda^*$.

Loan market equilibrium is assumed to be achieved by variations in the nominal loan rate $j$. For example, a larger amount of deposits $mh$ caused by expansionary monetary policy, an increase in $q$ caused by an increase in the state of confidence $\rho$, or a decrease in the regulation parameter $\alpha$ cause an excess supply of loans leading to a decrease in the price of loans $j$, and thereby to a reduction in the supply of loans until the market is in equilibrium again.

### 4.3 Short-Run Comparative-Static Analysis

#### 4.3.1 General Results

The macromodel consists of equations 4.1 to 4.7, containing seven endogenous variables $\bar{s}, q, \bar{p}, r, u, i$ and eight parameters $\lambda, \rho, m, h, v, \delta, \alpha, \alpha^*$, with $\alpha^*$ being a normalization parameter. Finding the partial derivatives of all endogenous variables with respect to all parameters requires the transformation of the set of simultaneous equations into the following form.
Transforming equations 4.1 to 4.7 into the required form yields the new system

\begin{align*}
F_1 &= u - \eta(q) - g(i - \hat{p}) - nx(\hat{s} - \hat{p}) = 0 \quad (4.8) \\
F_2 &= r - u(1 - v) + \delta + j \lambda = 0 \quad (4.9) \\
F_3 &= \hat{p} - \psi(u - u^*) = 0 \quad (4.10) \\
F_4 &= mh - d(u, \hat{p}, i - \hat{p}, r + \rho) = 0 \quad (4.11) \\
F_5 &= i - i^* - \beta(\rho) = 0 \quad (4.12) \\
F_6 &= q - r - \rho + \hat{p} = 0 \quad (4.13) \\
F_7 &= \lambda - \lambda^*(mh, j - \hat{p}, q, \alpha) = 0 \quad (4.14)
\end{align*}

Since not all functions are explicitly defined, one has to show firstly that the model can be solved in principle for all endogenous variables by using the implicit-function theorem. It can be shown that the system consisting of equations 4.8 to 4.14 satisfies the conditions of the implicit-function theorem, because (1) \(F_1, \ldots, F_7\) have continuous derivatives (since all the component functions have continuous derivatives by assumptions) with respect to all endogenous variables and with respect to all parameters, and (2) the determinant of the Jacobian matrix with respect to all endogenous variables when evaluated at the initial equilibrium (which is assumed to exist), as well as elsewhere is nonzero, which is going to be examined below.

After having shown that the system can be solved in principle for all endogenous variables, even if it may be not possible to obtain the solution in an explicit form, the partial derivatives of system 4.8 to 4.14 can be found by solving the following system of simultaneous equations

\[ J \cdot v = z \]

for \(v\), where \(J\) denotes the Jacobian matrix of the system 4.8 to 4.14 with respect to all endogenous variables, \(v\) the vector of differentials of all endogenous variables, and \(z\) the vector of differentials with respect to all parameters. Explicitly defined, the system reads
where partial derivatives are denoted as \( x_i = \partial x / \partial i \); for example, \( \lambda_{j-\hat{p}} = \partial \lambda^s / \partial (j - \hat{p}) \) denotes the partial derivative of \( \lambda^s \) with respect to \( j - \hat{p} \).

The determinant of the Jacobian matrix of system 4.15 is given by

\[
|J| = -nx_{j-\hat{p}}(d_{r+\rho}(\lambda_{j-\hat{p}} - \lambda_q^s)(-1 + v + \lambda \psi_u) - (\lambda_{j-\hat{p}} - (1 + \lambda)\lambda_q^s)(d_u + d_{\rho u} \psi_u)).
\]

The sign of the determinant can be shown to be positive under the following four assumptions. Firstly, banks' reaction on variations of the real interest rate on loans \( j - \hat{p} \) with respect to loan supply is much larger than their reaction on variations of Tobin's \( q \), formally \( \lambda_{j-\hat{p}} \gg \lambda_q^s \). Taking into consideration firms' balance sheet identity having been normalized by the numéraire, and reading as

\[
\begin{align*}
\frac{P_K K}{P K} &= L + P_B E \\
q &= \lambda + \frac{P_B E}{P K},
\end{align*}
\]

it can be argued that an increase in the normalized collateral value \( q \) by a definite amount \( x \), being e.g. caused by an increase in the equity price \( P_E \), induces banks to increase the asset-debt ratio maximally by the same amount \( x \) implying that a value of \( \lambda_{j-\hat{p}} = 1 \) is a realistic assumption, stating that loan supply can only be increased to that amount to which collateral increases. However, it is reasonable to assume that e.g. an increase in the real interest rate on bank loans of one percentage point increases banks' supply of loans more than one percent, i.e. a realistic value is \( \lambda_{j-\hat{p}} \approx 1 \). Secondly, a realistic value for the asset-debt ratio is \( 0 < \lambda < 1 \). Values of \( \lambda < 0 \) are not possible because in that case firms own claims against the banking sector, whereas values of \( \lambda > 1 \) are possible, which are however ruled out since they correspond to bankruptcy of the entire firm sector which is a very unrealistic scenario. Thirdly, the reaction of inflation with respect to changes in capacity utilization is assumed to be a very small number \( \psi_u \ll 1 \) because an increase of one percent in capacity utilization leads only to a very small increase
in inflation, being much lower than one percentage point. Fourthly, economic agents’ reaction of money demand with respect to capacity utilization is assumed to be larger in absolute terms than their money demand reaction with respect to the expected profit rate, i.e. $|d_u| > |d_{r+p}|$. Using these assumptions and taking into consideration that $v < 1$, the signs of the different parts of the determinant of the Jacobian matrix are as follows

$$
\lambda_{j-\beta}^s - \lambda_q^s > 0, \quad \lambda_{j-\beta}^s - (1 + \lambda)\lambda_q^s > 0, \quad (-1 + v + \lambda\psi_u) < 0, \quad (d_u + d_{\phi}\psi_u) > 0,
$$

resulting in

$$
|(d_{r+p}(\lambda_{j-\beta}^s - \lambda_q^s)(-1 + v + \lambda\psi_u))| < |(\lambda_{j-\beta}^s - (1 + \lambda)\lambda_q^s)(d_u + d_{\phi}\psi_u)|,
$$

and thereby leading to a positive sign of the determinant of the Jacobian, i.e. it holds that

$$
|J| > 0.
$$

The partial derivatives of all endogenous variables with respect to all parameters can be found by using Cramer’s rule, or by finding the inverse matrix. Table 4.1 represents a synopsis of the signs of all partial derivatives. All partial derivatives are explicitly given in section 4.7.

**Table 4.1: Signs of Qualitative Impact Effects on Temporary Variables**

<table>
<thead>
<tr>
<th>Response in</th>
<th>$u$</th>
<th>$r$</th>
<th>$\hat{p}$</th>
<th>$q$</th>
<th>$j$</th>
<th>$i$</th>
<th>$\hat{s}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-\textsuperscript{5}</td>
</tr>
<tr>
<td>$\rho$</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+\textsuperscript{5}</td>
</tr>
<tr>
<td>$h$</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>0</td>
<td>+\textsuperscript{5}</td>
</tr>
<tr>
<td>$m$</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>0</td>
<td>+\textsuperscript{5}</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>$i$\textsuperscript{*}</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+\textsuperscript{5}</td>
<td></td>
</tr>
<tr>
<td>$v$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>$\delta$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

\textsuperscript{5}: Explicit sign ambiguous, i.e. $\lambda \geq 0$ (see section 4.7). Signs in table chosen by assumption.

Though most of the partial derivatives have got an unequivocal sign there are various counteracting forces and different interdependencies behind each partial derivative owing to the complex model structure. Therefore, the following qualitative description of an exogenous increase in each parameter highlights only the most important and most influential transmission channel within the model for each case, and is definitely not complete.

A rise in indebtedness $\lambda$ lowers according to equation 4.2 the profit rate on capital $r$, leading to a decline in Tobin’s $q$ according to equation 4.6. A decrease in $q$ lowers the growth rate of the capital stock $\eta(q)$ and capacity utilization $v$ according to equation 4.1 which leads to a further decline in $r$ and in $q$ according to equations 4.2 and 4.6. A decline in $q$ lowers firms’ net worth and banks’ profits which induces banks to demand a higher loan rate $j$ as a compensation for a higher credit risk according to equation 4.7, which
leads to a further decline in $r$ and $u$. Decreasing capacity utilization leads according to equation 4.3 to lower inflation $\dot{p}$, or even to deflation. This decreasing inflation or deflation effect has an additional dampening effect on capacity utilization via an increase in the real interest rate on government bonds $i - \dot{p}$, which induces a reduction in government spending $g(i - \dot{p})$. Yet, a lowering value of $\dot{p}$ has also a stimulating effect on $u$ via an increasing real exchange rate $\dot{s} - \dot{p}$, stimulating net exports $nx$ which could increase $u, r, q$ and lower $j$. In equilibrium however, the initial stimulation of $nx$ is going to be completely compensated by a depreciation of the exchange rate, or equivalently by an appreciation of the home currency, i.e. by a decrease in $\dot{s}$. The reason for the exchange rate compensating the initial price effect stems from the fact that the capital account is zero in equilibrium due to the UIP assumption according to equation 4.5, requiring the current account also to take a zero value in equilibrium. A balanced current account in the present model can only be reached in case the exchange rate offsets the initial price effect because there is no dependence of $nx$ on $u$ like in the standard Mundell-Fleming model. In the case considered above, a decreasing value of $\dot{p}$ increases net exports leading to an excess supply of foreign currency which causes the exchange rate to depreciate as long as external equilibrium is restored. As it is indicated in table 4.1, especially the signs of the exchange rate’s rate of change cannot be determined unequivocally (see section 4.7). However, since the signs of the price level’s rate of change $\dot{p}$ are unambiguous, the sign of the exchange rate’s rate of change must be the same like for $\dot{p}$ due to the fact that the current account must be balanced in equilibrium. Summing up, the overall effect of an increasing value of $\lambda$ is a decrease in $u, \dot{p}, r, q, \dot{s}$ and an increase in $j$. The overall impact of $\lambda$ on the domestic interest rate on government bonds is zero because, according to equation 4.5, $i$ only depends on parameters $i^*$ and $\rho$ in the model. Thus, $i$ only reacts on changes in $i^*$ and $\rho$ and otherwise not.

A rise in the state of confidence parameter $\rho$ acts directly in the opposite way as an increase in indebtedness $\lambda$ with respect to $u, r, q, \dot{p}$ and $j$. An increase in $\rho$ raises Tobin’s $q$ according to equation 4.6, thereby stimulating the growth rate of investment demand $\eta(q)$ and capacity utilization $u$ according to equation 4.1 which leads to an increase in the profit rate $r$ according to equation 4.2. As to credit market conditions, a rising $q$ increases firms’ collateral and banks profits, resulting in a decline in the interest rate on bank loans $j$ inducing a further rise in $r, q$ and $u$. According to equation 4.3, the rise in $u$ leads to an increase in the growth rate of the price level $\dot{p}$. Since the expected growth rate of the exchange rate depends negatively on $\rho$, a rise in $\rho$ causes an appreciation expectation of the home currency, i.e. $\dot{s}^e < 0$, which firstly leads temporarily to capital inflows and to an actual appreciation of the home currency. According to equation 4.5, expected appreciation of the home currency and capital inflows very quickly lead to a lower domestic interest rate on government bonds $i$ in order to restore UIP. Inflation and appreciation of the home currency reduce net exports $nx$ temporarily but in order to restore a balanced current account in final equilibrium, the domestic currency has to devalue, i.e. $\dot{s} > 0$, since the temporary current account deficit leads to an excess supply of home currency, and therefore to a devaluation of the home currency in the final equilibrium.

An increase in normalized high-powered money $h$, as well as an increase in the money multiplier $m$ induced by a reduction in the required reserve ratio $\tau$, can be analyzed
together simply as expansionary monetary policy. A monetary expansion leads, via a lower interest rate on bank loans $j$ stemming from an increasing stock of deposits according to equation 4.7, to an increase in the profit rate $r$ according to equation 4.2, thereby leading to a rising Tobin's $q$ according to equation 4.6, to a higher growth rate of the capital stock $\eta(q)$, and to an increase in capacity utilization $u$ according to equation 4.1. Expansion of domestic activity by monetary policy leads to the conventional result of an increase in the growth rate of the price level $\hat{p}$ according to equation 4.3 which is compensated by a depreciation of the home currency, i.e. $\hat{s}$ rises. The effect on the domestic interest rate on government bonds $i$ in equilibrium is, as already explained above, zero.

A rise in $\alpha$ meaning stronger financial regulation with respect to the supply of loans leads according to equation 4.7 to a higher interest rate on loans $j$, thereby reducing $r, q, \eta(q), u, \hat{p}$ and $\hat{s}$ according to equations 4.1 to 4.3 and 4.6. The effect on $i$ is zero as already mentioned.

An increase in the foreign interest rate $i^*$ leads to an increase in the nominal domestic interest rate on government bonds $i$ to the same amount according to equation 4.5, and to an appreciation of the exchange rate $\hat{s}$ because of an excess demand for foreign currency stimulating net exports temporarily. In equilibrium net exports are again zero by the compensating effect of a rising $\hat{p}$. Though net exports are zero in equilibrium, and a rising nominal interest rate on government bonds $i$ reduces government spending, capacity utilization increases. The reason for this result is the fact that inflation increases much faster than the nominal domestic interest rate on bonds which, as a net effect, reduces the real interest rate on government bonds, leading to much higher government spending, and thereby increasing $u$ according to equation 4.1. Higher domestic activity leads to increases in $r$ and $q$ according to equations 4.2 and 4.6, stimulating a further expansion in $u$. A higher collateral value reduces the nominal interest rate on loans $j$ according to 4.7.

The effects of a higher wage share $v$, caused e.g. by an increase in the nominal wage $w$ or by a fall in labour productivity $Y/N$, and an increase in the depreciation rate $\delta$, caused e.g. by a negative technology shock, lead to the same aggregate results. Both negative shocks lead to a reduction in the profit rate $r$, as well as in Tobin's $q$ according to equations 4.2 and 4.6. A lower collateral value and decreasing bank profits induce banks to demand a higher loan rate $j$ according to equation 4.7 which in turn leads to a further decline in $r$ and $q$. A lower value of $q$ leads to a shrinking value of capacity utilization $u$ caused by a drop in the growth rate of the capital stock $\eta(q)$, which leads to a decline in the growth rate of the price level $\hat{p}$, stimulating net exports temporarily and leading the domestic currency to revalue in equilibrium, i.e. $\hat{s}$ decreases. The impact on $i$ is zero as explained above.

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19 For each kind of shock, partial derivatives are almost identical, and only differ with respect to variables $h$ and $m$. See section 4.7 for a formal derivation of these results.

20 The model also verifies the standard Mundell-Fleming result stating that monetary policy under flexible exchange rates causes temporarily a lower domestic interest rate (which rises again very quickly to its original level if UIP holds), thereby leading to capital outflows, and to an appreciation of the exchange rate stimulating net exports and output.

21 All partial derivatives with respect to changes in $v$ and $\delta$ are almost identical and differ only by partial derivatives with respect to $v$, containing additionally the variable $u$ in a multiplicative way. See section 4.7 for further details.
4.3.2 A Comparative-Static View of Financial Crises

Recent empirical research on financial crises has identified the following nine empirical regularities, outlined in chapter 3, which a consistent theory of financial crises should be able to explain. Firstly, banking, currency and twin crises both in industrial and in emerging market countries are in most cases linked to extensive boom-bust cycles in goods and financial markets. Secondly, though financial crises have a cyclical, recurrent character over time, not each business cycle generates financial crises, i.e. there are "tranquil" business cycles with stable financial and goods market conditions, which are sometimes interrupted by extensive cycles generating financial crises. Thirdly, the boom phase of extensive business cycles generating financial crises is often marked by a large exogenous positive shock as e.g. financial liberalization, or the emergence of a new technology regime. Fourthly, during the boom phase of a financial crisis cycle, financial fragility increases in the form of rising debt-asset ratios, a rising share of short-term debt to total debt, and rising external financing costs. Fifthly, financial crises happen after the economy has entered a recession being accompanied by an overvalued currency, increases in domestic and international interest rates, etc. Sixthly, the bust phase and financial crises are commonly preceded by a large domestic and external worsening of economic fundamentals, i.e. panic-driven financial crises caused by a random sudden shift in market sentiment at sound fundamentals are very rare. Seventhly, the recovery phase after the occurrence of a financial crisis is characterized by an improvement in economic fundamentals, and by a reduction in financial fragility due to a reduction in aggregate indebtedness. Eighthly, the time patterns of most macroeconomic variables during extensive boom-bust cycles generating financial crises in industrial countries, are very similar to those in emerging market countries except for the fact that emerging market countries' debt is denominated in foreign currency whereas industrial countries' debt is mostly denominated in domestic currency. Ninthly, though crises in industrial and emerging market countries are similar regarding the time patterns of macroeconomic variables, crisis frequency in emerging markets, especially in the post Bretton Woods era, is higher, i.e. there are less "tranquil" cycles in emerging market countries than in industrial countries.

These empirical regularities are used in the following for a theoretical construction of a highly stylized extensive boom-bust cycle engendering financial crises. This stylized theoretical financial crisis cycle is described in a first step by the comparative-static results of the model according to table 4.1 which provide a much deeper understanding of financial and goods markets' behaviour during different stages of business cycles than an investigation of empirical results could do. It must be noted however, that the formal explanation of the stylized facts by the signs of partial derivatives according to table 4.1 is only a qualitative description, since there is no possibility to determine explicitly the net effects on all endogenous variables if two or more counteracting parameters are varied due to the absence of a function describing in which relation different parameters are varied during different stages of the business cycle. Especially the debt-asset ratio $\lambda$, and the state of confidence $\rho$, being the two core driving variables of a financial crisis cycle, move in almost all stages of the cycle in the same direction, implying an ambiguous effect on aggregate economic activity according to table 4.1, since the net effect depends firstly, on the relative growth of the two parameters, and secondly, on the relative strength of influence on all endogenous variables, which both cannot be specified quantitatively by the comparative-static version of the model. As a result, the comparative-static description...
of a typical financial crisis cycle is a theoretically based qualitative approach analyzing, among other important determinants as e.g. monetary policy, which of the two counteracting effects of $\lambda$ and $\rho$ dominates in each phase of the cycle as a theoretical base for the dynamic version of the model in chapter 4.4, which is able to verify the comparative-static results by endogenizing $\lambda$ and $\rho$.

The Boom Phase. The boom phase starts with growing expectations of higher future profits, or equivalently with a rise in the "state of confidence" after an initial positive shock in one or more sectors in the economy (technology shock, domestic and international financial liberalization, etc.), inducing firms to increase investment which is financed by rising leverage. If monetary conditions are favourable, the initial boom in one sector of the economy spreads over to other sectors by various goods market and financial market linkages. Rising aggregate demand leads to higher cash flows and profits causing asset prices to rise (Tobin's $q$ increases). Higher stock market valuations increase net worth and collateral, making corporate balance sheets look sounder and reduce corporate risk. Due to higher collateral values, borrowing costs drop and lead to higher borrowing and investment. The debt structure becomes more short-term, since short-term rates tend to be much lower than long-term rates in boom phases. Summing up, during a boom corporate liquidity, profitability and solvency increase, leading to a higher valuation of firms in financial markets though the debt-to-asset ratio increases, whereas the debt-to-market capitalization ratio remains almost unchanged.

In terms of the model, a positive technology shock expressed by a fall in $\delta$, and/or a financial liberalization shock being indicated by a fall in $\alpha$ or by a rise in $m$ caused by a reduction of the required reserve ratio $\tau$, both lead to an economic expansion which is amplified by a simultaneous increase in the state of confidence parameter $\rho$. Favourable monetary conditions are represented by an increase in $h$, and perhaps by a further increase in $m$. Rising leverage for increasing investment finance is indicated by an increase in the debt-asset ratio $\lambda$. Though an increase in indebtedness $\lambda$ has a contractionary effect on overall macroeconomic activity, the net effect is expansionary, since the changes in $\alpha$, $\delta$, $\rho$, $h$ and $m$, all causing a macroeconomic expansion, overcompensate the debt-led contraction. Summing up, the boom phase is characterized by an increase in capacity utilization $u$, caused by larger investment demand $\eta(q)$ through an increase in Tobin's $q$, an increase in the profit rate $r$, an increase in inflation $\pi$, a decrease in the loan rate $j$, a decrease in the interest rate on government bonds $i$, and by a depreciation of the home currency, i.e. by a rise in $s$ caused by inflation.

The Overborrowing Symptom. During the boom phase of a financial crisis cycle, firms start to engage in excessive "overborrowing", being defined as a situation with largely growing debt-asset ratios caused by a rapid expansion of investment and declining or stagnating internal cash flows, requiring an increasing stock of external finance in the form of taking new loans or issuing new equities. Whether an economy tends to increase more equity or more bank loan financing depends on the nature of the financial system, that is whether the system is more bank-based or more market-based. The following

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22European and Japanese financial systems are bank-based, whereas North-American financial systems are more market-based.
description of overborrowing processes refers to a bank-based system, i.e. external finance is only provided in the form of bank loans.

The rapid growth of investment and indebtedness is based on very fast growing profit expectations increasing faster than actual gross profits (profits before external financing costs) though net profits (profits minus external financing costs) stagnate, i.e. additional gross profits caused by an expansion of sales do not lead to an increase in net profits due to an increase in external financing costs of approximately the same size. In order to differentiate the overborrowing phase from a state of “irrational exuberance” (which is going to be explained in the following paragraph), both being parts of the upswing, the overborrowing process is defined by a constant positive net profit rate, whereas a state of irrational exuberance is defined by a shrinking positive net profit rate with a minimum at zero, since a negative net profit rate corresponds to a situation of illiquidity which does not allow for a further expansion process due to a downward revision of expectations.

The extent and the velocity of a debt-led investment boom depends on the one hand on firms’ warranted expansion of investment, but on the other hand, also on financial markets’ willingness to expand credit. Consequently, a large capacity of an economy’s financial system to place new debt as well as favourable monetary conditions are necessary prerequisites for an overborrowing process. High profitability, favourable liquidity conditions and increasing net worth among financial intermediaries, caused by increasing interest income and less non-performing loans during the boom phase, attract additional financial means (e.g. by an increase in deposits, or new issues of debentures) which allow for the expansion of loans, being predominantly driven by rising profit expectations of banks since financial intermediaries live in the same expectational climate as firms. Favourable monetary conditions, i.e. a comparatively low aggregate interest rate level, caused by low inflation and low growth during the expansion phase of a business cycle, support the expansion of indebtedness among firms. The overborrowing process among firms is also accompanied by a lagged overborrowing process among financial intermediaries since they are also subject to stagnating cash flows due to increasing external debt costs, requiring to finance further expansions of credit by an increase in their debt-asset ratio. Furthermore, an ongoing expansion of credit, both in the firm and in the financial sector, leads at some point to rising refinancing costs even at unchanged favourable monetary conditions due to the existence of a natural maximum amount of credit, determined by the level of the discount rate and by the required reserve ratio. Rising external financing costs lead to a further amplification of the overborrowing effect due to a widening gap between stagnating available internal cash flows and rising expenses which are financed by increasing debt-asset ratios.

The overborrowing process both in the firm and in the financial sector causes a rising vulnerability of an economy to volatility in goods and in financial markets. The financial sector depends increasingly on the ability of the corporate sector to fulfill its debt payment commitments which can be realized only if there is a further actual expansion in aggregate demand. The corporate sector depends more and more on the willingness of financial markets to roll-over or to place new debt, which in turn depends on general monetary conditions and on financial markets’ expectations on future profitability of firms. Accordingly, in an “overborrowing” environment, general financial fragility, i.e.

\[23\] For the “irrational exuberance” phenomenon in connection with the “New Economy” stock market bubble, see e.g. Shiller (2000).
the probability that only little negative shocks in either goods or in financial markets can lead to widespread failures of firms and financial intermediaries, increases intensely.

In terms of the model, the overborrowing process is described by an increase in the debt-asset ratio \( \lambda \) and in the state of confidence \( \rho \), the expansionary effect of \( \rho \) being larger than the contractionary effect of \( \lambda \). The overall expansionary net effect leads to further increase in capacity utilization \( u \), inflation \( \tilde{p} \), Tobin’s \( q \), and in the exchange rate’s growth rate \( \delta \), and to a decrease in the loan rate \( j \) and in the domestic bond rate \( i \), whereas the profit rate \( r \) remains constant.

The Upper Turning Point and “Irrational Exuberance”. The time path to the upper turning point of the business cycle is characterized by a further deterioration of cash flows and by a shrinking net profit rate since interest rate costs, caused by further excessive overborrowing, increase by a larger amount than earnings which cannot be increased as expected. Accordingly, the path to the upper turning point is characterized by a tremendous increase in financial fragility. However, though net profits are actually decreasing, asset prices and leverage tend to increase still further because profit expectations tend to follow a cumulative upward trend, mainly driven by a self-reinforcing cycle without any consideration of a deterioration of fundamental data driving the economy in a state of a “bubble economy” and “irrational exuberance”. \(^{24}\) The bubble in financial markets is generally accompanied by an overheating in the real sector leading to rising inflation due to an excess demand at almost full capacity utilization. After a period of steady goods market inflation and asset price inflation, monetary authorities start to tighten monetary conditions, leading to a general tightening in financial markets and to a further decline in corporate and bank profits. Although monetary tightening serves to convince economic agents that expectations are exaggerated and should lead to a downward revision of expectations, contractionary monetary policy need not be the trigger for the burst of an asset price bubble. There are situations possible (see e.g. the “New Economy Hype” in year 2000 in the U.S.) in which asset prices and leverage keep on increasing despite monetary tightening, being caused by an extraordinary and further rise in profit expectations.

In terms of the model, the time path to the upper turning point of the business cycle is characterized by a reduction in \( m \) and \( h \) due to monetary contraction, and by further and more extensive overborrowing, i.e. by an increase in \( \lambda \) and \( \rho \). As opposed to the overborrowing phase, the negative influence of an increasing \( \lambda \) on the profit rate \( r \) is larger than the positive influence of an increasing \( \rho \) on \( r \), i.e. \( r \) declines with a lower bound of zero as outlined above. Intuitively, these developments would be generally assumed to cause an overall macroeconomic contraction. However, the overall net effect is expansionary mainly driven by a rising value of Tobin’s \( q \). Though Tobin’s \( q \) declines ceteris paribus by the fall in \( r \), there is a rise due to an overcompensating increase in the state of confidence \( \rho \) representing an “irrational” increase in profit expectations and asset prices. Summing up, the path to the upper turning point is characterized by an increase in capacity utilization \( u \), inflation \( \tilde{p} \), Tobin’s \( q \), in the exchange rate’s growth rate \( \delta \), and by a decrease in the bond rate \( i \) and in the loan rate \( j \) in spite of a declining profit rate \( r \).

\(^{24}\) The term “bubble economy” refers to a situation in which actual movements of economic variables, e.g. rising stock prices and excessive bank lending, cannot be justified by actual fundamental data, and are solely based on “irrational” positive expectations.
The Burst of the Bubble. The end of the excessive expansionary process in goods and financial markets is generally marked by a sudden stop in the expansion of credit and by a collapse of asset prices, leading to an aggregate deterioration of net worth positions and to sharp interest rate increases reflecting the magnified risk of default. These macroeconomic effects are caused by a sharp downward revision of profit expectations when investors realize that past expectations have been unrealistic, that the economy is financially fragile, and that “mania” expectations cannot be fulfilled by actual developments. The triggering event, or “wake-up call”, for an asset bubble’s burst can be either an endogenous failure of an important bank or corporation caused by past excessive over-borrowing, or contractionary monetary policy. According to the conventional view on financial crises, monetary tightening is often viewed as an exogenous shock being the sole triggering event of an asset bubble’s burst which could have been avoided if there had been no monetary contraction. It must be noted however firstly, that monetary tightening can be also viewed as an endogenous phenomenon to constrain rising inflation which has been caused by an endogenous debt-led investment boom, and secondly, that a monetary contraction can be the trigger for an asset bubble’s, but can also merely aggravate the collapse of expectations which occurred before monetary tightening. The reason why contractionary monetary policy is often viewed as the sole exogenous triggering event of an asset bubble’s burst stems from the fact that monetary tightening often marks the beginning of the asset price decline, and that a monetary contraction aggravates the downward revision of expectations leading to a further decline in asset prices.

In terms of the model, the collapse of profit expectations is represented by a large and sudden drop in the state of confidence $\rho$, leading to a large decline in Tobin’s $q$, and to a large and sudden rise in the loan rate $j$, and in the bond rate $i$. The sudden stop in the expansion of credit is represented by a sharp fall in the growth rate of the debt-asset ratio $\lambda$ to zero.

The Bust Cycle, Financial Crisis, Liquidity Trap and Debt Deflation. Whether an economy enters a severe financial crisis including a recession or even a depression depends firstly, on the extent of the drop in asset prices, and secondly on the vulnerability of firms’ and financial intermediaries’ liquidity and solvency positions in case of a large asset price drop. Consequently, if there is low vulnerability or only a small drop in asset prices, a burst of a bubble does not cause severe disruptions in financial and goods markets and serves more as an event to readjust expectations to their fundamentals. By way of contrast, if firms and banks are highly leveraged, and collateral and liquidity positions react very sensitively to changes in asset prices, a severe financial crises (twin crisis) involving an austere recession, or even a depression is likely going to occur.

Regarding the emergence of a full-fledged financial crisis, the initial fall in profit expectations having given rise to the asset price bubble’s burst causes widespread insolvency and illiquidity among firms. As to insolvency, the downward revision of expectations and falling asset prices have caused shrinking net worth positions, leading to a further drop in expectations due to an increased risk of default. Liquidity positions deteriorate on the one hand by rising interest rates caused by increased default risk, and on the other hand by a sharp reduction in sales due to a fall in aggregate demand induced mainly by firms cutting investment expenditures to fulfill due payment commitments. Furthermore, the cumulative process of collapsing expectations and asset prices, as well as the self-
reinforcing deterioration of firms' liquidity and solvency is often magnified additionally by rating agencies grading down a huge part of the corporate sector.

Regarding the availability of credit, financial intermediaries not only increase loan rates, but also start to cut credit lines and roll-over loans causing a severe credit crunch and further illiquidity among firms. There is no possibility to receive new liquid funds at financial markets by placing new debt, even at very high rates, since financial markets liquidity has dried up due to an overall increase in risk and uncertainty. As a result, firms are forced to start a “fire-sale” of their assets since there is no possibility to serve due loans out of current cash flow. However, a widespread “fire-sale” of assets leads to further drops in asset prices, collateral, net worth and liquidity and causes further illiquidity and bankruptcy among firms. Financial intermediaries incur severe losses due to sharp drops in interest rate income and rapid increases in non-performing loans, leading also to illiquidity, “fire-sale” of assets, and to widespread insolvency among banks. Accordingly, financial intermediaries are not able to protect themselves against losses by calling loans or by increasing interest rates, since these actions cause further losses in the corporate and, as a result, in the financial sector.

In the pre-World War II era, failures of financial intermediaries additionally triggered severe banking panics which led to a money supply collapse, massive deflation and financial disintermediation due to the absence of an effective lender of last resort and deposit insurance systems. In the post-World War II era, however, banking panics and their negative repercussions on goods and financial markets have been prevented through effective lender of last resort actions and deposit insurance systems. Though monetary policy has become effective in stabilizing the money supply and liquidity of banks, banking insolvency caused by drops in asset prices and losses through high shares of non-performing loans can still lead to severe banking crises nowadays. Furthermore, if there is a very sharp contraction in asset prices and in banks’ and business firms’ net worth, deflationary spirals increasing real interest rates, real interest payments, and the real stock of debt, leading to a further depression in output, cannot be prevented by expansionary monetary policy. In extreme cases, a “liquidity trap” situation can emerge which does not necessarily require that the interest rate remains constant at a minimum level (or even at zero) when the money supply is increased like in standard textbook IS-LM analysis. The impotence of monetary policy can even happen when the central banks' discount rate is positive and continues to fall as the money supply is increased. The reason for the ineffectiveness of monetary policy, even if the discount rate is above the zero level, stems from the fact that pessimistic expectations, drops in output, which reduce the actual profit rate, and deflation, lead to an enormous decline in Tobin’s q and in the marginal efficiency of capital reducing investment demand and output. Even if the central bank lowers the discount rate to zero, there is no mechanism leading to a recovering value of the marginal efficiency of capital and Tobin’s q which would stimulate aggregate investment and output.

The domestic financial crisis being subject to a severe banking crisis, widespread corporate failures, deflation and “liquidity trap” situations, can be accompanied by a speculative attack on the domestic currency causing a twin crisis, and possibly very high domestic interest rates due to increased country risk and large devaluation expectations of the home currency. The currency crisis exacerbates temporarily the recession because substantial depreciations are typically associated with sharp current account reversals, requiring the economy to quickly adjust the balance between domestic saving and invest-
ment by reducing output. However, if there are no debt contracts denominated in foreign currency, a devaluation of the home currency has, in the medium and in the long-run, an expansionary effect on output via stimulating net exports facilitating the recovery phase.

In terms of the model, a financial crisis engendering a severe recession, or even a depression, is caused by a further large decline in the state of confidence $\rho$, leading to a decrease in capacity utilization $u$, in the price level's growth rate $\dot{p}$ (where $\dot{p} < 0$ is a realistic scenario), in the profit rate $r$, in Tobin's $q$, and to a sharp increase in the loan rate $j$ and in the interest rate on government bonds $i$. In the short run, the exchange rate appreciates sharply, i.e. $\ddot{s} > 0$, due to rising capital outflows caused by devaluation expectations and a rising country risk premium. In severe cases, there arises the possibility of a currency crisis (inducing a twin crisis), i.e. a large rise in $\ddot{s}$. In the long-run however, the sharp reduction in $\rho$ leads to an appreciation of the home currency, i.e. to $\ddot{s} < 0$, due to a large macroeconomic contraction, causing the domestic price level's growth rate $\dot{p}$ and the exchange rate's growth rate $\dot{s}$ to fall. Despite expansionary lender of last resort actions and compensations by deposit insurance systems, being represented by increasing values of $m$ and $h$, there is an overall macroeconomic contraction owing to overcompensating negative effect of a drop in the state of confidence $\rho$ being typical of a “liquidity trap” situation, i.e. expansionary monetary policy via a reduction in $j$ cannot increase Tobin's $q$ due to very low levels of $r, u, \dot{p}$ and $\rho$. In the same way, a reduction in the debt-asset ratio $\lambda$, caused by financial intermediaries reducing the available stock of debt, cannot “turn” the economy into recovery due to the dominance of the contractionary $\rho$-effect.

**The Recovery Phase.** During the bust cycle period, firms and financial intermediaries start adjusting their external finance position by reducing the overall debt stock, and by cutting investment spending. The period of deleveraging is going to impede investment as long as firms' and financial intermediaries' debt levels are seen as abnormally high, and liquidity positions are seen as too weak. A new phase of expansion will begin only if debt and liquidity of the corporate as well of the financial sector are viewed as sustainable.

In terms of the model, the economy only begins to recover if a decrease in the debt-asset ratio $\lambda$ leads to an increase in the state of confidence $\rho$, inducing an economic expansion with an increase in capacity utilization $u$, in the profit rate $r$, in the price level's growth rate $\dot{p}$, in Tobin’s $q$, in the exchange rate’s growth rate $\dot{s}$, and a decrease in the loan rate $j$ and in the domestic bond rate $i$.

**4.4 Long-Run Dynamic Analysis**

**4.4.1 Finance, Investment and Long-Run Profit Expectations**

Though lots of parameters have been varied in the comparative-static description of financial crises, the two “driving” forces for the emergence of boom-bust cycles including financial crises are the “state of confidence” parameter $\rho$ and the debt-asset ratio $\lambda$. The technique of comparative statics however, is very unsatisfactory because it only allows a description of real world phenomena by varying exogenous parameters in a certain range; there is no explanation in a static model why expectations suddenly change and why credit constraints are binding from a certain point on. In order to overcome these shortcomings of comparative-statics, the dynamic version of the model is going to endogenize
the state of confidence parameter $\rho$ and the debt-asset ratio $\lambda$ in order to show firstly, that financial fragility is an *endogenous* phenomenon of each business cycle, secondly that market economies tend to be dynamically and cyclically stable by the emergence of endogenous business cycles without financial crises, and thirdly, that excessive boom-bust cycles generating financial crises are caused by exogenous *positive* shocks to expectations catapulting an initially, cyclically stable economy to an unstable and highly financially fragile cycle, which however converges, after the occurrence of a financial crisis, to its cyclical and dynamically stable steady state.

**The Dynamic Behaviour of Long-Run Profit Expectations.** Empirical studies, as well as the comparative-static description of financial crises in industrial countries according to section 4.3.2, have shown that the dynamic behaviour of profit expectations (and asset prices) can be described by a cumulative upward and downward processes in the boom and in the bust phase without any counteracting or equilibrating forces, whereas at the upper and lower turning point of the business cycle, cumulative processes are reversed by some "new" kind of information, resulting in a change of the direction of movement in expectations. An early economic treatment of this sort of behaviour of expectations can be found in Keynes' theory of "the state of long-term expectations".25 According to Keynes, it is not possible to form expectations of the future on the basis of the "most probable forecast" (Keynes 1936, p. 148) having the same time horizon as an investment in real capital goods; in most cases "there is no scientific basis on which to form any calculable probability whatever" (Keynes 1937, p. 114). In order to deal with this kind of uncertainty which cannot be reduced, Keynes identifies three principles according to which expectations are formed in reality:

1. *We assume that the present is a much more serviceable guide to the future than a candid examination of past experiences would show it to have been hitherto. In other words we largely ignore the prospect of future changes about the actual character of which we know nothing.*

2. *We assume that the existing state of opinion as expressed in prices and the character of existing output is based on a correct summing up of future prospects, so that we can accept it as such unless and until something new and relevant comes into the picture.*

3. *Knowing that our own individual judgement is worthless, we endeavor to fall back on the judgment of the rest of the world which is perhaps better informed. That is, we endeavor to conform with the behaviour of the majority or the average. The psychology of a society of individuals each of whom is endeavoring to copy the others leads to what we may strictly term a conventional judgment (Keynes 1937, p. 114, Keynes’ emphasis).*26

Point (1) states that expectations are based on the current or present state without any effort to predict future events by extrapolation of past events. Point (2) states that expectations only change if new events can be foreseen; otherwise expectations are based on the present state. Point (3) states that individual expectations are not only based

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25See e.g. chapter 12, "The State of Long-Term Expectations" in the General Theory (Keynes 1936).

26See also Flaschel, Franke and Semmler (1997), p. 344.

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on "objective" factors but also on the average opinion of the market which is very well explained by Keynes’ example of the “newspaper beauty contest” where the readers

... have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole; so that each competitor has to pick, not those faces which he himself finds prettiest, but those which he thinks likeliest to catch the fancy of the other competitors, all of whom are looking at the same point of view (Keynes 1936, p. 156).27

Transferring the “beauty contest theory” to investment decisions, the market valuation of investment goods, i.e. the valuation of the demand price of capital, is not based on “objective” or “real” facts. On the contrary, under the influence of mass psychology, market valuations are based on anticipation what average opinion expects the average opinion to be28, i.e. investors base their decisions on general conventions which are formed by the market. This behaviour is rational both for persons without any special knowledge and for persons with special knowledge because expecting what the market expects will result in higher returns than expecting what individual interpretations of “objective fundamentals” would say. As a result, investment decisions will be heavily influenced by bulls and bears of stock markets and not primarily by individual assessments which is described by Keynes as

[...]the entrepreneurs, who are directly responsible, will find it financially advantageous, and often unavoidable, to fall in with the ideas of the market, even though they themselves are better instructed (Keynes 1936, p. 316).29

Applying Keynes’ theory of the formation of (profit) expectations to the present model results in the change of the state of confidence $\rho$ depending positively on the actual state of expectations. Consequently, the state of confidence is going to increase further if the actual state of confidence is positive, and is going to decrease further in case the actual state of confidence is negative. Formally, this formation of expectations scheme can be described by

$$\dot{\rho} = f(\rho),$$

stating that the time derivative of the state of confidence $\dot{\rho} = \partial \rho / \partial t$ is positively dependent on the actual state of confidence $\rho$. This general differential equation allows for unstable exploding upward and downward movements depending on the initial state. From a business cycle perspective, this positive feedback loop mechanism allows for the emergence of cumulative boom and bust periods. However, this theoretical expectation formation scheme is incomplete since it does not explain a reversal of cumulative processes, i.e. it contains no counteracting forces slowing down the cumulative processes, and turning them back into the reverse direction at the turning points of the business cycle. Reversals of cumulative upward and downward processes in goods and financial markets are usually caused by the emergence of “new” information revealing that the current level of asset

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27 Other authors, like e.g. Flaschel, Franke and Semmler (1997), p. 344, and Eatwell and Taylor (2000), pp. 12 and 15, also refer to Keynes’ theory of the formation of expectations.


29 See also Flaschel, Franke and Semmler (1997), p. 422.
and goods prices does not correspond to actual fundamental data, causing sudden and large changes in asset and goods prices. Thus, the formal adjustment equation of the state of confidence has to be additionally dependent on “objective” factors representing a norm in the form of “economic fundamentals”. These objective factors have to be able to reinforce, to slow down, and even to reverse cumulative processes. Though there are numerous economic fundamentals which could be taken as an “objective” basis for expectations, the present model refers on two core fundamentals which are also used in real world assessments of current expectations, namely current profitability and the degree of indebtedness.

An obvious indicator for current profitability in the model is the actual profit rate \( r \). However, using \( r \) provides no information whether current profitability is “high” or “low”, or whether an investment in real capital is risky or riskless. As a result, current profitability can be only assessed by comparing the profit rate \( r \) to a riskless reference yield. The real interest rate on government bonds \( i - \hat{p} \) serves as a good riskless reference interest rate which investors can realize by shifting their portfolios from equities into government bonds with comparable low risk. Thus, the difference between the two rates \( \sigma \), formally given as

\[
\sigma = r - (i - \hat{p}),
\]

serves as a much better indicator. The difference \( \sigma \) can be interpreted as the risk premium firms have to pay to investors for holding capital assets because the profit rate \( r \) is, as outlined above, a good indicator for liquidity and solvency risk. Regarding the influence of \( \sigma \) on the formation of profit expectations, it holds that a shrinking value of \( \sigma \), caused by a fall in \( r \) and \( \hat{p} \), or by an increase in \( i \), indicates that investment in capital assets becomes more risky in comparison to government bonds, and will cause a reduction in the change of the “state of confidence” parameter \( \hat{p} \). By way of contrast, an increasing \( \sigma \) lowers the risk of capital assets, and thereby leads to an increasing value of \( \hat{p} \).

The level of indebtedness, serving as the second economic fundamental in the model, and providing information about the financial fragility of business firms' balance sheet structure. is measured by the debt-asset ratio \( \lambda \) being an indicator for liquidity and solvency risk. A high level of \( \lambda \) indicates high liquidity risk since a large part of current cash flow has to be employed for interest rate costs and repayment of the principal, i.e. only small shocks, as e.g. a drop in earnings or only small interest rate increases, can lead to illiquidity. Regarding solvency risk, the higher the debt-asset ratio \( \lambda \), the quicker insolvency emerges from a given drop in asset prices. By way of contrast, a low debt-asset ratio indicates low liquidity and low solvency risk. Respecting the influence of the debt-asset ratio \( \lambda \) on profit expectations, it holds that a high level of \( \lambda \) leads to a drop in profit expectations, whereas a low level of \( \lambda \) causes profit expectations to rise, i.e. it holds that a higher \( \lambda \) causes \( \hat{p} \) to shrink, whereas a lower \( \lambda \) causes \( \hat{p} \) to rise.

Summing up, a formal representation of the change of the state of confidence parameter could read as

\[
\hat{p} = f(\rho, \sigma, \lambda),
\]

stating that the change of the state of confidence is a positive function of the actual state of confidence, a positive function of the risk premium and a negative function of the debt-
This kind of expectation formation scheme is able to explain cumulative movements in expectations during the boom and the bust phase, as well as changes of past cumulative processes into the reverse direction at the turning points. During the boom and the bust phase, the positive influence of $\rho$ on $\dot{\rho}$ will dominate. However, at the turning points, the influence of $\sigma$ and $\lambda$ will dominate and “turn” the past development into the reverse direction. For example, as the comparative-static description of financial crises has shown, during the boom phase, the level of indebtedness is going to increase which reduces net profits, leading to a slow down of the boom and to a reversal into a bust cycle. During the bust cycle, the debt-asset ratio decreases and net profits are going to increase after some time, leading to a slow down of the cumulative downward trend and to a reversal for a new upswing.

This formal expectation formation scheme can be explained alternatively by business cycle phase dependent behaviour of two different kinds of investors. Type one investors are feedback investors, noise traders, or chartists. They have no expert knowledge and generally follow market sentiments by extrapolating past time trends into the future, i.e. in the boom phase, they speculate on increasing asset prices, and in the bust phase, they speculate on decreasing asset prices. Type two investors, so-called fundamentalists, are better informed, use more sophisticated forecasts, and rely more on fundamental data. Standard theory of financial markets would state that noise traders cannot survive forever in financial markets because changes in market sentiments are compensated by counter-acting rational arbitrageurs, so that less informed and less competitive investors are either going to be driven out of the market, or improve their performance by learning from past losses. As a result, according to standard theory, financial markets tend to be efficient due to the dominance of rational investors. Reality however, shows that this development does not take place as predicted by standard theory. For example, there arise situations especially in the boom and bust phase of business cycles in which fundamentalists follow general market sentiments though “objective” fundamental data would indicate a speculation against the trend. This phenomenon can be explained by the dominance of chartist behaviour in boom and bust phases, so that fundamentalists following chartist behaviour may earn higher yields than fundamentalists basing their expectations on a rational assessment of fundamental data. Thus, in boom and bust phases it seems useful for fundamentalists to follow general market opinion though they are more sensitive to new available data than feedback investors by observing more closely the evolution of fundamental variables which possibly could indicate a reversal of the ongoing cumulative process. As a result, the longer a boom or a bust phase is under way, and the more market prices differ from their fundamental value, the more fundamentalists attach increasing weight to fundamental factors by beginning to speculate against the market which, in the end, leads to a reversal of the past cumulative process. Summing up, during the boom and the bust phase of the business cycle, chartist behaviour, which is also adopted by a great number of fundamentalists, dominates general trading strategies, whereas at the turning points, the weight of fundamentalist behaviour dominates general

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30 For a similar time derivative of the “state of confidence” parameter, see Flaschel, Franke and Semmler (1997), p. 346.
31 For this example, see Flaschel, Franke and Semmler (1997), p. 346.
32 See Shleifer and Summers (1990) for an overview on noise trader theory.
market behaviour, overcompensating chartist strategies and causing the past cumulative process, i.e. past general market sentiment, to reverse.\(^{33}\)

The chartist-fundamentalist, or Keynesian theory of the formation of expectations has been criticized as being old-fashioned and not applicable to economic models by the rational expectations school due to the absence of intertemporal optimizing agents and efficient forecasts of variables based on the current status of available information. As to the rational expectations hypothesis, modelling expectations as being driven by general market opinion and by some economic fundamentals whose development can be only observed and not explained is unrealistic, since agents are generally rational in the sense that optimizing agents develop a correct model of the real world on which expectations are based. As a result, expectations and actual values of variables can only differ in case of unforeseen, exogenous shocks; otherwise, expected values are going to be realized since the real world is assumed to behave exactly according to the theoretical model developed by agents. In spite of the fact that the rational expectations hypothesis provides a powerful tool to analyze macroeconomic phenomena, its application is limited by agents' degree of available information about the future. Even Lucas (1977a) has argued that the rational expectations hypothesis does not hold under complete and irreducible uncertainty which has been assumed to prevail in the present model. Rather, in an environment with uncertainty, the formation of expectations according to the rational expectations hypothesis can also be characterized as "extrapolating expectations" by which proxies for future values of variables are obtained.\(^{34}\) As a result, the rational expectations hypothesis' criticism of the chartist-fundamentalist theory of the formation of expectations does not hold in the present model, though it seems reasonable to assume that agents possess at least a limited form rationality even in a world with irreducible uncertainty, since there are efforts to base expectations on theoretical models in the real world. Standard macroeconomic theory however, has not provided yet an approach combining both schemes to describe

\(^{33}\)The chartist-fundamentalist theory of the formation of (profit) expectations has been also tested by numerical simulations of non-linear dynamic models (chaos theory models) by Arthur et al. (1997) who mimicked markets made up of heterogenous traders (rational investors vs. feedback or noise traders), where rational investors were modelled, in contrast to the original chartist-fundamentalist theory, as forming their expectations according to the rational expectations hypothesis, and not according to a number of fundamentals. Arthur et al.'s experiment consisted of varying the relative weight of rational investors and feedback traders in order to test different trading strategies which were applied to the Santa Fe's computerized artificial stock market. Arthur et al. derived two important results from their numerical simulations. Firstly, when agents were modelled as adapting very slowly their forecasts to new observations of the market's behaviour, i.e. when agents were modelled predominantly as fundamentalists relying more on objective factors of an underlying model than on conventional wisdom of the market (rational expectations hypothesis), the market converged to a rational expectations regime. In such a regime "mutant" expectations could not yield extraordinary high profits, trading volume remained low and the theory of efficient financial markets could be validated. Secondly, when agents were modelled as adapting to new market observations at a more realistic (and faster) rate, heterogenous beliefs persisted and the market organized itself into a complex regime. A rich market psychology, i.e. a rich set of expectations became observable. Technical trading, i.e. chartists' strategy, emerged as a profitable activity and bubbles and crashes emerged from time to time. Trading volume varied over time with periods of very intensive market activity and periods with quiet market activity. Time series on prices showed persistence in volatility and in trading volume and individual behaviour of agents evolved over time, i.e. behaviour was path-dependent, and did not settle down like in a rational expectations equilibrium model.

the formation of expectations under real world conditions being subject to irreducible uncertainty since standard theory considers both approaches as not being compatible.

In contrast to standard macroeconomic theory, the present model is designed to provide an expectation formation scheme under irreducible uncertainty which contains at least some long-run rationality of investors, i.e. it combines the chartist-fundamentalist approach with a modified form of the rational expectations hypothesis. Thus far, it has been assumed that the change of the confidence parameter depends positively on the actual state of confidence, i.e. it has been argued that \( \frac{\partial \rho}{\partial \rho} > 0 \). This assumption, however, is not consistent with rational behaviour according to the rational expectations hypothesis, since it neglects agents’ knowledge of a theoretical model describing the real world as given by equations 4.1 to 4.7, which would imply the expectations rule \( r^e = r \) (expected profit rate equals actual profit rate), i.e. \( \rho = 0 \) for all \( t \). Furthermore, the assumption \( \frac{\partial \rho}{\partial \rho} > 0 \) implies that investors’ expectations never converge to actual equilibrium values, but “undershoot” or “overshoot” infinitely the actual equilibrium values which is an unrealistic scenario from an empirical viewpoint. The only kind of “rationality” built in the model preventing expectations to implode or to explode is the increasing reliance at the turning points on “objective” or fundamental data which, however, can be only observed but not explained by investors. In other words, investors’ expectations are adjusted back to fundamentals by a “wake-up call” scenario, implying that there is no knowledge of how fundamentals are determined and how these fundamentals can be explained by an economic model. According to the chartist-fundamentalist expectation formation scheme, investors are modelled as “naive and simple” behaving agents to follow general market conventions without any knowledge of economic nexus’ who only change their economic “direction of thinking” in case they get surprised by a “big-bang” event. Moreover, investors are also denied to learn from past experience since there is no mechanism inducing them to develop an economic model which is able to explain the recurrent discrepancy between fundamentals and expectations during each business cycle, and which can be used to base expectations on.

These and other drawbacks of the chartist-fundamentalist expectation formation scheme led rational expectations theorists to believe that economic agents are able to learn from past experience inducing them to develop a “correct” economic model of the real world on which expectations are going to be based. Yet, as outlined above, a pure application of the rational expectations hypothesis is also problematic as to its empirical evidence, since it cannot explain herding behaviour and cumulative processes in the absence of exogenous shocks\(^{35}\), which can be much better explained by the chartist-fundamentalist theory. Furthermore, the rational expectations hypothesis loses its validity in case of real world irreducible uncertainty, which is assumed to be existent in the model.

Summarizing, both schools of thought have their drawbacks but also contain important insights to describe real world phenomena. Accordingly, for the formation of (profit) expectations under irreducible uncertainty, it seems reasonable to use both the chartist-

\(^{35}\)It is possible to generate cyclical fluctuations in macromodels being subject to rational expectations which however, requires the assumption of exogenous shocks following well-defined stochastic processes. In such an environment, rational expectations are self-fulfilling, generating boom-bust cycles in goods and financial markets. By way of contrast, there is no possibility to generate endogenous cycles in rational expectations models if there are no exogenous shocks. These topics are going to be discussed in further detail in section 4.6, comparing the present theory of endogenous business cycles with alternative business cycle theories.
fundamentalist theory stating that investors tend to cumulative expectation processes which can be slowed down by investors realizing that expectations have been too pessimistic or optimistic in comparison to fundamental data, and the rational expectations theory stating that investors are rational in the sense that they have knowledge of fundamental economic processes inducing them to form an economic model on which expectations can be based. In terms of the model, rational behaviour is introduced by the assumption of long-run rationality of economic agents which means that they believe in the long-run rational expectations equilibrium $r^e = r$, implying a long-run steady state value of the state of confidence $\rho_E = 0$. By way of contrast, the model excludes short-run rationality, i.e. the rational expectations hypothesis in its original form, i.e. $r^e = r$ and $\rho_E = 0$ do not necessarily hold for all $t$. Accordingly, though agents believe in the long-run rational expectations equilibrium $\rho_E = 0$, the current state of confidence $\rho$ is allowed to differ substantially from its steady state level $\rho_E$ in the short-run, but is assumed to converge to its steady state level in the long-run by agents adjusting their current expectations to the steady state level in case the difference $\rho - \rho_E$ is too large or too small. This definition of long-run rationality implies that there exists, independently of the actual state of economic fundamentals ($\sigma$ and $\lambda$) and chartist forecasts, a “corridor” or a “normal range” around the long-run rational expectations equilibrium $\rho_E = 0$, in which the current state of confidence $\rho$ can move, but which cannot be left by $\rho$ due to countering forces in case $\rho$ reaches the “boundaries” of the corridor. The size of this corridor can be very large in reality and is subject to variations between different business cycles since large positive shocks, as e.g. the “New Economy” shock in the late 1990s, cause the corridor to increase, whereas a “normal” business cycle without any large shocks, causes the corridor to shrink.

The combination of long-run rationality and chartist-fundamentalist behaviour calls for a modified function for the change of the confidence parameter with respect to the state of confidence, formally given as

$$\dot{\rho} = f(\rho, \sigma, \lambda),$$

(4.16)

where it holds that $\partial \dot{\rho}/\partial \rho \geq 0$. This function assumes that over some “normal” range of the confidence parameter $\rho_1 < \rho < \rho_u$, where $\rho_1$ denotes the negative lower limit ($\rho_1 < 0$) and $\rho_u$ the positive upper limit ($\rho_u > 0$) of the corridor, it holds that $\partial \dot{\rho}/\partial \rho > 0$, stating that investors follow general market sentiments, because speculating against the market trend would result in losses, i.e. $\rho$ is expected to continue its past rise/fall in case the current value of $\rho$ is positive/negative. Yet, the closer the current value of $\rho$ moves to the upper and the lower limit of the normal range, the more investors start to doubt of its consistency with the long-run steady state level $\rho_E = 0$. Formally, the derivative $\partial \dot{\rho}/\partial \rho > 0$ is decreasing both in range $0 < \rho < \rho_u$ for increasing values of $\rho$, and in range $0 > \rho > \rho_1$ for decreasing values of $\rho$. At the upper and the lower bounds $\rho_u$ and $\rho_1$, agents stop to believe that $\rho$ is going to continue its past trend, i.e. at the corner points $\rho$ reaches its maximum/minimum, which can be justified rationally, or which is still consistent with its long-run equilibrium value $\rho_E = 0$, respectively. Formally, at the corner points $\rho_u$ and $\rho_1$, it holds that $\partial \dot{\rho}/\partial \rho = 0$. If the state of confidence exceeds, or falls short of the normal range, i.e. in regions $\rho < \rho_1$ and $\rho > \rho_u$, investors start to “break” the past trend into the reverse direction by speculating against past general market sentiments since agents realize...
that the current change of expectations \( \dot{\rho} \) and the current level of expectations \( \rho \) cannot be "rational", i.e. "irrational exuberance" or "irrational understatement" are regarded as being actually irrational, or as not being consistent with the long-run equilibrium level \( \rho_E = 0 \). Formally, in regions \( \rho < \rho_l \) and \( \rho > \rho_u \), it holds that \( \partial \dot{\rho} / \partial \rho < 0 \). Though long-run rationality guarantees that profit expectations converge back into the normal range \( \rho_u > 0 > \rho_l \) in case the normal range has been left irrespective of the actual level of fundamental data, there exists some probability that regions \( \rho < \rho_l \) and \( \rho > \rho_u \) are never reached in reality and that, as a result, the reversal of expectations at the turning points of the business cycle is driven both by a switch from chartist-driven expectations to fundamentals-driven expectations, and by rational investors slowing down the growth of profit expectations.

Figure 4.2: Graphical Representation of Function \( \dot{\rho} = f(\rho, \sigma, \lambda) \).

Figure 4.2 summarizes the dynamic behaviour of the state of confidence \( \rho \) defined by equation 4.16, which is illustrated as a simple phase diagram for constant values of the debt-asset ratio \( \lambda \) and the risk premium \( \sigma \). In region \( \rho_l < \rho < \rho_u \), the slope \( \partial \dot{\rho} / \partial \rho \) is positive but declining both for increasing values of \( \rho \) in region \( 0 < \rho < \rho_u \), and for decreasing values \( \rho \) in region \( 0 > \rho > \rho_l \). At the turning points \( \rho_u \) and \( \rho_l \), the slope \( \partial \dot{\rho} / \partial \rho \) is zero. In regions \( \rho < \rho_l \) and \( \rho > \rho_u \), the slope \( \partial \dot{\rho} / \partial \rho \) is negative. There arise three dynamic equilibria A, B and C, where B represents the rational expectations equilibrium \( \rho_E = 0 \) being dynamically unstable, and A and B "irrational" long-run equilibria being dynamically stable. Equilibria A and C are denoted as "irrational" equilibria since they correspond to a stable long-run situation being characterized firstly, by investors steadily over- or underestimating the actual profit rate, and secondly, by the expected profit rate.
lying outside the normal range, a situation which cannot be validated by the stylized facts. This result is a first hint that the economic system tends to instability if investors follow general market sentiments, and to stability in case investors speculate against "mass psychology" due to the belief in the long-run rational expectations equilibrium \( \rho_E = 0 \), leading however to "irrational" and stable long-run multiple equilibria.

**The Dynamic Behaviour of the Debt-Asset Ratio.** The present model assumes that the firm sector has two sources of finance for (net) investment: retained earnings and (net) borrowing from banks. Issuance of new shares is neglected but would not change the general results of the model.\(^{36}\) Formally, the nominal financing condition for new investment can be stated as

\[
P I = \eta(q) K P = s_r r P K + \dot{L},
\]

where \( s_r \) denotes the retention ratio or the "saving rate" out of profits, \( s_r r P K \) retained earnings, and \( \dot{L} \) the new amount of loans. This perspective treats loans as a residual, implying that firms are not directly quantity constrained as to the amount of loans. However, since financial intermediaries live in the same expectational climate like private investors, a kind of credit rationing takes places via the influence of Tobin's \( q \) on the amount of new investment. If, for example, the state of confidence deteriorates suddenly, the result in the model is a quick reduction in investment; the same reduction in investment can be also explained by banks cutting their supply of new borrowing due to the deterioration of expectations. As a result, though there is no explicit credit rationing owing to the assumption of bank loans serving as a residual in the financing process, some kind of implicit credit rationing is incorporated via Tobin's \( q \). Dividing both sides of equation 4.17 by the numéraire \( PK \), and taking into consideration that it holds that \( 1/PK = \lambda/P \), the nominal financing condition in terms of growth rates can be restated as

\[
\eta(q) = s_r r + \frac{\dot{L}}{L} \lambda.
\]

The dynamic behaviour of the debt-asset ratio in differential equation form is derived firstly, by solving the growth rate of the debt asset ratio, formally given as

\[
\dot{\lambda} = \frac{\dot{L}}{L} - \frac{\dot{P}}{P} - \frac{\dot{K}}{K} = \frac{\dot{L}}{L} - \dot{p} - \eta(q),
\]

for \( \dot{\lambda} \), reading as

\[
\dot{\lambda} = \frac{\dot{L}}{L} \lambda - \dot{p} \lambda - \eta(q) \lambda,
\]

secondly, by solving the modified nominal financing condition for \( (\dot{L}/L)\lambda \) reading as

\[
\frac{\dot{L}}{L} \lambda = \eta(q) - s_r r,
\]

\(^{36}\)Neglecting the issuance of new equities as another possible form of external finance can be justified, according to the theory of imperfect capital markets and according to empirical data, by the fact that retained earnings and loans are the cheapest and thereby the most important sources of finance.
and thirdly, by inserting the expression \((\dot{L}/L_0)\lambda\) into the above given equation for \(\dot{\lambda}\), resulting after some further algebra in the change of the debt-asset ratio, formally given by

\[ \dot{\lambda} = (1 - \lambda) \eta(q) - s_r \, r - \dot{\rho} \lambda. \]  

(4.18)

Hence, an increase in indebtedness, i.e. a rise in \(\dot{\lambda}\) for a given \(\lambda\), results ceteris paribus from an increase in the capital stock's growth rate \(\eta(q)\), from a fall in the retention ratio \(s_r\), from a fall in the profit rate \(r\), and from a fall in the price level's growth rate \(\dot{p}\) reflecting Fisher's debt deflation process in disinflationary or deflationary periods.

4.4.2 The Local Dynamics of the System

Equations 4.16 and 4.18 constitute a nonlinear differential equation system in the two variables \(\lambda\) and \(\rho\), formally given by

\[
\begin{align*}
\dot{\lambda} &= F_1(\lambda, \rho) = (1 - \lambda) \eta(q) - s_r \, r - \dot{\rho} \lambda \\
\dot{\rho} &= F_2(\lambda, \rho) = f(\rho, \sigma, \lambda).
\end{align*}
\]

(4.19)  
(4.20)

To study the local dynamics of the system, the nonlinear system has to be linearized around the local intertemporal equilibrium point \(\lambda_E, \rho_E\) by a linear Taylor expansion, formally described by

\[
\begin{bmatrix}
\dot{\lambda} \\
\dot{\rho}
\end{bmatrix} = \begin{bmatrix}
\frac{\partial F_1}{\partial \lambda} & \frac{\partial F_1}{\partial \rho} \\
\frac{\partial F_2}{\partial \lambda} & \frac{\partial F_2}{\partial \rho}
\end{bmatrix}_{(\lambda_E, \rho_E)} \begin{bmatrix}
\lambda - \lambda_E \\
\rho - \rho_E
\end{bmatrix} = \mathbf{J}_E \cdot \begin{bmatrix}
\lambda - \lambda_E \\
\rho - \rho_E
\end{bmatrix},
\]

where \(\mathbf{J}_E\) denotes the Jacobian matrix evaluated at the local intertemporal equilibrium \(\lambda_E, \rho_E\). The signs of the partial derivatives of the Jacobian matrix \(\mathbf{J}_E\) are evaluated by making use of the partial derivatives' signs of the comparative static analysis given explicitly in section 4.7. The partial derivative of function \(F_1\) with respect to \(\lambda\) is given as

\[
\frac{\partial F_1}{\partial \lambda} = (-\eta(q) - \dot{p}) + (1 - \lambda) \frac{d\eta}{dq} \frac{\partial q}{\partial \lambda} + (-s_r) \frac{\partial r}{\partial \lambda} + (-\lambda) \frac{\partial \dot{\rho}}{\partial \lambda} < 0,
\]

which is assumed to be negative because \(s_r\) and \(\partial \dot{\rho}/\partial \lambda\) are comparatively small in relation to other terms. The partial derivative of function \(F_1\) with respect to \(\rho\) reads as

\[
\frac{\partial F_1}{\partial \rho} = (1 - \lambda) \frac{d\eta}{dq} \frac{\partial q}{\partial \rho} + (-s_r) \frac{\partial r}{\partial \rho} + (-\lambda) \frac{\partial \dot{\rho}}{\partial \rho} > 0,
\]

which is assumed to have a positive sign because, like in the case above, \(s_r\) and \(\partial \dot{\rho}/\partial \rho\) are comparatively small in relation to the other terms. The partial derivative of \(F_2\) with respect to \(\lambda\) is given by

\[
\frac{\partial F_2}{\partial \lambda} = \frac{\partial f}{\partial \lambda} + \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial \lambda} < 0,
\]

being negative, where it holds that

\[
\frac{\partial \sigma}{\partial \lambda} = \frac{\partial \sigma}{\partial r} \frac{\partial r}{\partial \lambda} + \frac{\partial \sigma}{\partial \dot{\rho}} \frac{\partial \dot{\rho}}{\partial \lambda} < 0.
\]
The partial derivative of function $F_2$ with respect to $\rho$, determining whether investors follow or speculate against general market conventions depending on the actual levels of the state of confidence and economic fundamentals, is the core variable determining stability or instability of the system which is formally given by

\[
\frac{\partial F_2}{\partial \rho} = \frac{\partial f}{\partial \rho} + \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial \rho} \geq 0,
\]

where it holds that

\[
\frac{\partial f}{\partial \rho} < 0, \quad \frac{\partial \sigma}{\partial \rho} = \frac{\partial \tau}{\partial \rho} + \frac{\partial \sigma}{\partial \tau} \frac{\partial \tau}{\partial \rho} + \frac{\partial \sigma}{\partial \rho} \frac{\partial \rho}{\partial \rho} > 0 \quad \text{and} \quad \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial \rho} > 0.
\]

Ergo, the sign of $\partial F_2/\partial \rho$ is ambiguous, depending on the sign of $\partial f/\partial \rho$, i.e. on the actual position of the state of confidence $\rho$ within the normal range $\rho_l < 0 < \rho_u$ having been discussed before. Summing up, the Jacobian matrix can take the following signs

\[
J = \begin{bmatrix} \frac{\partial F_1}{\partial \lambda} & \frac{\partial F_1}{\partial \rho} \\ \frac{\partial F_2}{\partial \lambda} & \frac{\partial F_2}{\partial \rho} \end{bmatrix} = \begin{bmatrix} - & + \\ - & 0, + \end{bmatrix},
\]

where local asymptotic stability or instability depends on the signs of $\partial F_2/\partial \rho$ and $\partial f/\partial \rho$, i.e. on investors’ willingness to follow general market conventions irrespective of the current state of fundamentals.

Regarding local dynamic stability of potential intertemporal equilibria, which are going to be discussed in the following section, there arise three possible stability patterns. Case 1 comprises three subcases, where subcase 1 refers to a situation in which the state of confidence at the fixed point $\rho_E$ lies inside the normal range $\rho_l < 0 < \rho_u$ but is located nearly to the corner points, i.e. when investors willingness to keep on following general market sentiments declines rapidly; formally, subcase 1 corresponds to an only slightly positive sign of derivative $\partial f/\partial \rho$. Subcase 2 refers to the situation when the state of confidence at the fixed point $\rho_E$ coincides with the two corner points $\rho_l$ and $\rho_u$, i.e. when investors stop to follow the past trend of general market sentiment since the minimum/maximum value of $\rho$ has been reached which is still compatible with the long-run rational expectations equilibrium $\rho_E = 0$; formally, this situation corresponds to a zero value of derivative $\partial f/\partial \rho$. Subcase 3 refers to the situation when the state of confidence at the fixed point $\rho_E$ lies outside the normal range in regions $\rho < \rho_l$ and $\rho > \rho_u$, i.e. when investors speculate against the past market trend since the actual level of $\rho$ is viewed as being irrationally underestimated/exaggerated and not compatible with the long-run rational expectations equilibrium $\rho_E = 0$; formally, subcase 3 corresponds to a negative sign of derivative $\partial f/\partial \rho$. Summing up, case 1 is formally characterized by the condition

\[
\frac{\partial f}{\partial \rho} \leq 0 \quad \text{or} \quad \frac{\partial f}{\partial \rho} > 0 \quad \text{but very small},
\]

leading to a negative, zero or a slightly positive (in comparison to cases 2 and 3) sign of derivative $\partial F_2/\partial \rho$, since

\[
\frac{\partial F_2}{\partial \rho} = \frac{\partial f}{\partial \rho} \quad \text{and} \quad \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial \rho}.
\]
resulting in
\[ \frac{\partial F_2}{\partial \rho} \leq 0 \text{ or } \frac{\partial F_2}{\partial \rho} > 0 \text{ but very small.} \]

A local fixed point being subject to formal conditions of case 1 exhibits local asymptotic stability due to a negative sign of the trace and a positive sign of the determinant of the Jacobian evaluated at the intertemporal equilibrium, i.e. the local fixed point is either a stable node or a stable focus. Formally, it holds that

\[ \text{tr} J_E = \frac{\partial F_1}{\partial \lambda} + \frac{\partial F_2}{\partial \rho} < 0 \]

and

\[ |J_E| = \frac{\partial F_1}{\partial \lambda} \frac{\partial F_2}{\partial \rho} - \frac{\partial F_1}{\partial \rho} \frac{\partial F_2}{\partial \lambda} > 0. \]

Case 2 and case 3 both refer to a situation when the state of confidence at the fixed point \( \rho_E \) lies close to the rational expectations equilibrium \( \rho_E = 0 \) inside the normal range \( \rho_t < 0 < \rho_u \), i.e. when investors' willingness to follow general market sentiments by extrapolating past realizations of \( \rho \) into the future is has reached its maximum. However, investors' willingness to follow general market sentiments can be subdivided on the one hand into a case being characterized by "hypersensitively" reacting investors constituting case 2, and on the other hand into with "normally" reacting investors constituting case 3 giving rise to different dynamic stability patters.

Case 2 relating to hypersensitively reacting investors, refers to a situation when expectations within the normal range near to the rational expectations equilibrium react very sensitively to general market sentiments, leading to a large value of \( \rho \) in absolute terms at a given fixed point. Formally, case 2 is characterized by the condition

\[ \frac{\partial f}{\partial \rho} \gg 0, \]

leading to a large positive sign of derivative \( \partial F_2/\partial \rho \) since it holds that

\[ \frac{\partial F_2}{\partial \rho} = \frac{\partial f}{\partial \rho} + \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial \rho} \gg 0. \]

A local fixed point being subject to the characteristics of hypersensitively reacting investors exhibits saddle point behaviour, i.e. the local fixed point is dynamically unstable since the determinant of the Jacobian matrix is negative which constitutes a necessary and sufficient condition for a saddle point equilibrium independently of the sign of the trace. Formally, the trace and the determinant of the Jacobian evaluated at the local fixed point are given by

\[ \text{tr} J_E = \frac{\partial F_1}{\partial \lambda} + \frac{\partial F_2}{\partial \rho} \gg 0 \]

and

\[ |J_E| = \frac{\partial F_1}{\partial \lambda} \frac{\partial F_2}{\partial \rho} - \frac{\partial F_1}{\partial \rho} \frac{\partial F_2}{\partial \lambda} < 0. \]
Case 3 refers to a situation when expectations within the normal range near to the rational expectations equilibrium follow general market sentiments in a "normal" way, i.e. when the same fixed point near the rational expectations equilibrium as in case 2 leads to a much smaller value of $\hat{p}$ in absolute terms. Formally, normally reacting investors in case 3 are described by the condition

$$\frac{\partial f}{\partial \rho} > 0,$$

where the positive sign is smaller than in case 2, but larger than in case 1. As a result, derivative $\partial F_2/\partial \rho$ has also a "normal" positive sign since

$$\frac{\partial F_2}{\partial \rho} = \frac{\partial f}{\partial \rho} + \frac{\partial \sigma}{\partial \rho} > 0,$$

which is however smaller than in case 2. A local fixed point being subject to formal conditions of case 3 is subject to local asymptotic instability, because both the trace and the determinant have a positive sign, i.e. the local fixed point exhibits either the characteristics of an unstable node or an unstable focus. Formally, the trace is given by

$$tr J_E = \frac{\partial F_1}{\partial \lambda} + \frac{\partial F_2}{\partial \rho} > 0,$$

having a positive sign since it holds that $|\partial F_1/\partial \lambda| < |\partial F_2/\partial \rho|$ which is consistent with the assumptions made in cases 1 and 2. The determinant is given by

$$|J_E| = \frac{\partial F_1}{\partial \lambda} \frac{\partial F_2}{\partial \rho} - \frac{\partial F_1}{\partial \rho} \frac{\partial F_2}{\partial \lambda} > 0,$$

however, having a positive sign only if condition

$$\left| \frac{\partial F_1}{\partial \lambda} \frac{\partial F_2}{\partial \rho} \right| < \left| \frac{\partial F_1}{\partial \rho} \frac{\partial F_2}{\partial \lambda} \right|$$

is fulfilled which is going to be proved in the following phase diagram analysis.

4.4.3 Phase Diagram Analysis

The slope of demarcation curve $\lambda = F_1(\lambda, \rho) = 0$, being denoted as $(d\lambda/d\rho)_{F_1}$ and derived from equation 4.19, is positive over the entire range because

$$\left( \frac{d\lambda}{d\rho} \right)_{F_1} = - \frac{\partial F_1}{\partial \rho} > 0.$$

The slope of demarcation curve $\rho = F_2(\lambda, \rho) = 0$, being denoted as $(d\lambda/d\rho)_{F_2}$ and derived from equation 4.20, varies with $\rho$ since it depends on the slope of function $\partial F_2/\partial \rho$ which is determined by the slope of function $\dot{\rho} = f(\rho, \sigma, \lambda)$ depicted in figure 4.2 for
constant values \( \bar{\sigma} \) and \( \bar{\lambda} \). Formally, the slope of the demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \) is given by

\[
\left( \frac{d\lambda}{d\rho} \right)_{F_2} = -\frac{-\frac{\partial F_2}{\partial \rho}}{\frac{\partial F_2}{\partial \lambda}} > 0.
\]

Since \( \partial F_2/\partial \lambda \) is negative, a negative sign of \( \partial F_2/\partial \rho \) caused by a negative value of \( \partial f/\partial \rho \) for which it holds that \( |\partial f/\partial \rho| > |(\partial f/\partial \sigma)(\partial \sigma/\partial \rho)| \), leads to a negative slope of demarcation curve \( \dot{\rho} = 0 \), i.e. \( (\partial \lambda/\partial \rho)_{F_2} < 0 \). A negative value of \( \partial f/\partial \rho \) which amounts to \( \partial f/\partial \rho = (-\partial f/\partial \sigma)(\partial \sigma/\partial \rho) \) leads to a zero value of \( \partial F_2/\partial \rho \), and therefore to a zero slope of demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \), i.e. \( (\partial \lambda/\partial \rho)_{F_2} = 0 \). A negative value of \( \partial f/\partial \rho \) for which it holds that \( |\partial f/\partial \rho| < |(\partial f/\partial \sigma)(\partial \sigma/\partial \rho)| \), a zero value of \( \partial f/\partial \rho \), and all positive values of \( \partial f/\partial \rho \) lead to a positive sign of \( \partial F_2/\partial \rho \), and therefore to a positive slope of demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \), i.e. \( (\partial \lambda/\partial \rho)_{F_2} > 0 \). Though the points with zero slope of demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \) do not equal exactly the outer bounds of the normal range \( \rho_l \) and \( \rho_u \) but only approximately, the shape of demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \) can be explained analogously to the course of function \( \dot{\rho} = f(\rho, \sigma, \lambda) \). As a result, demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \) exhibits a positive slope in case \( \rho \) is located within the area of the normal range, a shrinking positive slope reducing to zero in case \( \rho \) reaches the area of the two corner points \( \rho_l \) and \( \rho_u \), and a negative slope in case \( \rho \) reaches the area outside the normal range.

Despite the fact that each demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \) exhibits the same basic cubic shape as function \( \dot{\rho} = f(\rho, \sigma, \lambda) \), demarcation curves can differ with respect to their steepness within and outside the normal range depending on the strength of the influence of the current state of confidence \( \rho \) on investors' change in profit expectations \( \partial f/\partial \rho \). As outlined in the local stability analysis in section 4.4.2, two relevant cases of investors' behaviour giving rise to different local dynamics have to be distinguished, i.e. the case of “normally”, and the case of “hypersensitively” reacting investors within the normal range of \( \rho \), having been discussed as cases 2 and 3 of local stability analysis. As a result, phase diagram analysis has to consider as well both possible forms of investors' behaviour being reflected in two different classes of demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \). Figure 4.3 depicts two possible demarcation curves \( \dot{\rho} = F_2(\lambda, \rho) = 0 \), where the solid line corresponds to case 3 of local stability analysis assuming “normally” reacting investors within the normal range, i.e. it holds that \( \partial f/\partial \rho > 0 \) within the normal range, whereas the dotted line corresponds to case 2 of local stability analysis assuming “hypersensitively” reacting investors within the normal range, i.e. here it holds that \( \partial f/\partial \rho \gg 0 \) within the normal range. As a result, the more sensitively investors react to changes in \( \rho \) within the normal range, the steeper the demarcation curve \( \dot{\rho} = 0 \) in the normal range becomes. It must be noted that no explicit distinction has been made between normal and hypersensitive investors' behaviour outside the normal range since it does not influence significantly the dynamic patterns of the model. As a result, though the slope of the dotted demarcation curve in figure 4.3 outside the normal range is assumed to be steeper than the slope of the solid demarcation curve, it is also possible that the slope of the dotted line outside the normal range is flatter than the slope of the solid line.

The distinction among hypersensitively and normally reacting investors, resulting in different shapes of demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \) and in different phase diagrams
Figure 4.3: Possible Demarcation Curves $\dot{\rho} = 0$ Depending on Investors’ Sensitivity as to Changes in $\rho$

being illustrated in figures 4.4 and 4.5, is not only of crucial importance for the local dynamics of the system, but also for the number of possible intertemporal equilibria, determining the global dynamics of the system. Figure 4.4 refers to the case when investors react very sensitively as to changes in the state of confidence $\rho$, being represented by a comparatively steep demarcation curve $\dot{\rho} = F_2(\lambda, \rho) = 0$ in the normal range. As phase diagram analysis in figure 4.4 indicates, there arise three fixed points $A, B$ and $C$ with different stability patterns. Points $A$ and $C$ are local asymptotically stable because of a local negatively sloped demarcation curve $\dot{\rho} = F_2(\lambda, \rho) = 0$ (since $\partial f / \partial \rho < 0$ and $\partial F_2 / \partial \rho$ at $A$ and $C$), and a positively sloped demarcation curve $\dot{\lambda} = F_1(\lambda, \rho) = 0$, i.e. formally it holds that

$$
\begin{align*}
\left( \frac{\partial \lambda}{\partial \rho} \right)_{F_1} + \left( \frac{\partial \lambda}{\partial \rho} \right)_{F_2} &> \left( \frac{\partial \lambda}{\partial \rho} \right)_{F_1} - \left( \frac{\partial \lambda}{\partial \rho} \right)_{F_2} \\
\frac{\partial F_1}{\partial \lambda} &> -\frac{\partial F_2}{\partial \lambda},
\end{align*}
$$

which, after rearranging terms, can be transformed into the Jacobian’s determinant at the fixed points $A$ and $C$, being denoted as $|J|_{(A,C)}$, which exhibits a positive sign since it holds that

$$
|J|_{(A,C)} = \begin{vmatrix} \frac{\partial F_1}{\partial \lambda} & \frac{\partial F_2}{\partial \rho} \\ -\frac{\partial F_1}{\partial \rho} & \frac{\partial F_2}{\partial \lambda} \end{vmatrix} > 0.
$$

The trace of the Jacobian matrix at fixed points $A$ and $C$, being denoted as $trJ_{(A,C)}$,
exhibits a negative sign because

\[ tr\mathbf{J}_{(A,C)} = \frac{\partial F_1}{\partial \lambda} + \frac{\partial F_2}{\partial \rho} < 0, \]

causing local asymptotic stability of points A and C according to case 1 of local stability analysis.

Equilibrium point B is subject to saddle point behaviour since both demarcation curves exhibit a positive slope, where demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \), being subject to \( \partial f / \partial \rho > 0 \) and \( \partial F_2 / \partial \rho > 0 \), is steeper than demarcation curve \( \dot{\lambda} = F_1(\lambda, \rho) = 0 \), i.e. formally it holds that

\[
\begin{align*}
\left( \frac{\partial \lambda}{\partial \rho} \right)_F &< \left( \frac{\partial \lambda}{\partial \rho} \right)_{F_2} \\
\frac{\partial F_1}{\partial \rho} &< \frac{\partial F_2}{\partial \rho},
\end{align*}
\]

which can be transformed by rearranging terms into the Jacobian's determinant at point B, being denoted as \( |\mathbf{J}_{(B)}| \), having a negative sign because

\[
|\mathbf{J}_{(B)}| = \frac{\partial F_1}{\partial \lambda} \frac{\partial F_2}{\partial \rho} - \frac{\partial F_1}{\partial \rho} \frac{\partial F_2}{\partial \lambda} < 0.
\]

The trace of the Jacobian matrix at point B, being denoted as \( tr\mathbf{J}_{(B)} \), exhibits a positive sign because

\[
tr\mathbf{J}_{(B)} = \frac{\partial F_1}{\partial \lambda} + \frac{\partial F_2}{\partial \rho} > 0,
\]

giving rise to saddle point behaviour corresponding to case 2 of local stability analysis in section 4.4.2.

Though the case of multiple equilibria depicted in figure 4.4 is a possible theoretical solution, it has no empirical relevance since settling down in stable fixed points A or C would mean that economic agents persistently under- or overestimate the actual profit rate due to \( \rho_E \neq 0 \) in A and C lying near the corner points of the normal range of \( \rho \). Consequently, hypersensitively reacting investors do not behave rationally even in the long-run, which has been assumed explicitly to hold according to the expectation formation scheme \( \dot{\rho} = f(\rho, \sigma, \lambda) \). Moreover, the dynamic system is subject to path dependent behaviour, i.e. whether the system comes to a halt in the “good” (golden-age) boom equilibrium C, or settles down in the “bad” depression equilibrium A, is a matter of chance since the long-run steady-state is dependent on the initial starting position which can be located everywhere in the \((\lambda, \rho)\)-space. Guaranteeing a unique long-run stable solution at point B by assuming, like in rational expectations models, that rational investors can always “jump” on the stable branches of the saddle point is not possible in the present case since the state of confidence \( \rho \) does not exhibit the characteristics of a pure forward looking or jump variable, firstly, owing to its dependence on the two backward looking
variables $\sigma$ and $\lambda$, and secondly due to the assumption that investors are not subject to (short-run) rational behaviour according to the rational expectations hypothesis.\footnote{For the distinction between forward and backward looking variables, and their influence on general solutions to rational expectations models, see appendix D.}

It has to be emphasized however, that there exists the possibility of jumps in $\rho$ independently of the current state of economic fundamentals $\sigma$ and $\lambda$, in case the economy is hit by direct exogenous shocks having only an influence on the current state of $\rho$. By way of contrast, direct exogenous shocks to fundamentals $\sigma$ and $\lambda$, as well as indirect exogenous shocks to $\sigma$ and $\lambda$ via shocks to other variables influencing $\sigma$ and $\lambda$, do not lead to a jump in $\rho$. For example, the introduction of a new technology regime or beginning financial liberalization can cause a sudden upward "jump" in $\rho$ due to a discontinuous rise in profit expectations though there is no change in fundamentals $\sigma$ and $\lambda$, as well as no exogenous shock to other variables influencing $\sigma$ and $\lambda$. Despite the fact that direct shocks to $\rho$ lead to a discontinuous change of the $\rho$-coordinate within the $(\lambda, \rho)$-space, they do not cause a change of the two demarcation curves, as well as no alteration of the vector field, i.e. there is no change of trajectories. As a result, direct exogenous shocks to the state of confidence $\rho$ interrupt past dynamic behaviour by jumping to another new initial condition setting up a new dynamic process in the $(\lambda, \rho)$-space. In the same way, a direct exogenous shock to the debt-asset ratio $\lambda$ causes a change of the $\lambda$-coordinate within the $(\lambda, \rho)$-space without changing demarcation curves and trajectories. By way of
contrast, a direct exogenous shock to $\sigma$, as well as any exogenous shock to other variables influencing $\sigma$ cause firstly, a change both in the position and in the slope of the two demarcation curves, and secondly, a change in the slope of the current trajectory though the system rests at the current $(\lambda, \rho)$-coordinate at the moment of the shock, i.e. there arise no jumps within the $(\lambda, \rho)$-space but changes in the vector field.38

Despite the fact that there are possible jumps in the state of confidence $\rho$, there is no mechanism as in rational expectations models guaranteeing that the jump in $\rho$ catapults the dynamic system to the stable branches of the saddle point, thereby leading to a unique and asymptotically stable intertemporal equilibrium. As a result, the dynamic system under hypersensitively reacting investors is most likely to settle down either in stable fixed point $A$ or in stable fixed point $C$, since the probability of reaching the stable branches of the saddle point $B$ is very low. However, settling down in $A$ or $C$ means that investors are subject to long-run expectations errors, which is on the one hand a very unrealistic scenario from an empirical point of view, and on the other hand not consistent with the model assumption of long-run rational behaviour. Thus, it seems reasonable to assume that, in case the system has settled down either in $A$ or $C$, investors are going to readjust their profit expectations after having realized that expectations cannot be fulfilled by the actual development of the profit rate, leading to a change in the expectation formation scheme until the actual profit rate corresponds to its expectation value, i.e. until the system comes to a halt in the long-run rational expectations equilibrium $\rho_E = 0$. Formally, the assumption of readjusting expectations as long as they are fulfilled by actual data means that settling down either in $A$ or $C$ leads to a shift in the expectation formation function $\hat{\lambda} = f(\rho, \sigma, \lambda)$ and, as a result, in demarcation curve $\hat{\rho} = F_2(\lambda, \rho) = 0$ until the long-run rational expectations equilibrium $\rho_E = 0$ is realized.

Accordingly, it seems reasonable to assume that the long-run steady state value of the state of confidence $\rho$ is the long-run rational expectations equilibrium $\rho_E = 0$ since each constellation $r^e \neq r$ leads to a readjustment of functions $\hat{\lambda} = f(\rho, \sigma, \lambda)$ and $\hat{\rho} = F_2(\lambda, \rho) = 0$ until $\rho_E = 0$ is realized. Moreover, it seems also reasonable to assume that there exists only one fixed point $(\lambda_E, \rho_E)$ for which it holds that $\rho_E = 0$ and $\lambda_E > 0^{39}$, since a unique value for $\rho_E$ implies a unique value for $\lambda_E$ due to the fact that demarcation curve $\hat{\lambda} = F_1(\lambda, \rho) = 0$ is a strictly monotone increasing function in the $(\lambda, \rho)$-space. However, these two assumptions, which are necessary conditions for a meaningful empirical result, require that investors react “normally” within the normal range for $\rho$, i.e. the dynamic system has to fulfill the condition $\partial f / \partial \rho > 0$ and $\partial F_2 / \partial \rho > 0$ within the normal range, implying a much less steeper demarcation curve $\hat{\rho} = F_2(\lambda, \rho) = 0$, and giving rise to a single fixed point as depicted in figure 4.5.

38 The impact of different kinds of exogenous shocks on the $(\lambda, \rho)$-phase plane can be studied by analyzing the impact on the two demarcation curves, as well as on the integral curves which are formally given by

$$
\frac{d\lambda}{d\rho} = \frac{F_1(\lambda, \rho)}{F_2(\lambda, \rho)} = \frac{(1 - \lambda) \eta(q) - s_r r - \hat{\rho} \lambda}{f(\rho, \sigma, \lambda)},
$$

having been derived by eliminating $dt$ from system 4.19 and 4.20. For a formal treatment of integral curves, see Gandolfo (1997), chapter 21.3.2.1.

39 Negative values for $\lambda$, which would imply that the firm sector owns financial claims towards the banking system, are excluded by assumption.
Figure 4.5: Phase Diagram in Case of Normally Reacting Investors Within the Normal Range of $\rho$

The dynamic system under normally reacting investors in figure 4.5 is characterized by a single fixed point $D$ for which it holds that $\rho_E = 0$ and $\lambda_E > 0$. Equilibrium point $D$ is asymptotically unstable since both demarcation curves have a positive slope, whereas the slope of demarcation curve $\dot{\lambda} = F_1(\lambda, \rho) = 0$ is steeper than demarcation curve $\dot{\rho} = F_2(\lambda, \rho) = 0$ at point $D$ because $\partial f / \partial \rho > 0$ and $\partial F_2 / \partial \rho > 0$, i.e. formally it holds that

$$\left(\frac{\partial \lambda}{\partial \rho}\right)_{F_1} > \left(\frac{\partial \lambda}{\partial \rho}\right)_{F_2}$$

$$\frac{\partial F_1}{\partial \rho} > -\frac{\partial F_2}{\partial \rho}$$

This inequality yields, after rearranging terms, the determinant of the Jacobian at fixed point $D$, being denoted as $|J(D)|$, having a positive sign since

$$|J_D| = \frac{\partial F_1}{\partial \lambda} \frac{\partial F_2}{\partial \rho} - \frac{\partial F_1}{\partial \rho} \frac{\partial F_2}{\partial \lambda} > 0.$$ 

The trace of the Jacobian matrix at fixed point $D$, which is denoted as $trJ(D)$, has also a positive sign since

$$trJ_D = \frac{\partial F_1}{\partial \lambda} + \frac{\partial F_2}{\partial \rho} > 0,$$
giving rise to an unstable local fixed point (unstable node or unstable focus) according to case 3 of local stability analysis in section 4.4.2. One important dynamic property of the phase diagram in figure 4.5 is the fact that the non-linear system causes counterclockwise cyclical motions which cannot converge to the unstable fixed point $D$, giving rise to the question of global dynamic stability being analyzed in the following section.

4.4.4 The Global Dynamics of the System

The Emergence of a Globally Stable Closed Orbit. Phase diagram analysis has concluded that the case of normally reacting investors depicted in figure 4.5 can be considered as a good approximation to the formation of expectations under irreducible uncertainty since it allows for a single fixed point at the long-run rational expectations equilibrium $\rho_E = 0$. However, a first ad-hoc interpretation of the global dynamics in figure 4.5 causes doubts regarding global dynamic stability in the sense that the system actually converges to $\rho_E = 0$ for two reasons. Firstly, though the long-run rational expectations equilibrium $\rho_E = 0$ exists, the system cannot settle down in unstable fixed point $D$ unless the system starts in point $D$. Secondly, it is not clear whether the system is going to explode by outward spiraling counterclockwise motions, or whether the system comes to a cyclical halt, i.e. whether the system converges to a closed curve so that there exists at least a cyclical tendency to reach the long-run rational expectations equilibrium $\rho_E = 0$. That is, there arises the question whether the model economy is subject to increasing instability in the sense that boom-bust cycles and financial crises tend to become more and more pronounced, or whether there exists a “cyclical” equilibrium to which the system converges, being characterized by stable boom-bust cycles with constant amplitudes which are possibly subject to financial distress.

In mathematical terms, the main question reads whether there arise closed orbits in figure 4.5 which are attractors. If a closed orbit is an attractor, it will be defined as a limit cycle in the following. The existence of limit cycles can be proved by the Poincaré-Bendixon theorem providing sufficient conditions for the existence of closed orbits in particular sub-areas of the plane\(^{40}\) which reads as:

**Theorem 4.1 (The Poincaré-Bendixon Theorem)** A non-empty compact limit set of a $C^1$ dynamical system in $\mathbb{R}^2$, which contains no fixed point, is a closed orbit.

The proof of the existence of closed orbits in the present case by applying the Poincaré-Bendixon theorem is outlined by geometrical considerations of figure 4.6 which is an extended version of figure 4.5. The first prerequisite for the emergence of closed orbits is the existence of an invariant or compact set $D$. In geometrical terms, an invariant set $D$ is a set whose vector field on the boundary points inwards everywhere, so that all trajectories once having entered the set will stay within the compact set for all $t$. The definition of an invariant set $D$ in the $(\lambda, \rho)$-space requires to impose global boundedness on variables $\lambda$ and $\rho$. Regarding the debt-asset ratio $\lambda$, values smaller than zero, i.e. $\lambda < 0$, are not possible by definition since a negative debt-asset ratio would imply that business firms own claims on the banking sector. Thus, it seems reasonable to assume

\( \lambda = 0 \) as a lower bound which cannot be fallen short of. Respecting the upper bound of \( \lambda \), a value smaller than one, i.e. \( \lambda < 1 \), could serve as a realistic reference value. However, in case of systemic financial crises, a value greater than one, i.e. \( \lambda > 1 \) implying bankruptcy of the entire firm sector, has to be regarded, though being an event with low probability from an empirical viewpoint, as a possible scenario as well. As a result, it seems reasonable to assume an upper bound \( \lambda > 1 \) to exist, which however cannot increase to infinity, since in case of bankruptcy of the entire firm sector debt relief or debt restructuring supported by the domestic government is likely to occur preventing \( \lambda \) to exceed a certain positive threshold. Summing up, the debt-asset ratio \( \lambda \) is assumed to have a lower bound \( \lambda = 0 \), and an upper positive bound \( \lambda > 1 \). Regarding global boundedness of the state of confidence, \( \rho \) is allowed to take possible negative and positive values largely lying outside the normal range \( p_1 < 0 < p_u \), which are however bounded since it seems unrealistic to assume infinite positive as well as infinite negative values of \( \rho \). Summing up, the model assumes that there exists a negative lower and a positive upper bound for \( \rho \) whose range exceeds the normal range \( p_1 < 0 < p_u \).

The global bounds imposed on \( \lambda \) and \( \rho \) within the \((\lambda, \rho)\)-space allow for the construction of an invariant set in figure 4.6 which is given by the simply connected set \( V \), being described by rectangle \( EFGH \). As the vector field on the boundaries of compact set \( D \) in figure 4.6 indicates, there arise situations in which trajectories may hit the boundaries, but cannot leave due to global boundedness assumptions on \( \lambda \) and \( \rho \) to guarantee that a trajectory once having entered the compact set \( D \) cannot leave it any more. For example, the trajectory starting in point \( Z \) hits the boundary of \( D \) in \( Z' \) and would naturally leave compact set \( D \) in northwest direction unless it has been assumed that there exists an upper bound for \( \lambda \). As a result, once the trajectory starting in \( Z \) has reached point \( Z' \), the trajectory is going to move along the vertical boundary from \( Z' \) to \( Q \), and then back into the interior of set \( D \). In case the boundaries' modification along the passages \( GQ \) and \( EO \) was neglected by giving up the strict boundedness assumptions on \( \lambda \) and \( \rho \), an alternative invariant set could be set up by area \( OFPQRST \) which reduces the feasible global range of \( \lambda \) and \( \rho \) but arises naturally. Despite the fact that compact set \( OFPQRST \) requires less restrictive assumptions respecting global boundedness, the following analysis refers to compact set \( D \) described by area \( EFGH \) since the global boundedness assumptions made above on \( \lambda \) and \( \rho \) cover a broader class of possible realizations within the \((\lambda, \rho)\)-space both from a theoretical and from an empirical viewpoint.

After having shown that the first prerequisite for the emergence of closed orbits is met, i.e. that a trajectory, once having entered the invariant set \( D \), stays within the set for all \( t \), there arises the question how a trajectory may move after it has entered the set, i.e. whether the system converges to a closed orbit within compact set \( D \), or whether the system is subject to different dynamic patterns excluding the existence of closed orbits. In mathematical terms, the question reads whether the invariant set \( D \) contains limit sets. In \( \mathbb{R}^2 \) there exist three possible forms of limit sets, namely fixed point attractors, limit cycles and saddle loops (or separatrices), differing firstly with respect to the number of fixed points, and secondly with respect to the local stability properties of these fixed points. In case the invariant set \( D \subset \mathbb{R}^2 \) contains limit sets, all three types of limit sets are possible among which the Poincaré-Bendixon theorem distinguishes. A fixed point attractor

---

\[41\) For the difference between "simply connected sets" and "connected sets" see Arrowsmith and Place (1990), p. 111 and Debreu (1959), p. 15.\]
one possible form of limit sets in \( \mathbb{R}^2 \) does not give rise to a closed orbit according to the Poincaré-Bendixon theorem since it requires the limit set to contain no fixed point, i.e. to contain only one fixed point being locally unstable, so that trajectories starting near the fixed point are going to be repelled from it. Consequently, as trajectories in continuous-time dynamical systems cannot cross, the only possible remaining limit sets emerging in the compact set \( \mathcal{D} \) are limit cycles or saddle loops if the fixed point is unstable. As saddle loops imply at least one further fixed point being subject to saddle point behaviour, this possibility is excluded from the Poincaré-Bendixon theorem. As a result, if there is no possibility for trajectories to leave the compact set \( \mathcal{D} \) once they have entered the set, and if there is no possibility for trajectories to reach the single unstable fixed point, and if there is no possibility for trajectories at first to spiral inwards to the fixed point and afterwards to spiral outwards to the boundaries of \( \mathcal{D} \) and vice versa since trajectories cannot cross, it follows that all initial points in the compact set \( \mathcal{D} \) must converge to a closed curve, i.e. to a limit cycle for \( t \to \infty \).

Despite the fact that the Poincaré-Bendixon theorem excludes the fixed point from the limit set giving rise to a closed orbit, a closed orbit in \( \mathbb{R}^2 \) always encloses a fixed point according to the following theorem:

**Theorem 4.2** A closed trajectory of a continuously differentiable dynamical system in \( \mathbb{R}^2 \), given by the two-dimensional differential equation system

\[
\begin{align*}
\dot{x}_1 &= f(x_1, x_2) \\
\dot{x}_2 &= g(x_1, x_2),
\end{align*}
\]

must necessarily enclose a fixed point with \( \dot{x}_1 = \dot{x}_2 = 0. \)

Summing up, the existence of a closed orbit in \( \mathbb{R}^2 \) for a given dynamic system according to the Poincaré-Bendixon theorem can be proved by the following procedure. At first, locate a fixed point of the dynamic system and explore its stability characteristics. Then, in case the fixed point is unstable, search for a compact set \( \mathcal{D} \) enclosing the unstable fixed point. In case a closed orbit does not coincide with the boundaries of invariant set \( \mathcal{D} \), the vector field of the dynamic system must point into the interior of set \( \mathcal{D} \) giving rise to closed orbits and to at least one limit cycle.

In terms of figure 4.6, the Poincaré-Bendixon theorem is fulfilled since firstly, the fixed point \( D \) is unstable, and secondly, everywhere on the boundary of the compact set \( \mathcal{D} \) the vector field points inwards implying the existence of a globally stable closed orbit, i.e. a limit cycle, which is drawn as a thick circle moving in counterclockwise direction. The convergence of all initial points in \( \mathcal{D} \) towards the limit cycle is shown by two sample trajectories, one starting in point \( I \) spiraling inwards and converging to the limit cycle, and the other one starting in point \( J \) spiraling outwards and converging to the limit cycle.

One drawback of the Poincaré-Bendixon theorem is the fact that the theorem only provides sufficient conditions for the existence of closed orbits in an invariant set \( \mathcal{D} \), but does not make any statement about the number of closed orbits. Thus, it is possible that, as e.g. in figure 4.6, there arise several closed orbits. Accordingly, the Poincaré-Bendixon theorem only provides sufficient conditions for the existence of at least one limit cycle, i.e. a closed orbit being dynamically stable. It is obvious that in case there are more closed orbits, they do not cross.
orbits, not all of them can be attracting, i.e. not all closed orbits can be limit cycles. It holds that in case the fixed point is unstable, the innermost cycle in the compact set \( D \) is stable, that is, that the innermost closed orbit in \( D \) is a limit cycle. Additional closed orbits with increasing amplitude are alternately unstable and stable implying that the innermost and the outermost closed orbits are limit cycles. Ergo, if there exists only one closed orbit, this closed orbit is a limit cycle.

The question of how many closed orbits arise in a dynamical system is highly important since the choice of the initial condition in case of multiple cycles determines the long-run amplitude. Especially in business cycle models, the number of cycles determines whether it is possible to reduce the amplitude by “choosing the most convenient initial condition” or not. In the present case, the number of cycles is of special importance since in the case of multiple limit cycles there arise some equilibrium cycles near the unstable fixed point \( D \) being subject to low long-run amplitudes and financial stability, whereas there exist other long-run equilibrium cycles having a much larger radius with high amplitudes and much longer duration, giving rise to permanent and recurrent financial crises. Which kind of cycle is going to be realized in the long-run is dependent on the initial condition which is predominantly influenced by exogenous shocks. As a result, the existence of multiple limit cycles in the present case implies general dynamic instability of the model economy since exogenous events are able to catapult a long-run financially stable economy with
low business cycle amplitudes into a long-run financially unstable economy with high
business cycle amplitudes and vice versa. Furthermore, the existence of multiple limit
cycles excludes the existence of endogenous mechanisms which guarantee a return to a
cyclically equilibrium situation with low amplitudes and financial stability after the model
economy has been hit by an adverse exogenous shock.

This result justifies permanent market interventions of a social planner in order to
guarantee a long-run financially stable equilibrium situation with low business cycle am-
plitudes. Mathematically, interventions by a social planner in case of multiple limit cycles
would mean to “choose” a “better” initial condition after the occurrence of a shock in
order to guarantee a long-run convergence to a limit cycle with low business cycle am-
plitudes and financial stability. Yet, despite the existence of multiple cycles, it is often
not possible to set up a new dynamic process by jumping instantaneously to a new and
“better” initial condition after the occurrence of an adverse exogenous shock due to the
backward looking characteristics of \( \lambda \) and \( \rho \), as well as due to the inability of the social
planner to cause a sudden change in profit expectations.

It has to be emphasized however, that the debt-asset ratio can be controlled by the
social planner via financial market regulation in order to prevent a shift from a financially
stable into a financially unstable situation in the case of an exogenous shock. For example,
imposing an upper bound on the level of indebtedness by credit ceilings reduces the risk of
widespread illiquidity and insolvency in case of an adverse shock. However, in a financially
liberalized system there is no possibility for a social planner to guarantee financial stability
by imposing global bounds on \( \lambda \). Furthermore, though it has been argued above that there
are no possibilities for a social planner to induce jumps in the \((\lambda, \rho)\)-space after an adverse
shocks, there exists the possibility to change the debt-asset ratio via debt relief or debt
restructuring negotiations, initiating a new dynamic process by jumping to a new initial
condition. Still, in most cases, debt relief or debt restructuring negotiations only take
place a long time after an economy has experienced a systemic financial crises which has
been followed by a long depression period. Thus, though it is possible for a social planner
to change the debt-asset ratio, there is no possibility to catapult \( \lambda \) to a favourable initial
condition shortly after the occurrence of an adverse shock in order to neutralize negative
repercussions immediately.

Consequently, the existence of multiple limit cycles implies firstly, that capitalist sys-
tems are inherently unstable, secondly, that long-run stability or long-run instability are
determined by random events, thirdly, that an economy being subject to a “vicious” equi-
librium cycle with high amplitudes experiences recurrent financial crises, and fourthly,
that vicious cycles can be only left by exogenous events. However, stylized facts of finan-
cial crises have shown firstly, that economies tend to be stable in the long-run, secondly.
that financial crises are not predominantly a consequence of exogenous shocks but also an
endogenous phenomenon, thirdly, that not each business cycle generates financial crises,
and fourthly, that in spite of very long recovery periods, economies generally tend to
return to an equilibrium situation being characterized by low business cycle amplitudes
and financial stability. Consequently, the case of multiple limit cycles seems not to be
applicable to real world phenomena. By way of contrast, in case the dynamic system
is subject to only one closed orbit, which could serve as an reference equilibrium busi-
ness cycle with moderate amplitudes and financial stability representing “tranquil times”,
there are endogenous mechanisms guaranteeing a return to the equilibrium cycle in case
The economy has been hit by an exogenous shock having induced an excessive boom-bust cycle and a financial crisis. Furthermore, a single limit cycle with long-run endogenous financial stability would make permanent interventions by a social planner superfluous. As a result, the model's potential to be applicable to real world phenomena depends on the number of closed orbits arising from system 4.19 and 4.20.

There are only few methods of determining the uniqueness of limit cycles which are not generally applicable to all dynamic systems due to their complexity. One of the few non-linear dynamical systems for which sufficient conditions for the uniqueness of limit cycles can be established is the so-called generalized Liénard-equation having been developed from the van der Pol equation which describes relaxation phenomena in physics.\textsuperscript{43} Hence, in order to prove the uniqueness of a limit cycle in economic systems, the original non-linear system has to be transformed, if it is possible at all, into a generalized Liénard-equation which requires very restrictive assumptions regarding the differential equation system.\textsuperscript{44} The technique of the generalized Liénard-van-der-Pol equation is not going to be applied in the present case firstly, in order not to lose the general validity of the model, and secondly, due to arising complexity which would not provide more relevant insights. A more convenient method to prove the existence and uniqueness of closed orbits, which does not require a transformation of the original dynamic system into a specific functional form, is the application of the \textit{Hopf Bifurcation Theorem} named after E. Hopf (1942) being used in the present case and outlined in detail below.

\textbf{The Emergence of a Supercritical Hopf Bifurcation.} The local stability properties of non-linear systems are generally examined in a two step procedure, where the first step involves a transformation of the non-linear system into a linear one, and the second step an analysis of the Jacobian's trace and determinant at the local fixed points. In case the real parts of the latent roots of the linearly approximated dynamical system are negative/positive, the original non-linear system is locally stable/unstable. However, if the real parts of the linearly approximated system are zero, giving rise to cyclical behaviour, it is not possible any more to examine the local behaviour of the non-linear system by its linear approximation since the \textit{Hartman-Grobman Theorem}\textsuperscript{45} is only valid for nonzero real roots. This is exactly the case where the Hopf bifurcation theorem comes into help to study the local dynamics of the non-linear system.

Bifurcation theory in general studies the question whether the qualitative characteristics of a dynamic system change when one or more (exogenous) parameters are changed. The value of the parameter at which the dynamic patterns change is called bifurcation value. The Hopf bifurcation theorem, requiring at least a $2 \times 2$ system to appear, is of special interest since it shows how a system with a stable fixed point can lose its stability, giving rise to a (possibly) stable closed orbit when an important parameter on which

\textsuperscript{43}For an analytical treatment regarding the uniqueness of limit cycles by applying the Liénard-equation, see e.g. Yan-Qian (1986), Gandolfo (1997), pp. 439-441, and Lorenz (1993), chapters 2.3 and 2.5.

\textsuperscript{44}For the transformation of Kaldor's (1940) non-linear business cycle model into a relaxation oscillation type model by modifying assumptions see e.g. Gandolfo (1997), pp. 445-447 and Lorenz (1993), pp. 57-60.

\textsuperscript{45}The \textit{Hartman-Grobman Theorem} states that the local properties of a linearized (non-linear) dynamical system can be carried over to the original non-linear system if the linear system's Jacobian matrix has no root with zero real part (zero real root or pure imaginary root). For details, see Guckenheimer and Holmes (1986), p. 13.
the system depends, is changed. It has been outlined many times in the present model that both the local, as well as the global dynamics of system 4.19 and 4.20 are predominantly determined by the strength of the influence of the current state of confidence \( \rho \) on investors' change in profit expectations \( \dot{\rho} \), so that derivative \( \partial f / \partial \rho \) can be used as the relevant parameter \( \mu \) to study the nature of bifurcation that takes place when investors’ sensitivity changes.

The Hopf bifurcation theorem consists of two parts. The existence part provides sufficient conditions for the emergence of closed orbits in a neighborhood of a fixed point under certain conditions, whereas the stability part provides sufficient conditions for orbital stability of the cycle.\(^{46}\) To study the nature of the Hopf bifurcation, consider the continuous-time system

\[
\dot{x} = f(x, \mu), \quad x \in \mathbb{R}^n, \quad \mu \in \mathbb{R},
\]

where \( \mu \) is the bifurcation parameter. Assume that the system possesses an unique equilibrium point \( x_0^* \) at the value \( \mu_0 \) of the parameter \( \mu \), i.e. assume that for each value of \( \mu \) the system has an isolated equilibrium point \( x_0^* \) which can be obtain by solving the system

\[
\dot{x} = 0 = f(x_0^*, \mu_0).
\]

Likewise, assume that the determinant of the Jacobian matrix \( J \) of the basic system differs from zero for all possible fixed points \( (x, \mu) \). Then, by applying the implicit function theorem it can be shown that there exists a smooth function \( x^* = x^*(\mu) \), that is, for every parameter value \( \mu \) (in a certain neighborhood) there exists a unique fixed point \( x^* \).

In order to derive the formal conditions of the existence part of the Hopf bifurcation theorem, assume that this fixed point is stable for small values of \( \mu \), i.e. that the system has a stable fixed point for values \( \mu < \mu_0 \).\(^{47}\) The existence part itself provides sufficient conditions for the existence of closed orbits in a neighborhood of a fixed point for appropriate values of the parameter \( \mu \), reading as\(^{48}\):

**Theorem 4.3 (Hopf Bifurcation - Existence Part)** Suppose that the dynamic system

\[
\dot{x} = f(x, \mu), \quad x \in \mathbb{R}^n, \quad \mu \in \mathbb{R}
\]

has a fixed point \( (x_0^*, \mu_0) \) at which the following properties are satisfied:

\[ H.1 \] The Jacobian matrix of the dynamical system, evaluated at \( (x_0^*, \mu_0) \), has a pair of pure imaginary eigenvalues and no other eigenvalues with zero real parts.

This implies that there is a smooth curve of fixed points \( (x^*(\mu), \mu) \) with \( x^*(\mu_0) = x_0^* \). The complex conjugate eigenvalues \( \theta(\mu), \bar{\theta}(\mu) \) of the Jacobian which are purely imaginary at \( \mu = \mu_0 \) vary smoothly with \( \mu \). If moreover

---


\(^{47}\)Alternatively, it is possible as well to assume that there exists an unstable fixed point for values \( \mu < \mu_0 \). In that case, all statements which are going to be made above in the form of \( \mu \geq \mu_0 \) have to be reversed.

\[ H.2 \quad \frac{d \text{Re} \theta (\mu)}{d \mu} \bigg|_{\mu = \mu_0} > 0, \]

then the system has a family of periodic solutions where the critical value \( \mu_0 \) is called the Hopf bifurcation point of the system.

The theorem states firstly, that in case parameter \( \mu \) is increased from \( \mu < \mu_0 \) to \( \mu > \mu_0 \) the unique fixed point changes its stability properties from local stability into local instability as the real parts \( \text{Re} \theta \) become positive, and secondly, that there arise closed orbits for \( \mu \geq \mu_0 \).

Consequently, in order to show the emergence of closed orbits in the present case the first step, according to condition \( H.1 \) of the existence part, is to show the emergence of pure imaginary roots at the critical value \( \mu = \mu_0 \) where it holds that \( \mu = \partial f / \partial \rho = \partial \rho / \partial \rho \). The characteristic equation of the system 4.19 and 4.20, being determined from the Jacobian matrix, reads as

\[
\begin{align*}
\theta^2 + & \left( -\frac{\partial F_1}{\partial \lambda} - \frac{\partial F_2}{\partial \rho} \right) \theta + \left( \frac{\partial F_1}{\partial \lambda} \frac{\partial F_2}{\partial \rho} - \frac{\partial F_1}{\partial \rho} \frac{\partial F_2}{\partial \lambda} \right) = 0, \\
& a_1 = -\text{tr}J \\
& a_2 = |J|
\end{align*}
\]

giving the roots as

\[
\theta_{1,2} = -\frac{a_1}{2} \pm \frac{\sqrt{4a_2 - a_1^2}}{2} i.
\]

A pair of pure imaginary roots emerges only in case the following two conditions are fulfilled. Firstly, the determinant of the Jacobian \( |J| = a_2 \) has to have a positive sign, i.e. formally it must hold that

\[
|J| = a_2 > 0,
\]

and secondly, the real part of the roots has to become zero which implies a zero value of the Jacobian’s trace \( \text{tr}J = -a_1 \), i.e. formally it must hold that

\[
\text{Re} \theta = -\frac{a_1}{2} = 0 \quad \text{implies} \quad a_1 = -\text{tr}J = 0.
\]

The first condition \( a_2 = |J| > 0 \) is met since the positive slope of demarcation curve \( \lambda = F_1(\lambda, \rho) = 0 \) is larger than the positive slope of demarcation curve \( \dot{\rho} = F_2(\lambda, \rho) = 0 \), a condition which has been imposed in order to guarantee the unique long-run rational expectations equilibrium in figures 4.5 and 4.6. Generally, the system has a positive determinant firstly, in case \( \partial f / \partial \rho \) has a negative or zero value, i.e. in case \( \mu = \partial f / \partial \rho \leq 0 \), and secondly in case \( \partial f / \partial \rho \) is “normally” positive, i.e. in case \( \mu = \partial f / \partial \rho > 0 \), implying “normally” reacting investors within the normal range; these two cases correspond to cases 1 and 3 of the local stability analysis. However, condition \( a_2 > 0 \) is not met in case investors behave hypersensitively, i.e. in case it holds that \( \mu = \partial f / \partial \rho > 0 \), corresponding to case 2 of local stability analysis which has been ruled out. Summing up, condition \( a_2 > 0 \) is fulfilled for all possible values of function 4.20.

The second condition \( a_1 = 0 \) determines the critical value of the parameter \( \mu \), or the Hopf bifurcation point, when the real part becomes zero giving rise to the emergence
of closed orbits. Using the fact that \( \partial F_2/\partial p = \partial f/\partial p + (\partial f/\partial \sigma)(\partial \sigma/\partial p) \), the Hopf bifurcation point \( \mu_0 = (\partial f/\partial p)_0 \) is given as

\[
\mu_0 = \left( \frac{\partial f}{\partial p} \right)_0 = -\frac{\partial F_1}{\partial \lambda} - \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial p},
\]

stating that at \( \mu_0 \), the real parts of the roots \( Re \theta \), and \( a_1 \) become zero. To answer the question which nature the real parts of the roots possess for values \( \mu > \mu_0 \) and \( \mu < \mu_0 \), one can show that if

\[
Re \theta = \frac{-a_1}{2} \leq 0,
\]

implying

\[
a_1 \geq 0,
\]

then it holds that

\[
\frac{\partial F_1}{\partial \lambda} - \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial p} \geq \frac{\partial f}{\partial p},
\]

or

\[
\mu_0 \geq \mu,
\]

respectively. Summing up, it holds that

\[
Re \theta \leq 0 \iff a_1 \leq 0 \iff \mu \leq \mu_0.
\]

Using words, this condition implies that for values \( \mu < \mu_0 \), there arise no closed orbits and that there exists a stable fixed point because of \( a_1 > 0 \) implying \( Re \theta < 0 \). For values \( \mu > \mu_0 \), there arise closed orbits and the fixed point is unstable because of \( a_1 < 0 \) implying \( Re \theta > 0 \). At the bifurcation point it holds that \( \mu = \mu_0 \), implying \( a_1 = 0 \) and \( Re \theta = 0 \), i.e. there arise closed orbits since the real parts of the roots vanish, and the fixed point is locally unstable. Summing up, condition \( H.1 \) is fulfilled, i.e. at \( \mu_0 \) the Jacobian has a pair of pure imaginary roots \( \theta = \pm \sqrt{a_1} i \) causing cyclical behaviour of the system. The roots remain conjugate complex for \( \mu > \mu_0 \) sufficiently near to \( \mu_0 \).

As to condition \( H.2 \) of the Hopf bifurcation theorem, it is easy to check that

\[
\left. \frac{d Re \theta(\mu)}{d \mu} \right|_{\mu=\mu_0} = \left. \frac{d(-\frac{1}{2} a_1)}{d \left( \frac{\partial f}{\partial p} \right)} \right|_{\mu=\mu_0} = -\frac{1}{2} \left( -\frac{\partial F_1}{\partial \lambda} - \frac{\partial f}{\partial \sigma} \frac{\partial \sigma}{\partial p} \right) = \frac{1}{2} > 0,
\]

i.e. condition \( H.2 \) is fulfilled as well. Consequently, the existence of a closed orbit in the present model according to theorem 4.3 is proved.

Despite the fact that the existence part of the Hopf bifurcation theorem 4.3 provides sufficient conditions for the emergence of closed orbits it cannot make any statement on stability properties of emerging cycles. Generally, checking the stability of closed orbits by calculating the normal form of a dynamical system is very complex and does, in lots of cases, not give any results for general function models unless the models are going to be parameterized which means referring to a special subcase and losing the general validity of the results.\(^{49}\) This drawback gives rise to the conclusion that bifurcation theory in

comparison with the Poincaré-Bendixon theorem cannot provide any new insights and is in a certain sense "inferior" because the Poincaré-Bendixon theorem can prove, among the emergence of closed orbits, the existence of at least one limit cycle. However, if the stability properties of a Hopf bifurcation can be determined, bifurcation theory can provide useful insights as to the uniqueness of limit cycles which cannot be investigated by the Poincaré-Bendixon theorem, but only by generalized Liénard equations which are difficult to use. Still, in many cases, checking the stability of the closed orbits emerging from Hopf bifurcations is as laborious as applying the generalized Liénard equation, so that the determination of the number of limit cycles remains a difficult, if not impossible task.

There are special cases however, being characterized by specific functional forms of demarcation curves, as e.g. quadratic or cubic functions, giving rise to so-called sub- or supercritical Hopf bifurcations which allow for the determination of the number and the stability of closed orbits. In the present case, it can be shown that the situation in figure 4.6 engenders only one stable limit cycle since the Hopf bifurcation is supercritical. The supercritical Hopf bifurcation is characterized by the fact that for parameter values \( \mu < \mu_0 \), the local fixed point is stable and there are no closed orbits, whereas for parameter values \( \mu > \mu_0 \) the fixed point is unstable and there are closed orbits which are attractors, i.e. limit cycles appear. Generally, there arises a supercritical Hopf bifurcation in \( \mathbb{R}^2 \), if firstly, one of the two demarcation curves can be described by a polynomial of the type

\[
\lambda(\rho) = -b_0 \rho^3 + b_1 \rho^2 \pm b_2 \rho \pm b_3, \quad b_1 > 0,
\]

where \( b_1 \) has to be chosen sufficiently small, giving rise to a cubic function of the type shown in figure 4.6, and secondly, if the second demarcation curve is steeper at the fixed point than the non-linear demarcation curve. In the present case in figure 4.6, these two conditions are fulfilled, since firstly, demarcation curve \( \dot{\rho} = F_1(\lambda, \rho) = 0 \) can be described by the cubic polynomial cited above, and secondly, because demarcation curve \( \lambda = F_2(\lambda, \rho) = 0 \) is steeper in fixed point \( D \) than demarcation curve \( \dot{\rho} = F_1(\lambda, \rho) = 0 \).

Summing up, the Hopf bifurcation in the present case is supercritical which implies that for each parameter value there is only one cyclically stable closed orbit. This implies in terms of figure 4.6, which is drawn for a special parameter value \( \mu > \mu_0 \), that there exists only one limit cycle, i.e. all trajectories starting in the invariant set \( \mathcal{V} \) converge to this limit cycle. In this case, the local information of the Hopf bifurcation serves to specify the global information of the Poincaré-Bendixon theorem.

### 4.4.5 A Dynamic View of Financial Crises and Macroeconomic Fluctuations

Empirical data and the comparative static version of the model have shown that the two core variables \( \lambda \) and \( \rho \) are mainly responsible for the emergence of boom-bust cycles

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\(^{50}\) Generally, the subcritical case, which is not going to be discussed in the following, and the supercritical case of the Hopf bifurcation are the most important cases whereas lots of other possibilities can emerge. For a full discussion and graphical representations of different cases, see Wiggins (1990), chapter 3.1B pp. 270-278. For a graphical representation and comparison of the subcritical and the supercritical case, see Lorenz (1993), pp. 97-101.

\(^{51}\) For a formal treatment of these conditions, see Wiggins (1990) chapter 3.1B, pp. 270-278, Lux (1992), p. 189, and Flaschel, Franke and Semmler (1997), chapter 3, pp. 33-60.
involving systemic financial crises. Other variables, like e.g. monetary policy variables \( m \) and \( h \), have an influence as well, but chiefly react on changes in \( \lambda \) and \( \rho \), i.e. changes in \( m \) and \( h \) can be interpreted as an endogenous reaction on the current state of \( \lambda \) and \( \rho \), and not as exogenous events irrespective of the actual level of \( \lambda \) and \( \rho \). One main drawback of comparative static analysis has been its descriptive-static character, so that stylized facts of financial crises could be explained only qualitatively by the use of static partial derivatives which were not in a position to determine quantitatively the overall net effect on endogenous variables in case the two counteracting forces \( \lambda \) and \( \rho \) have moved into the same direction. The dynamic version of the model however, bridges this theoretical gap by deriving explicit time paths for \( \lambda \) and \( \rho \), giving rise to an endogenous explanation of business cycles and financial fragility inducing financial crises. As financial crises are generally linked to business cycles, but not each business cycle generates a financial crisis, the following analysis is going to distinguish between so-called "equilibrium business cycles" generating no financial crisis and serving as a reference position, and cycles involving systemic financial crises.

4.4.5.1 The Emergence of Endogenous Long-Run Equilibrium Business Cycles

The long-run dynamic analysis has shown that the model economy, after it has been hit by an exogenous shock catapulting the system away from the limit cycle into the interior of compact set \( D \), converges in the long-run to a cyclically stable closed orbit with constant amplitudes by counterclockwise cyclical motions. As the two sample trajectories in figure 4.6 indicate, there are two possible forms of converging to the limit cycle. Initial conditions within compact set \( D \) but outside the limit cycle, as e.g. point \( I \) in figure 4.6, generate several cycles with shrinking amplitudes as they converge to the limit cycle; however, all converging cycles are subject to larger amplitudes than the closed orbit. By way of contrast, initial conditions within invariant set \( D \) but inside the limit cycle, as e.g. point \( J \) in figure 4.6, create several cycles with growing amplitudes where all cycles are subject to smaller amplitudes than the limit cycle. Once a trajectory has fully converged to the limit cycle, subsequent cycles (which can be theoretically infinite) exhibit a constant amplitude. Summing up, there exist three theoretical forms of long-run dynamic behaviour, i.e. a movement on the limit cycle, convergence from the outer region to the limit cycle, and convergence from the inner region to the limit cycle.

After having determined possible theoretical forms of long-run behaviour, there arises the question whether the dynamic patterns of the model fit the stylized facts of financial crises, or whether the model predicts outcomes which are theoretically possible, but never come up in reality. In graphical terms, there arises the question of whether the entire compact set \( D \) represents a feasible set for arising time paths, or whether some regions of invariant set \( D \) have to be excluded because they represent empirically irrelevant cases. The empirical analysis has identified the following four stylized facts regarding the long-run dynamics of financial crises and business cycles which are going to be compared with the theoretical long-run behaviour predicted by the model. Firstly, systemic financial crises are part of extensive boom-bust cycles in goods and financial markets being reflected in much larger amplitudes of key macroeconomic variables than in "tranquil times", i.e. during business cycles without the occurrence of financial crisis. Secondly, not each business cycle generates a financial crises. Thirdly, boom-bust cycles generating
financial crises are often preceded by a large exogenous shock, as e.g. the introduction of a new technology regime or liberalization of financial and goods markets, having a positive effect on expected future productivity and profits. Fourthly, after the occurrence of financial crises, economies generally tend to converge back to tranquil business cycle fluctuations though recovery periods can be very long (see e.g. the long recovery period following the Great Depression in the 1930s and 1940s, or the Japanese recovery path during the last decade without having recovered yet).

A comparison of long-run stylized facts with the dynamic patterns of the model, being illustrated in figure 4.7 which is a slightly modified version of figure 4.6, leads to the conclusion that the single limit cycle, being defined by points $A, B, C, D$ and $E$, represents an equilibrium business cycle to which economies converge in the long-run being characterized by modest and constant amplitudes and by the absence of financial crises. It has to be pointed out however, that even equilibrium business cycles in tranquil times generate scattered financial distress on the upper turning point of the business cycle leading to illiquidity and insolvency of business and financial firms. Still, this kind of financial distress is not in a position to cause a widespread system financial crises since only a small fraction of firms and banks are financially fragile. The inner area of the limit cycle in figure 4.7 represents an empirical irrelevant region since there are no disequilibrium cycles in reality with growing amplitudes converging to a stable long-run cycle, being subject to larger fluctuations and a higher degree of financial fragility on the upper turning point than all cycles during the convergence process. By way of contrast, the region between the boundaries of compact set $D$ and the outer bounds of the limit cycle gives rise firstly, to business cycles having a much larger amplitude than the equilibrium business cycle, and secondly, to cycles whose amplitude is shrinking during the convergence process. These cycles are subject to much larger fluctuations in the debt-asset ratio and in profit expectations giving rise to a build-up of widespread financial fragility during the upswing and possibly to systemic financial crises during the downswing. Consequently, it seems reasonable to assume that the feasible region for real world business cycles has to be restricted to the invariant set $D$ without the inner area of the limit cycle. Summing up, empirical evidence gives rise to the supposition that, in terms of the model, there are periods in which trajectories do move outside the limit cycle generating high amplitudes and financial crises, whereas there are also periods in which trajectories move in the neighbourhood of, or on the limit cycle engendering modest boom-bust periods being characterized by a normal functioning of goods and financial markets. If there are no exogenous shocks, economies tend to converge to the limit cycle over time with shrinking amplitudes and declining financial fragility, i.e. economies tend to be cyclically and financially stable in the long-run. Consequently, systemic financial crises can be only induced by large exogenous shocks catapulting the system away from the limit cycle into the outer region.

In order to study the difference between periods of modest business cycles and extensive boom-bust periods involving systemic financial crises, the following description starts with a stylized endogenous equilibrium business cycle, being located on the limit cycle serving as a reference time path. The boom phase starts in point $A$ after the last business cycle has ended when agents realize that economic fundamentals, both $\lambda$ and $\sigma$, have returned to sound levels giving rise to a quick and comparatively large increase in profit expectations. This increase in $\rho$ leads to a rise in investment demand which is financed
mainly by profits and not by a pronounced increase in indebtedness though $\lambda$ starts to rise slowly. As the state of confidence $\rho$ increases much faster than the debt-asset ratio $\lambda$, there is an overall macroeconomic expansion which is characterized, according to the comparative static results given in table 4.1, by an increase in $u, r, \dot{p}, q$ and $\dot{s}$ and by a decline in $j$ and $i$. Though the expectation formation scheme is dominated by fundamentalist behaviour at the beginning of the boom phase, being indicated by time path from $A$ to $B$, there is a rising reliance on general market sentiments, i.e. chartist type behaviour increases overproportionally.

The overborrowing process starts in point $B$, which is characterized by much lower debt-asset ratios than an overborrowing process of an extensive boom-bust cycle that generates financial crises. As a result, though an equilibrium cycle cannot cause a financial crisis, there arises a small degree of financial fragility by overborrowing. During the overborrowing phase, the level of $\lambda$ increases sharply because profit expectations rise much faster than actual profits, so that the large rise in investment demand is going to be mainly financed by increasing external indebtedness, leading to lower growth, or even to stagnation of actual profits due to rising debt costs. Despite the fact that there is a deterioration of profits, the state of confidence $\rho$ is subject to a further significant rise,

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**Figure 4.7:** A Dynamic Description of Financial Crises in Industrial Countries
firstly, due to the dominance of chartist type behaviour, and secondly, because fundamentals provide a neutral picture where both \( \lambda \) and \( \sigma \) rise.\(^{52}\) The significant rise in the state of confidence \( \rho \), dominating the increase in the debt-asset ratio \( \lambda \) with respect to the overall macroeconomic performance, causes a further macroeconomic expansion being characterized by an additional rise in \( u, \hat{p}, q \) and \( \hat{s} \), and a further decline in \( j \) and \( i \), where \( r \) remains constant.

The time path to the upper turning point \( C \) is subject to an increasing overborrowing process driving the economy into a state of exuberance, which is however less pronounced than during cycles that generate financial crises. Though there is a large increase in the debt-asset ratio \( \lambda \) leading to a decline in the profit rate \( r \) and in the risk premium \( \sigma \), profit expectations and investment demand are subject to a further rise since the dominance of chartist type behaviour has reached its maximum. There is a further macroeconomic expansion due to the dominance of \( \rho \) over \( \lambda \) though the growth rate of \( \rho \) is declining, leading to a further increase in \( u, \hat{p}, q \) and \( \hat{s} \), and to a further decline in \( j \) and \( i \), where \( r \) deteriorates with a minimum lower bound of zero.

At the upper turning point \( C \), the growth in \( \rho \) ends, firstly because agents realize that expectations cannot be validated by current profits being zero or even negative, and secondly because the current state of \( \rho \) is located near, or outside the boundaries of the normal range of \( \rho \). As a result, there is a sudden switch in the formation of expectations at point \( C \) from chartist type behaviour to fundamentalist type behaviour, leading to a sharp decline in \( \rho \). In reality, this sudden change in expectations can be caused by very small, but endogenous events, as e.g. overborrowing-induced illiquidity or insolvency of some business firms or banks. This pessimistic shift in expectations causes a general tightening of financial market conditions being characterized by declining asset prices, i.e. by a drop in Tobin’s \( q \), and by rising interest rates \( j \) and \( i \) due to deteriorating collateral and net worth positions. Though there is a general tightening of financial market conditions, the debt-asset ratio \( \lambda \) is subject to a further rise on the path from point \( C \) to \( D \), since potential illiquidity (due to \( r < 0 \)) is avoided by an increase in short-term debt according to equation 4.19. In case financial markets are not willing to bridge the liquidity gap, some firms and banks may become illiquid or even insolvent. However, even if there arises a total liquidity and credit crunch, a financial crisis is not going to occur since overall financial fragility is very low.

The bust phase starts in point \( D \) which is characterized by a reduction in the debt-asset ratio \( \lambda \) due to a deleveraging process, being financed by cutting investment expenditures to a large extent in order to pay back outstanding loans. Furthermore, expectations start to be dominated again by chartist type behaviour, leading to an accelerating pessimism among investors. Despite the fact that there is a positive impulse on macroeconomic performance by a reduction in \( \lambda \), the negative effect of a quickly declining \( \rho \) dominates, so that there is an overall macroeconomic contraction being characterized by a reduction in \( u, r, \hat{p}, q \) and \( \hat{s} \), and by a rise in \( j \) and \( i \). The length of the downswing depends predominantly on how fast balance sheets are deleveraged, i.e. on the effect of the debt-asset ratio \( \lambda \) on the state of confidence \( \rho \).

The recovery phase starts in point \( E \) when investors realize that actual profits have been underestimated, i.e. it holds that \( r^e < r \). The expectation formation scheme then

\(^{52}\)Though the actual profit rate \( r \) declines, there is a rise in the risk premium \( \sigma \) due to a rise in \( \hat{p} \) and a decline in \( i \).
again switches from pessimistic chartist type behaviour to more or less optimistic fundamentalist type behaviour, firstly, because improved macroeconomic fundamentals $\sigma$ and $\lambda$ do not justify any longer a decline in $\rho$, and secondly, because $\rho$ has moved to the lower, or outside the lower bound of the normal range. The recovery path from point $E$ to $A$ is subject to an almost constant debt-asset ratio $\lambda$, and to an increasing state of confidence $\rho$ leading to an overall macroeconomic recovery. This recovery process is characterized by an increase in $u, r, \hat{p}, q$ and $\hat{s}$, and by a decline in $j$ and $i$, giving rise to a new equilibrium business cycle with the same dynamic patterns as the cycle described above.

4.4.5.2 The Emergence of Financial Crises

Extensive boom-bust cycles involving financial crises typically begin after the recovery phase of an equilibrium business cycle by the occurrence of a large positive exogenous shock to profit expectations which, in terms of figure 4.7, catapults the economy from point $A$ to point $F$. Exogenous shocks to the state of confidence $\rho$ can take e.g. the form of positive technology shocks which, in the view of economic agents, revolutionize an economy’s entire productivity scheme of past decades, causing a large rise in expected productivity and profitability. An alternative source of rising profit expectations can be a switch to another economic school of thought, as for example a change from an interventional economic system to a more liberal scheme, involving widespread liberalization of goods and financial markets which are believed to increase overall efficiency, productivity, and profitability.

The boom phase starting in point $F$ exhibits the same features as the boom period on the equilibrium business cycle but to a much larger extent. Investment demand, and thereby actual profits, increase substantially, causing only a modest increase in the debt-asset ratio $\lambda$ since most of investment is financed by internal profits. Favourable fundamentals, i.e. a large $\sigma$ due to a large $r$ and a low $\lambda$, and large profits validating the initial increase in profit expectations, lead very quickly to a shift of the expectation formation scheme from fundamentalist to chartist behaviour. There is a huge macroeconomic expansion being subject to an increase in $u, r, \hat{p}, q$ and $\hat{s}$, and a decline in $j$ and $i$ reflecting favourable financial market conditions.

The overborrowing process begins much earlier, and is characterized by a much larger increase in the debt-asset ratio $\lambda$ than the overborrowing phase during tranquil times. Though there is a much larger increase in the actual profit rate than during tranquil times, the debt-asset ratio $\lambda$ increases as profit expectations and investment demand rise much faster than actual profits. The formation of expectations is predominantly driven by chartist type behaviour causing the state of confidence $\rho$ to rise much faster than the debt-asset ratio $\lambda$. Consequently, there is a further expansion in macroeconomic activity being indicated by a further rise in $u, r, \hat{p}, q$ and $\hat{s}$, and a further decline in $j$ and $i$, where the positive growth in $r$ declines rapidly due to rising debt costs.

The path to the upper turning point is characterized by “mania” expectations, driving the economy during the latter phase of the overborrowing process into a state of “irrational exuberance” giving rise to a large asset price bubble. Though the actual profit rate $r$ declines owing to an overproportional rise in the debt-asset ratio, the state of confidence $\rho$ and investment demand are subject to a further rise due to the dominance of chartist type behaviour which neglects very poor levels of fundamentals, i.e. a very high $\lambda$ and a very low $\sigma$, induced by a very low profit rate $r$. As the “irrational” increase in $\rho$
(despite a declining $r$) dominates the increase in the debt-asset ratio $\lambda$, there is a further macroeconomic expansion being subject to an increase in $u, \hat{p}, q$ and $\hat{s}$, and a further decline in $j$ and $i$, where $r$ shrinks rapidly up to a lower bound of zero.

The overborrowing process comes to a halt at upper turning point at point $G$ when agents suddenly realize that profit expectations cannot be validated any more by actual profits. Profit expectations collapse due to an abrupt switch from chartist type to fundamentalist type behaviour which is induced on the one hand, by a historical poor record of fundamentals $\lambda$ and $\sigma$, and on the other hand, by an actual value of $\rho$ which lies on the upper, or outside the upper bound of the normal range. The breakdown of profit expectations can be triggered either by very small *endogenous* shocks, as e.g. the failure of an important bank or business firm, which would be in a position to cause an aggregate downward shift in expectations in case financial fragility was low, or by contractionary monetary policy. According to the standard view on financial crises, monetary tightening is often viewed as an exogenous shock inducing a financial crisis which would not have happened in case there had been no monetary contraction. However, according to the present view on financial crises, monetary tightening in the form of an exogenous shock would never be able to cause a financial crisis by itself if there had been no massive build-up of financial fragility during the boom and the overborrowing phase. Consequently, even if a monetary contraction takes the form of an exogenous event, it only accelerates the *endogenous* collapse of expectations which would have occurred also without monetary tightening. By way of contrast, monetary tightening on the upper turning of the business cycle can be also interpreted as an *endogenous* reaction on the overborrowing process to stop a further increase in asset and goods prices. The fall in $\rho$ causes the asset price bubble to burst, being indicated by a rapid fall in $q$, and by a sharp rise in interest rates $j$ and $i$. Deteriorating net worth positions, rising debt costs, and a drying-up of liquidity cause a sudden stop in the debt-asset ratio’s growth rate, which leads to widespread illiquidity and insolvency among firms and financial institutions. In terms of figure 4.7, the sudden stop at the upper turning point $G$ is indicated by an almost constant value of $\lambda$ on path $GH$ which, in contrast to the equilibrium business cycle, does not allow an increase in $\lambda$ after the asset price bubble’s burst. Consequently, during tranquil times, a downward shift in expectations allows for a continuous financing or rolling over of due payment obligations, whereas during excessive cycles the breakdown of $\rho$ leads to an interruption of credit chains and to a severe domestic banking crisis due to a largely rising amount of nonperforming loans.

Point $H$ marks the beginning of the bust phase, being characterized initially by a period of constant high debt levels which is followed by large debt reducing and debt restructuring efforts, and by a further collapse of profit expectations being mainly driven by pessimistic chartist type behaviour. The abrupt reduction in $\lambda$ causes further illiquidity and insolvency, as well as a sharp reduction in investment expenditures. Notwithstanding the expansionary macroeconomic effect of deleveraging, there is a severe macroeconomic contraction due to the sharp decline in $\rho$, being characterized by large drops in $u, \hat{p}$ and $q$, and a further rise in $j$ and $i$, where $r$ becomes negative. The fall in $\rho$ can possibly induce

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"Such failures are often accompanied by the unveiling of criminal accounting practices which were used to hush up severe liquidity and/or solvency problems. One recent example is the Enron debacle in the U.S. For details, see Crafts (2000), and International Monetary Fund (2000, chapter II, p.5)."
a currency crisis and thereby a twin crisis in case largely rising devaluation expectations lead to a sharp drop in $\ddot{s}$.

Lender of last resort interventions by monetary authorities, indicated by an increase in $h$ and $m$, are able to reduce at least partly widespread illiquidity and possibly insolvency among financial institutions by providing large amounts of liquidity to stop a further fire-sale of assets and interruptions of credit chains. However, central banks cannot reduce the aggregate debt stock among firms and banks, i.e. monetary policy can only avoid illiquidity and insolvency but cannot reduce $\lambda$. In graphical terms, there is no possibility to jump downward at point $H$ to a trajectory being located between the limit cycle and the current cycle by increasing $h$ and $m$. The only effect of an increase in $h$ and $m$ is a change of the slope of the current trajectory in point $H$ from almost zero to a positive value, as well as a slight change of both demarcation curves, so that the reduction in $\lambda$ takes possibly less time than without monetary intervention. As a result, even if there is an effective lender of last resort intervention, monetary policy cannot prevent a large macroeconomic contraction because the process of deleveraging requires to reduce investment expenditures, which leads to a further fall in $u, \tilde{p}, q$ and $r$, and to a further rise in $j$ and $i$. In case short-run lender of last resort actions do not lead to a quick restructuring of banks' balance sheets, a liquidity trap situation accompanied by deflationary spirals, and a long lasting depression period can emerge, since short-run liquidity supports do not prevent banks from insolvency. Consequently, the duration of the bust phase depends on an economy’s capacity to restructure poor balance sheets.$^{54}$

The recovery phase begins when fundamentals $\lambda$ and $\sigma$ have returned to sound levels, and when investors realize that profits have been steadily underestimated owing to pessimistic chartist behaviour, having led to an actual value of $p$ being located at the lower, or outside the lower bound of the normal range. The expectation formation scheme then switches back from chartist type behaviour to fundamentalist type behaviour giving rise to a macroeconomic expansion, being subject to a rise in $u, \tilde{p}, q, r$ and $\ddot{s}$, and a decline in $j$ and $i$. In case there are no further exogenous shocks, the next cycle following the financial crisis cycle has a much lower amplitude and is going to converge to the tranquil time equilibrium business cycle.

It must be noted that such systemic crises cycles as described above are very rare because huge positive shocks to expectations in the form of new technology regimes or liberalization efforts are rare events as well. Typical examples of systemic crises in industrial countries are the two “New Economy” hypes in the 1920s and in the 1990s, and the developments in Japan from the late 1980s up to now. However, in reality there arise intermediate cases which cause boom-bust cycles involving financial distress as well, but to a far smaller extent than the systemic crises mentioned above.

$^{54}$This result could explain the Japanese depression since lots of banks are potentially bankrupt and can only survive by massive government interventions in the form of liquidity supports. However, these poor bank balance sheets do not allow for a new expansion of credit giving rise to a new upswing. Consequently, the Japanese economy is possibly going to turn into recovery only when bank balance sheets have been restructured. By way of contrast, liquidity supports of U.S. Federal Reserve could prevent a systemic banking crisis after the failure of the LTCM hedge fund in 1998 since a large fraction of the U.S. banking system was subject to sound balance sheet positions.
4.4.6 A Keynesian Perspective on Global Dynamics

Hitherto, the formation of expectations has been modelled as a synthesis between the chartist-fundamentalist or Keynesian approach, and the rational expectations school. It has been assumed that investors' expectations are influenced by general market sentiments as well as by fundamentals, but also rely on long-run rationality guaranteeing a reversal of profit expectations irrespective of the current state of fundamentals in case the normal corridor has been left. By way of contrast, this section is going to abstract from long-run rationality by investors, so that expectations are formed according to a pure chartist-fundamentalist approach giving rise to the important question whether a Keynesian expectation formation scheme is subject to different dynamic patterns in comparison with a world involving long-run rationality.

Formally, a pure chartist-fundamentalist approach requires to relinquish the "normal range" assumption, i.e. the assumption \( \partial f/\partial \rho \leq 0 \) on the outer bounds \( \rho_l \) and \( \rho_u \), as well as the existence of \( \rho_l \) and \( \rho_u \) are going to be abandoned. This modified expectation formation scheme gives rise to a modified non-linear differential equation in the state of confidence \( \rho \), which is given by

\[
\dot{\rho} = F_2(\lambda, \rho) = f(\rho, \sigma, \lambda),
\]

stating that the change of the state of confidence \( \dot{\rho} \) is positively dependent on the actual state of confidence \( \rho \), positively dependent on \( \sigma \), and negatively dependent on \( \lambda \). Though it holds that \( \partial f/\partial \rho \) is positive over the entire range of \( \rho \), it is assumed that \( \partial f/\partial \rho \) becomes less positive in case \( \rho \) departs from the intertemporal equilibrium \( \rho_E = 0 \), whose existence, even in a pure chartist-fundamentalist world, is going to be proved below. These assumptions result in an S-shaped demarcation curve \( \dot{\rho} = 0 \), implying that investors believe in an infinitely increasing or decreasing state of confidence \( \rho \), whose change \( \dot{\rho} \) however declines the more \( \rho \) departs from \( \rho_E = 0 \). The dynamic behaviour of the debt-asset ratio follows equation 4.19 as before.

The new dynamic system consisting of equations 4.19 and 4.21 generates, as well as the model involving long-run rationality, two different forms of long-run dynamics depending on investors' sensitivity \( \partial f/\partial \rho \) near the intertemporal equilibrium \( \rho_E = 0 \). The first case, being illustrated in figure 4.8, refers to hypersensitively reacting investors near the intertemporal equilibrium \( \rho_E = 0 \), i.e. it holds that \( \partial f/\partial \rho \gg 0 \) near \( \rho_E = 0 \), giving rise to multiple equilibria. According to the local stability analysis in section 4.4.2, points \( A \) and \( C \) are locally unstable whereas point \( B \) exhibits the characteristics of a saddle point. Regarding the global dynamics of the system, rectangle \( O P Q R \) describes an invariant or compact set \( D \), where the boundaries have been determined in the same way as in section 4.4.4. An application of the Poincaré-Bendixon theorem shows that invariant set \( D \) contains a limit set in the form of a saddle loop (a homoclinic orbit or also known as separatrices) consisting of the two loops surrounding the unstable fixed points \( A \) and \( C \) and the saddle point \( B \) itself. All initial points within invariant set \( D \) which do not lie on the saddle loop give rise to trajectories converging to the saddle loop. Thus, trajectories starting near points \( A \) and \( C \) spiral outwards to the saddle loop whereas trajectories

starting outside the saddle loop spiral inwards and converge to the saddle loop. Once a
trajectory has reached the saddle loop, the system converges to fixed point $B$.

Though the case of hypersensitively reacting investors represents one possible form of
global dynamic behaviour, it does not fit the stylized facts. Trajectories starting inside
the saddle loop would either produce only boom cycles with increasing amplitudes if the
initial point lies near fixed point $C$, or only bust cycles with increasing amplitudes in case
the initial point lies near fixed point $A$. In the long-run, both types of cycles converge
to the saddle loop for $t \rightarrow \infty$, causing the system to settle down in fixed point $B$. If,
on the other hand, trajectories start outside the saddle loop, there emerge boom-bust
patterns around the equilibrium in $B$ which are however dampened around point $B$, i.e.
each traverse from boom to bust, and vice versa, is going to be soothed. In the long-run,
these dampened cycles converge to the saddle loop for $t \rightarrow \infty$ as well, coming to a halt
in fixed point $B$. If the system starts on the saddle loop (except in point $B$), there arises
only one boom or only one bust cycle, coming to a halt in fixed point $B$. Summing up,

![Figure 4.8: Global Keynesian Dynamics with Hypersensitively Reacting Investors](image_url)

**Figure 4.8:** Global Keynesian Dynamics with Hypersensitively Reacting Investors
there is no time pattern emerging from the hypersensitive case which corresponds to the stylized facts due to the emergence of multiple equilibria.

Hence, in order to rule out multiple equilibria it seems reasonable to assume "normally" reacting investors around the intertemporal equilibrium $\rho_E = 0$, i.e. it holds that $\partial f / \partial \rho > 0$ near $\rho_E = 0$, giving rise to a single fixed point which is illustrated in figure 4.9. The assumption that the intertemporal equilibrium value of the state of confidence in a pure chartist-fundamentalist world corresponds to the long-run rational expectations equilibrium $\rho_E = 0$ seems to be an arbitrary assumption at first sight. However, in case the system settles down at an equilibrium value $\rho_E \neq 0$, implying $r \neq r^e$ in the long-run, it is likely that agents are going to readjust their profit expectations resulting in a shift in function $\dot{\rho} = f(\rho, \lambda, \sigma)$ and in demarcation curve $\dot{\rho} = 0$ until profit expectations correspond to the actual level of profits in the long-run. Consequently, it is reasonable to assume the existence of a long-run equilibrium value $\rho_E = 0$, implying $r = r^e$, even in a pure chartist-fundamentalist world.

![Figure 4.9: Global Keynesian Dynamics with Normally Reacting Investors](image)

The global dynamics under normally reacting investors depicted in figure 4.9 lead to the emergence of closed orbits according to the Poincaré-Bendixon theorem since the fixed point $E$ is locally unstable, and rectangle $OPQR$ represents an invariant set $D$ whose boundaries have been determined by the procedure outlined in section 4.4.4. It is not possible however, to ensure that there exists only one closed orbit, i.e. it is open whether there arises a supercritical Hopf bifurcation. In case there arise multiple closed
orbits and limit cycles, the economy is subject to cyclical instability since there exist equilibrium cycles near the fixed point $E$ with low amplitudes, being comparable to the equilibrium cycle under long-run rationality, as well as equilibrium cycles which lie near the boundaries of compact set $\mathcal{D}$ implying possibly financial crises on each business cycle. Thus, financial stability, as well as equilibrium fluctuations depend on the initial condition, i.e. exogenous shocks are in a position to catapult an initially cyclically stable economy into an "equilibrium" situation with huge fluctuations in goods and financial markets resulting possibly in financial crises.

Despite the fact that there is no possibility to determine the number of cycles, there arise also important differences to the long-run rationality case if there exists only one limit cycle as drawn in figure 4.9, which corresponds much better to the stylized facts since there exists only one stable equilibrium cycle to which economies converge in the long-run. Firstly, the equilibrium business cycle under a pure chartist-fundamentalist expectation formation scheme is subject to larger equilibrium fluctuations as an equilibrium cycle under long-run rational behaviour due to the absence of the counteracting force $\partial f/\partial \rho < 0$ outside the normal range. Secondly, financial distress on the upper turning point of the equilibrium cycle is much larger than under long-run rational behaviour since there is a longer and deeper build-up of financial fragility during the boom and the overborrowing phase. Thus, there arises the possibility that each equilibrium cycle is subject to a financial crisis. Thirdly, in case the equilibrium cycle is not subject to financial crises on the upper turning point, economies tend to be cyclically stable in the long-run implying that financial crises can be only induced by large positive shocks to expectations as in the long-run rationality case. However, in case a positive shock to $\rho$ has induced an extensive boom-bust cycle, the subsequent financial crisis is much deeper and lasts much longer than under long-run rationality since there is no dampening effect $\partial f/\partial \rho < 0$ outside the normal range.

Summing up, the comparison between the Keynesian and the long-run rationality approach gives rise to the supposition that the assumption of long-run rationality leads to model results which correspond much better to the stylized facts than a pure chartist-fundamentalist regime. By way of contrast, a pure rational expectations approach is not in a position to explain endogenous equilibrium fluctuations and endogenous financial fragility in a world without exogenous shocks. Consequently, only the combination of both approaches is able to provide better insights into business cycles and their link to financial crises.

### 4.5 A Comparison with Standard Theory of Financial Crises

The present "cyclical" approach to financial crises differs substantially from standard models which have been briefly set out and compared to the stylized facts of financial crises in section 3.5. In order to highlight these differences, as well as the advantages of the present approach over existing models, sections 4.5.1 to 4.5.5 review the most important standard models of financial crises, which have been classified according to section 3.5 into inconsistent macroeconomic policy models, self-fulfilling expectations models, asymmetric information models, credit constraint and balance sheet models, and endogenous financial
crisis models, and elaborate the basic mechanisms triggering financial crises in terms of the comparative-static version of the industrial country model, being also an evidence for the universal validity of the model. This procedure could have been performed alternatively by means of a dynamic framework, which however would not have provided more insights than a comparative-static framework. It is self-evident that the present model structure cannot exactly fit all standard models which are going to be discussed in the following, and therefore refers sometimes, if necessary, to other variables or parameters than in the original models, which however can catch the basic logic of the standard models. Section 4.5.6 discusses briefly both the common grounds and differences of the industrial country model in comparison with standard approaches to financial crises, and highlights the new elements of the present approach that distinguish it from standard models.

The following analysis refers exclusively to standard models which can be applied to industrial countries with flexible exchange rates. Standard models of financial crises in emerging market countries, emphasizing both the role of large foreign debt stocks and the role of fixed exchange rates in the propagation mechanisms of financial crises, are discussed in section 5.5.

4.5.1 Inconsistent Macroeconomic Policy Models

Predictable Bank Runs Due to Deflationary Monetary Policies. Flood and Garber (1981b) discuss the effects of deflationary monetary policies on banking liquidity and solvency in a perfect foresight model. Their model, which refers closely to I. Fisher's (1911) theory of bank defaults caused by deflation, was mainly motivated by the occurrence of multiple banking crises in the U.S. during the Great Depression period from 1929 until 1933. They argue that the main cause of widespread bank runs following the stock market crash in 1929 and the first banking crises in 1930 was the Federal Reserve's refusal to provide liquidity supports to troubled banks which experienced liquidity shortages caused by large-scale deposit withdrawals. The large number of bank runs caused a massive reduction in the money supply which led to an extensive credit crunch followed by an output collapse and deflation. According to Flood and Garber, the fall in the price level triggered further bank runs since deflation reduced banks' asset values whereas banks' debts, i.e. commitments to pay one unit high-powered money for one unit of deposits, remained constant, having led to a steady deterioration of banks' net worth, and in case bank debts were not longer covered by bank assets, to bank runs.

In their model, banks transform deposits $D$ into reserves $R$ and long-term bonds $P_B B$, where $P_B$ denotes the market price of bonds, and $B$ the real stock of bonds held by banks; the entire real stock of bonds in the model economy is denoted as $\hat{B}$, i.e. $B/\hat{B}$ represents banks' real share of bonds in the model economy. Banks have committed themselves to pay on demand one unit high-powered money for one unit of deposits, commitments to pay one unit of high-powered money for one unit of deposits, remained constant, having led to a steady deterioration of banks' net worth, and in case bank debts were not longer covered by bank assets, to bank runs.

In their model, banks transform deposits $D$ into reserves $R$ and long-term bonds $P_B B$, where $P_B$ denotes the market price of bonds, and $B$ the real stock of bonds held by banks; the entire real stock of bonds in the model economy is denoted as $\hat{B}$, i.e. $B/\hat{B}$ represents banks' real share of bonds in the model economy. Banks have committed themselves to pay on demand one unit high-powered money for each unit of deposits. Furthermore, it is assumed that there is no deposit insurance system and that deposits do not earn interest. Owing to the absence of a deposit insurance system, banks remain liquid and solvent and suffer no bank runs as long as debts are fully covered by banks' assets, i.e. as long as it holds that $R + P_B B = D$; for reasons of simplicity, bank capital is assumed to be zero. The firm sector of the model economy finances itself by issuing bonds to banks and other creditors, and receives nominal earnings from selling output to the amount of $P \hat{Y}$, where $P$ denotes the nominal price level, and $\hat{Y}$ real output, the product of
labour and capital, which is assumed as fixed. Nominal earnings of the firm sector are distributed among bond holders and the labour force. Bond holders earn a fraction $\theta PY$ of nominal earnings, whereas labour receives $(1 - \theta) PY$. Bonds' market price $PB$ is positively dependent on nominal earnings $PY$, i.e. positively dependent on variations of the price level.

In case of deflation which is caused by the central bank reducing steadily high powered money, banks suffer asset losses on the one hand from a reduction in nominal earnings, and on the other hand from a reduction in the bond price. In order to maintain the nominal value of their assets, banks have to purchase new bonds to offset losses. Banks are willing to purchase additional bonds as long as their earnings from asset holding exceed the sum of portfolio managing costs and capital losses, i.e. as long as it holds that $\theta PB (B/B) + PB > TB$ where $T$ denotes the cost per bond of managing banks' portfolio. Persistent deflation however, leads to a suspension of full asset backing, i.e. to $R + PB B < D$, since earnings of holding bonds eventually fall short of costs, i.e. steady deflation leads to $\theta PB (B/B) + PB B < TB$. At the moment when it is not longer profitable to maintain full asset backing, depositors run the bank in the absence of an effective deposit insurance system in order to minimize their losses because agents foresee a further reduction in the price level due to perfect foresight.

Translating Flood and Garber's model into the present industrial country model structure in which banks' assets consist only of loans to firms, the central bank's refuse to provide liquidity supports to troubled banks is indicated, like in the original Flood and Garber model, by a steady fall in high-powered money $h$ which leads to reductions in $u$, $r$, and $\hat{p}$, and to an increase in the loan rate $j$ caused by a credit crunch due to shrinking deposits $mh$. The exchange rate depreciates because of the initial gain in competitiveness caused by deflation. All effects lead to a shrinking net worth of business firms being indicated by a fall in Tobin's $q$, giving rise to a fall in banks' net worth due to an increase in non-performing loans and losses on the stock exchange, being also indicated by a shrinking value of $q$. This process of economic contraction lasts until banks' net worth reaches a zero value. At that moment, depositors run the bank because a further decline in $\hat{p}$ which can be foreseen, and which would cause losses to holders of deposits. A bank run involves generally a sudden switch from deposits into cash or high-powered money, leading to a sharp drop in the money multiplier caused by a sudden increases in the currency/deposit ratio, and in the reserve/deposit ratio due to banks' increasing need for high-powered money. Since cash was excluded from the model, a run could be modelled by a sudden increase in the demand for bonds or equities, indicated by an increase in derivatives $d_{r+p}$ and $d_{r-p}$. However, comparative-static analysis has not considered these shocks. In order to follow Flood and Garber, cash can simply be introduced in the model by assuming that in case of a run the reserve/deposit ratio increases to $\tau = 1$, reducing the money multiplier suddenly also to a value of 1 indicating that banks must hold one unit of high-powered money for each unit of deposits. In terms of the model, a sharp fall in the money multiplier $m$ to a value of $m = 1$ causes a further decrease in $u, r, \hat{p}, q, \hat{s}$, and a further increase in $j$ deteriorating the initial fall in the money supply. Since banks have to liquidate loans in order to receive high-powered money from the central bank, a credit crunch is going to follow, being indicated by a sharp fall in $\lambda$ which reduces the negative effects of $m$ and $h$ partly. But, as shown in the dynamic version of the model, business firms' investment activity is indirectly constrained by available credit, i.e. investment
demand is going to collapse leading to a further deterioration because of accelerating deflation. Since economic activity is mainly determined by expectations, bank runs and a widespread contraction will lead additionally to a sharp drop in $\rho$, leading to further bank runs, contraction and deflation.

It is important to note that Flood and Garber explicitly assume the absence of an effective deposit insurance system. However, the model keeps its general validity also in case of an effective deposit insurance system. In this case, depositors do not provoke a bank run, but banks simply go bankrupt by deflation which leads not to such a dramatic reduction in the money multiplier like in the bank run scenario, but also to a drastic contraction in bank lending due to disintermediation effects. Furthermore, in case there is a widespread failure of banks, the existence of a deposit insurance system is no guarantee for the absence of a bank run. It seems possible that in extreme cases guarantees lose their credibility because losses have reached such a high dimension that a bail-out seems to be unrealistic triggering a bank run.

**Predictable Bank Runs Due to Inflationary Monetary Policies.** The idea that the existence of a deposit insurance system does not prevent depositors from a bank run in case government guarantees are no longer credible due to high capital losses among banks, has been discussed in Flood and Garber's second paper (1981a) which had been stimulated by the Savings and Loan (S & L) crises in the U.S. from 1981 until 1991. This model, in contrast to the preceding one, shows how an inflationary environment can induce a bank run.

In Flood and Garber's model, the S & L's asset side consists of long-term bonds representing fixed-interest mortgages, whereas the debt side contains only deposits and net worth. They assume that the central bank pursues an inflationary policy by a steady increase in high powered money. As they abstract from real sector responses by assuming that output is constant, an increase in the money supply is completely transmitted into an increase in the price level or in the inflation rate. Assuming the Fisher equation to hold with a constant real interest rate, increasing inflation results in a steady rising nominal interest rate which reduces the market value of bonds leading to a shrinking net worth, because deposits do not change in nominal terms. Flood and Garber assume that though there is a deposit insurance system, losses of S & L institutions are only financed partly by the lender of last resort. If losses, being indicated by negative net worth, exceed a certain value guaranteed by the government, then the run occurs.

In terms of the industrial country model, inflationary monetary policy is represented, as in the Flood and Garber model, by an increase in high powered money $h$ leading to an expansion in the real sector being indicated by increases in $u, r, q$ and a reduction in $j$; an increase in the money supply leads to inflation causing an appreciation of the exchange rate $s$. However, since the model does not consider explicitly inflation expectations and does not assume the validity of the Fisher equation, inflation caused by an increase in $h$ does not lead automatically to higher nominal interest rates. Still, it has been argued at the outset that inflation expectations are already incorporated in the state of confidence parameter $\rho$. An increase in inflation then leads to an expectation of higher nominal interest rates in the future, reducing expected profits and thereby inducing a declining value of $\rho$. In an accelerating inflationary environment, the resulting drop in the state of confidence can provoke a banking crisis and an adjacent bank run by reducing $u, r$
and increasing $j$ and $i$, causing a drop in business firms' and banks' net worth which is indicated by a falling $q$; moreover, accelerating inflation leads to a devaluation of the home currency, indicating the outbreak of a currency, and of a twin crisis if, according to the index of speculative pressure (section 3.1.1), certain threshold values of $s$, $i$ and $j$ are exceeded. If banks' negative net worth falls short of a certain negative value having been guaranteed by the lender of last resort, depositors run the bank. All events following the bank run coincide with the above mentioned case of deflationary monetary policy.

First-Generation Currency Crises Due to Inconsistent Expansionary Monetary Policy. Krugman's (1979), and Flood and Garber's (1984a) first generation currency crises models and their extensions\(^{56}\) abstract from the existence of a banking sector and refer exclusively to the breakdown of fixed exchange rate regimes caused by excessive expansionary monetary policies, which are predominantly induced by money-financed fiscal deficits. According to first-generation currency crises models, a steady increase in high-powered money leads to a steady fall in foreign exchange reserves to the same amount due to capital outflows, being induced by a steady downward pressure on domestic interest rates. The speculative attack on the domestic currency, which is followed by a flexible exchange rate regime, occurs when the flexible shadow exchange rate has increased to the level of the fixed exchange rate, i.e. when speculators can earn profits by buying the central bank's remaining stock of foreign exchange reserves at the fixed exchange rate, and selling them later at an appreciated post-crisis flexible exchange rate.\(^{57}\) As most of first-generation models assume a constant value of output, first-generation currency crises models cannot explain the occurrence of systemic financial crises.\(^{58}\)

In terms of the industrial country model, a first generation currency crisis, which, in the present case, occurs under a flexible exchange rate regime leading to a large devaluation of the (flexible) home currency, is caused by an increase in high-powered money $h$, leading to a rise in $s$, and being accompanied by a real sector expansion which is represented by an increase in $u, r, q, \hat{p}$, and by a reduction in $j$.

Latest models of the explanation of twin crises caused by inconsistent expansionary monetary policies, as e.g. the model by Buch and Heinrich (1999), cannot be applied to the industrial country model, since they refer to emerging market economies with large foreign debt stocks. These models are going to be discussed in chapter 5.5.1.

4.5.2 Self-Fulfilling Expectations Models

Unpredictable Bank Runs Due to “Random Withdrawals”. The closed-economy bank run model by Diamond and Dybvig (1983) studies the effects of a sudden shift in expectations due to external shocks on banking liquidity and solvency. The Diamond-Dybvig model is based on the assumption that there is an asymmetry between investment projects to mature and the time horizon of investors. Investors are modelled as short-sighted agents since they need short-run resources for consumption, or want to possess

\(^{56}\) For an overview of first generation currency crises models and their extensions, see e.g. Agénor, Bhandari and Flood (1992), and Flood and Marion (1998).

\(^{57}\) For a detailed discussion of Krugman's (1979), and Flood and Garber's (1984a) models, see Radke (2000a).

\(^{58}\) One exception considering explicitly output effects in a first-generation model is Willman (1988).
liquid assets to invest in other investment projects in the short-run. In contrast to investors' short-run time horizon, investment projects need time to mature, i.e. short-run interruptions are not profitable. In order to overcome this tradeoff, Diamond and Dybvig introduce banks and explain their existence by their function of transforming maturities. Banks try to maximize profits by offering short-term assets (deposits) to investors, and by investing these proceeds in production (granting loans) which needs time to mature. In other words, banks transform their illiquid assets into liquid ones. This transformation by banks enables the economy to raise more funds for long-term investment, but also engenders the possibility of bank runs.

Diamond and Dybvig show that there exist two kinds of equilibria, a “superior” and an “inferior” one. The “superior” equilibrium is characterized by a situation in which banks offer a positive return on deposits, and allow early withdrawals which can be met by banks’ reserves because only a small fraction of depositors wants to withdraw deposits in the short-run. Banks are able to invest most of deposits into the long-term high-yield technology which allows a prosperous economic development. This equilibrium to prevail requires that each depositor has to trust in other depositors also not to withdraw their funds in the short-run, and that all depositors believe in banks’ ability to satisfy short-term withdrawals. If however, depositors lose confidence in the banking system by the belief that banks are unsafe, and additionally believe that all other depositors share the same view, a bank run, the “inferior” equilibrium, occurs with all depositors withdrawing in the short-run. Banks are forced to liquidate long-run investments which causes great harm to the real sector in order to meet cash withdrawals. Since the liquidation value of long-term assets is less than the amount of deposits, banks fail in case of a bank run. According to Calomiris and Gorton (1991), depositors’ hurriedness to withdraw in case of a bank-run results form the first-come-first-served rule of deposit withdrawals. Depositors withdrawing too late receive nothing, which causes them to compete for being the first to withdraw. Which equilibrium prevails depends, according to Diamond and Dybvig, on random factors and cannot be foreseen. The event which triggers the move from the “no-run-equilibrium” to the “run-equilibrium” may depend on commonly observed random variables like bad earnings, an observed run at another bank, but it is also possible that expectations shift without any negative shock to banks’ fundamentals, implying that if depositors expect a bank run to occur, the bank run is going to occur. In order to prevent bank runs, Diamond and Dybvig recommend establishing deposit insurance systems, so that a switch from “good” to “bad” expectations is no longer possible, as depositors are guaranteed to obtain their funds at any time.

In terms of the industrial country model, the Diamond-Dybvig story can be set out simply by shifts in the state of confidence parameter. If all economic agents believe in the healthiness of the banking system, which depends on business firms and general financial market conditions, the state of confidence parameter is positive, indicating further future profits. The economy is financially stable, being represented by “low” values of $\rho$ and $j$, and is subject to real sector growth indicated by “large” values of $u, r$ and $g$. There is inflation and a steady devaluation of the home currency. The “bank-run” equilibrium is caused by a sudden downward shift in the state of confidence, where it holds that $\rho < 0$, causing a collapse of the real economy indicated by “low” values of $u, r, g$, and inducing a financial crisis being represented by “high” interest rates $i$ and $j$; furthermore, the economy can tip into deflation, leading to an appreciation of the home currency.
Second-Generation Currency Crises Due to Self-Fulfilling Expectations. Self-fulfilling currency crises models by Obstfeld (1986, 1994, 1997) are discussed in chapter 5.5.2, as these models refer to fixed exchange rate regimes and policy rules which contradict in some situations, thereby forcing authorities to devalue.

“Random Withdrawal” Bank Runs in the Open Economy. There are various approaches, as for example by Garber and Grilli (1989), Goldfajn and Valdés (1997b), and Chang and Velasco (1998a, 1998b, 1998c, 1999) which extend the closed-economy Diamond and Dybvig model to the open economy. In contrast to the closed-economy Diamond and Dybvig model, the debt side of banks’ balance sheets additionally contains deposits in foreign currency, while the asset side still consists of long-term domestic assets denominated in domestic currency. As the book value of banks’ long-term assets in the short-run, i.e. their short-run liquidation value, is smaller than the book value of deposits, financial intermediaries are susceptible to bank runs which cause a bank’s failure due to illiquidity and insolvency. Since banks’ debt side contains a considerable stock of foreign deposits, banks are not only subject to the risk of a bank run by domestic depositors, but additionally to the risk of a bank run by foreign depositors, being followed by a currency crisis due to large capital outflows. Bank runs are caused, as in the original Diamond-Dybvig model, by a self-fulfilling shift in expectations induced by an exogenous shock. Since most of the models refer to twin crises in emerging market economies by emphasizing the interaction of large foreign debt stocks with domestic banks and fixed exchange rate regimes, they are discussed in chapter 5.5.2.

One exception however, is the approach by Chang and Velasco (1998a, 1998b, 1998c, 1999), considering explicitly the case of a bank run being caused solely by domestic residents. As there are no deposit withdrawals by foreign depositors, there arises no currency crisis. Chang and Velasco assume that in case of a bank run by domestic depositors, banks can always repay foreign debt even if there arise liquidity problems because of the possibility to roll-over foreign debt. As in the Diamond-Dybvig case, there are two possible equilibria. The “good” one is characterized by only some depositors withdrawing deposits in the short-run; these withdrawals can be financed completely by borrowing from abroad and there is no need to liquidate long-term assets. The “bank run” equilibrium is characterized by a situation in which all domestic agents want to withdraw their deposits because of the widespread believe that everyone else is going to withdraw deposits. If there is no deposit insurance system providing short-run liquidity supports, banks are going to fail in case of a bank run.

In terms of the industrial country model, Chang and Velasco’s approach can be also set out by sudden shifts in the state of confidence parameter $\rho$, leading to the same results like the application of the Diamond-Dybvig case. A special feature however, is the effect on the exchange rate in case of the bank-run, i.e. if it holds that $\rho < 0$, as the contraction in the real sector causing deflationary pressures possibly leads to a currency crisis which is, in contrast to the general case of currency crises, characterized by a sharp appreciation of the domestic currency, and not by a depreciation.$^{59}$

$^{59}$This special case of currency crises has been also emphasized by Grilli (1986) in terms of a modified first-generation currency crisis model by Flood and Garber (1984a).
4.5.3 Asymmetric Information Models

Unpredictable Bank Runs Due to Asymmetric Information and Exogenous Shocks. Models of bank runs caused by asymmetric information and exogenous shocks, as e.g. by Gorton (1985), Chari and Jagannathan (1988), Calomiris and Gorton (1991), and Calomiris and Kahn (1991), also emphasize the role of multiple equilibria like Diamond and Dybvig, but explain the move from the “no-run-equilibrium” to the “run-equilibrium” by an exogenous triggering event which provides “new” information for depositors about the quality of banks’ assets.

As a large fraction of banks’ assets are nonmarketable, depositors cannot monitor perfectly asset quality. Besides, depositors cannot distinguish “good” banks from “bad” banks, i.e. they do not know which banks are most affected by a negative shock. As a result, in case of a large negative exogenous shock, depositors decide to run all banks. After the run, banks suspend convertibility and sort out “bad” failed banks due to their information advantage. From this perspective, bank runs can solve the information asymmetry between depositors and banks, and can help depositors to monitor banks more efficiently.

If, on the contrary, there are no adverse shocks, there will be no bank runs, since depositors believe in the healthiness of the banking system. Consequently, widespread bank runs can be only triggered by an exogenous shock, and not by a pure shift of self-fulfilling expectations as in the Diamond-Dybvig (1983) model. Since the probability of shocks cannot be determined in these models, bank runs remain an unpredictable event.

In terms of the industrial country model, the change from the “good” to the “bad” equilibrium can be explained by a change from a positive \( p \) value to a negative \( p \) value which is caused by some “news”. For example, a sudden change in the banking regulation scheme (e.g. the introduction of the Basel II capital accord) limiting banks’ credit supply, being represented by a sharp increase in \( \alpha \), reduces banks’ net worth and could trigger a run; in the same way, an adverse productivity shock, being indicated by a sudden increase in the wage share \( \nu \), or by a sudden increase in the depreciation rate \( \delta \) lowering firms’ profits and banks’ net worth, could be a triggering event for a bank run.

Moral Hazard, Overinvestment and Overborrowing Due to Exogenous Shocks or Owing to Self-Fulfilling Expectations - Third-Generation Models. The literature on moral hazard driven financial crises, being labelled as the third-generation approach to financial crises, emphasizes that implicit or explicit government guarantees on the liabilities of banks, on foreign investors’ claims, on the stability of exchange rates, or investment subsidies raise the private return on assets, making creditors and debtors engage in riskier investment projects than they would do if there were no guarantees, as in case of default, losses are transferred to the tax payer. Moral hazard driven booms being subject to overinvestment, overborrowing, and asset price bubbles can generate financial crises if one additionally assumes the existence of an exogenous limit on the cumulative financial costs of government support policies. In case the financial government support has reached its maximum, and is going to, or expected to be suspended in the future, expected asset returns collapse, leading to widespread bankruptcies among firms and banks, and in severe cases, to full-fledged financial crises. In the case of deposit insurance systems or guarantees to bail-out troubled banks, governments are going to abandon guarantees if the budget deficit reaches undesirable levels which would cause high inflation. In case of fixed exchange rate systems, central banks’ reserves limit the credibility of guarantees;
if there are huge outflows reducing reserves to zero, and if there is no possibility to get reserves from international capital markets, the fixed parity has to be abandoned.

Regarding the suspensions' causes, being the triggering events of financial crises, the literature on third-generation models differentiates among exogenous shocks and self-fulfilling expectations. In case a huge shock, like e.g. an interest rate or negative productivity shock, exhausts governments capacity to bail out the banking system, or to guarantee a fixed exchange rate for financial claims of international investors, there will be a suspension of government guarantees leading to a bank run, to a currency, or to a twin crisis. However, governments' capacity to fulfill guarantees can be likewise exhausted by a simple shift in expectations. If agents start to believe, without any fundamental reason, that government guarantees will be removed in the future, agents are going to run on banks or currencies, making the government provide financial support due to its obligation to bail out banks, or to support the exchange rate. When governments' resources to bail out banks or to stabilize exchange rates are used up, a banking, currency crisis or twin crisis is going to follow, validating ex post investors' pessimistic ex ante expectations. If, on the other hand, investors believe in the stability of future government guarantees, there will be no financial crisis, validating investors' optimistic ex ante expectations.

Apart from the distinction between self-fulfilling and exogenous shock driven financial crises, third generation approaches can be classified into closed economy models which concentrate on government guarantees to bail-out the banking system, like e.g. Krugman (1998), and into open economy models, as e.g. Diaz-Alejandro (1985), Velasco (1987), McKinnon (1993), Dooley (1997), McKinnon and Pill (1997, 1998, 1999), Burns, Eichenbaum and Rebelo (1998), and Corsetti, Pesenti and Roubini (1998), focusing additionally, next to bail-out promises, on government guarantees to maintain a fixed exchange rate regime. Since the industrial country financial crisis model operates under a flexible exchange rate system and does not consider foreign debt, this paragraph refers to closed economy approaches emphasizing the role of government guarantees to bail-out troubled banks, whereas open economy approaches generating twin crises are discussed in section 5.5.3.

The Diamond-Dybvig (1983) literature recommended the establishment of deposit insurance systems to prevent future bank runs, but did not take into account that deposit guarantees can cause banks to grant much riskier loans than in the absence of guarantees, since in the case of banks' default, e.g. due to large fraction of non-performing loans, losses which would have normally to be borne by depositors, are taken over by the government, and indirectly by the tax payer. This argument was brought forward by Krugman (1998) in connection to the Asian crisis. In his model, only banks allocate funds to investment projects which are assumed to be protected against losses by government guarantees. Banks face two different investment projects; one secure investment with a known yield, and one risky investment whose yield is not known at the beginning, but for which probabilities for different outcomes ("good" or "bad") are available. A risk neutral investor will calculate the expected profit rate of the risky investment and compares it to the known profit rate of the secure investment. In case the expected value is lower than the known secure value, the risky investment will not be carried out. However, in case the government establishes guarantees, the probability of default of the risky investment can be neglected since losses are borne by the government. As a result, the expected profit rate of the risky investment project is going to increase to its so-called "Pangloss"
value, causing risk-neutral banks to engage in the risky investment project in case its expected yield is higher than the yield of the secure investment project. In case the risky investment project turns out to be the more profitable one, banks are going to invest all funds into the risky investment project and will extend investment to an amount which is larger than under the absence of government guarantees, i.e. moral hazard leads to overinvestment. Since investment has to be financed mainly externally, the increase in banks' debt is also larger than under the lack of guarantees, i.e. overinvestment leads to overborrowing, making the market price of the risky investment good, in case of an perfectly inelastic supply (as e.g. in case of land or housing), increase significantly. Accordingly, overinvestment and overborrowing lead to the emergence of asset price bubbles. This bubble effect however, amplifies banks' losses in case of default, because there arise not only lower yields, but additionally larger capital losses since banks are more indebted than it would be optimal due to the distortion in expected yields.

According to Krugman (1998), there are two possible triggers for a full-fledged financial crisis. Firstly, an exogenous shock causes a bad return of the risky investment, generating huge losses with banks which exceed the government’s capacity to bail-out all troubled banks, and therefore leading to a guarantee suspension and to a banking crises. Secondly, self-fulfilling expectations, making the end of the guarantee regime endogenous, can cause a financial crisis, which validates ex post the initial shift towards pessimistic expectations. If banks’ are believed to incur huge losses leading to abolishment of guarantees, there will be a plunge in asset prices, and depositors who expect that there is no bail-out are going to run on banks, inducing a severe financial crisis. If however, there is the widespread believe that there arise no losses, there is also no believe that the guarantee system will be abandoned which prevents a financial crises. Yet, the switch from the “no-crisis” to the “crisis-equilibrium” is assumed to be random and not explained by the model.

In terms of the industrial country model, moral hazard driven overinvestment can be represented by the government explicitly guaranteeing to subsidize firms in case firms incur losses due to unfavourable outcomes of a risky investment project. This explicit guarantee on firms also implies an implicit guarantee to bail out banks because losses in the firm sector, which would lead to non-performing loans in the banking sector, are taken over by the government. Assume that there are two different technologies in which firms can invest. Technology 1 is assumed to be secure whose return or profit rate is $r_1 = E(r_1) = 0.09$, implying a state of confidence value of $\rho = 0$. Technology 2 is assumed to be risky in the sense that there exist two possible outcomes of the profit rate, one realization value being negative $-r_{2n} = -0.08$, and the other one being positive $r_{2p} = 0.2$, both with equal probability $0.5$. As a result, the expected value of the profit rate of the risky investment project amounts to $E(r_2) = 0.5 \cdot (-0.08) + 0.5 \cdot 0.2 = 0.06$, being smaller than the expected value of the secure investment in case of the absence of government guarantees, i.e. it holds that $E(r_2) = 0.06 < E(r_1) = 0.09$. Accordingly, without government guarantees, firms are going to invest solely in the secure technology 1, implying a state of confidence value of $\rho = 0$.

Introducing government guarantees however, changes the expected value of the risky investment project. Since in case of default, losses are taken over by the government, i.e. in case of an unfavourable outcome the government pays $r_g = 0.08$ to firms, resulting in an actual profit rate of $r_{2d} = r_{2n} + r_g = -0.08 + 0.08 = 0$, the risky investment project has an expected value of $E(r_2) = 0.5 \cdot 0 + 0.5 \cdot 0.2 = 0.1$ (its "Pangloss" value), implying a state...
of confidence value of $\rho = 0.1$. Comparing expected values of both investment projects in case of the existence of government guarantees makes firms invest into the risky investment project since it holds that $E(r_1) = 0.09 < E(r_2) = 0.1$. As a result, since the state of confidence $\rho$ increases from 0 to 0.1 by investing in technology 2 and not in technology 1 due to the existence of government guarantees, there is a large macroeconomic expansion induced by overinvestment, i.e. $r, q, u, \hat{p}, \hat{s}$ increase and $j$ and $i$ decrease. Overinvestment leads to overborrowing by firms, being represented by a significant increase in the debt-asset ratio $\lambda$, dampening but not offsetting the macroeconomic expansion induced by the rise in $\rho$.

A financial crisis in this state of overborrowing and overinvestment can emanate either from an exogenous shock or from self-fulfilling expectations. As to the shock scenario, consider a negative productivity shock (increase in $v$ or $\delta$), validating the expected negative realization value $-r_{2n} = -0.08$. This drop in the actual profit rate leads to declines in $q, u, \hat{p}, \hat{s}$ and increases in $j$ and $i$, causing bankruptcies in the firm and in the banking sector since losses exceed government guarantees inducing depositors to run on banks. All events following the bank run are identical with those described in the Diamond-Dybvig model. If, by way of contrast, there is no negative shock and an actual value of $r_{2p} = 0.2$ can be realized, no crisis is going to happen. Regarding self-fulfilling expectations as a triggering event, assume that agents expect government guarantees not to be continued in the future, making expected profits drop to $E(r) = 0.5 \cdot (-0.08) + 0.5 \cdot 0.2 < 0.06$, implying a fall in $\rho$, leading to a decline in $r, q, u, \hat{p}, \hat{s}$, and to a rise in $j$ and $i$, forcing the government to subsidize firms in case profits are negative. If guarantees are actually suspended, since losses exceed the government’s financial resources, agents’ initial shift towards pessimistic expectations is going to be validated ex post by the occurrence of a banking crisis. If, on the other hand, agents believe in the continuation of government guarantees, there is no drop in $\rho$, and therefore no macroeconomic contraction followed by a financial crisis, also validating ex post agents’ optimistic expectations.

### 4.5.4 Credit Constraint and Balance Sheet Models

**Borrowing Constraints, Financial Crises and Output Collapses Due to Exogenous Shocks and Self-Fulfilling Expectations - Fourth-Generation Models.**

Credit constraint and balance sheet models of financial crises, being labelled as the fourth-generation approach to financial crises\(^\text{60}\), are based on the theory of imperfect capital markets having been outlined in detail in section 2.2.2.2.\(^\text{61}\) The theory of imperfect capital markets generally assumes that the existence of information asymmetries in financial markets leads to credit rationing and gives rise to the financial accelerator effect. The rationale for considering explicitly balance sheet and net worth positions in theoretical models of financial crises resulted from the stylized fact that financial crises in the 1990s, both in industrial and emerging market countries, were accompanied by large collapses in investment and output owing to credit crunches, having been induced by large drops in net worth positions of business firms and banks due to collapses in asset prices and exchange rates. Though credit constraint and balance sheet financial crisis models are built upon the nature of asymmetric information, they are not classified as asymmetric.

\(^\text{60}\)For this terminology, see Krugman (2001).

\(^\text{61}\)For references, see also section 2.2.2.2.
information models according to section 4.5.3, since the causes of financial crises do not have their roots in distorted incentives of agents, but in borrowing constraints, becoming binding conditional on an increase in asymmetric information.

In terms of fourth-generation models, a financial crisis is defined as a situation in which there is a sudden increase in credit constraints, as e.g. cuts in credit lines or refusals to roll-over debt and/or an impetuous increase in interest rates on debt due to a rise in risk premiums, leading to a sharp drying-up of liquidity in credit markets (credit crunch), and to collapses in output since investment finance is assumed to hinge largely upon external finance according to the existence of a financial hierarchy. In severe cases, financial markets stop working and do not provide any longer necessary information to overcome existing asymmetries. This sharp contraction in the available amount of credit and output is assumed either to stem from exogenous shocks which increase asymmetric information, aggravating the difficulty for financial intermediaries to distinguish between “good” and “bad” risks, or due to self-fulfilling expectations. Both forms of financial crises are going to be discussed in the following paragraphs.

Financial Crises Due to Exogenous Shocks. A very prominent example of the asymmetric information view of financial crises both in industrial and in emerging market countries, being triggered by exogenous shocks and leading to binding credit and balance sheet constraints, is given by Mishkin (1991, 1996, 1997, 1998a, 1998b, 1999a, 1999b). He analyzes different kinds of exogenous shocks like unexpected variations in the inflation rate, interest rate changes, exchange rate changes, stock market crashes, etc. In all cases, exogenous shocks to the financial system interfere with information flows, leading to a contraction in credit supply. For example, a stock market crash, or a sharp interest rate increase reduce net worth of financial and business firms, leading to a reduction in available credit, investment and output; in severe cases, a drying-up in lending can cause a severe financial crises. Other examples which mainly refer to (international) credit constraints of emerging market countries owing to borrowing in foreign currency, which become binding and/or are going to be cut back in case of exogenous shocks, are given by Dornbusch (1998a, 1998b, 1999, 2001), Cespedes, Chang and Velasco (2001a, 2001b), Velasco (2001, 2002), and Caballero and Krishnamurthy (2002), being discussed in chapter 5.5.4.

Translating these ideas into the industrial country model can be done by various kinds of shocks. Productivity shocks for example, being represented by increasing values in $v$ and $\delta$, lead to an economic contraction via a reduction in the “borrowing constraint” being represented by Tobin’s $q$. A collapse of Tobin’s $q$, indicating large drops in liquidity and net worth positions, lead to a decline in $u, r, q, \hat{p}, \hat{s}$, and to an increase in $j$, causing in severe cases a full-fledged banking crisis and to lots of bankruptcies among firms. Shocks like the sudden bankruptcy of an important business or financial firm can cause a sharp decline in the “state of confidence” $p$ and in Tobin’s $q$, generating the same adverse macroeconomic effects like increases in $v$ and $\delta$.

towards pessimistic (profit) expectations, which can be induced by small shocks, or simply without any reason. Collapsing expectations lead to sharp declines in asset prices and exchange rates, inducing systemic financial crises due to large drops in business firms’ net worth, either by falling asset values, or by increasing foreign debt stocks valued in domestic currency due to nominal depreciations of the home currency. The collapse of asset prices and exchange rates, as well as the outbreak of financial crises validates ex post investors’ ex ante shift towards pessimistic expectations.

Krugman develops two different fourth-generation models, one on emerging market crises (Krugman 1999a, 1999b), relating to the influence of exchange rate variations on business firms’ net worth in case of large foreign debt stocks to be discussed in chapter 5.5.2, and a second one on financial crises in industrial countries (Krugman 2001), which is going to be analyzed in the following, relating to the influence of changing asset prices on business firms’ net worth positions.

In Krugman’s (2001) closed economy model, business firms’ investment activities are constrained by their net worth which depends on the level of asset prices. Asset prices, which are represented by Tobin’s q, depend positively on output and negatively on interest rates. There arise two possible simultaneous asset and goods market equilibria. The “no-crisis” equilibrium is characterized by a strong confidence in the economy, high asset prices, strong net worth and high output. The “crisis” equilibrium, on the other hand, is characterized by low confidence in the economy, low asset prices, weak net worth and low output. Furthermore, the “crisis” equilibrium is characterized by a “liquidity trap” situation, as nominal interest rate cuts by the central bank to a minimum level of zero do not induce a recovery of the economy owing to the maintenance of pessimistic profit expectations. By way of contrast, both expansionary and contractionary monetary policy in the “no-crisis” equilibrium remain effective. Accordingly, there is no endogenous mechanism leading to a reversal of expectations and to a recovery of the economy. Financial crises, i.e. a switch from the “no-crisis” to the “crisis” equilibrium, are triggered by a sudden shift from optimistic towards pessimistic expectations as to the economy’s profitability, causing a large decline in asset prices, net worth, investment, and in output, thereby validating the initial shift towards pessimistic expectations. Factors causing a shift in expectations are assumed to be purely random, and are not going to be explained by the model, as in all other self-fulfilling expectations models.

Translating the mechanisms of the Krugman model into the present model can be done easily by referring to the Diamond-Dybvig story which has been explained by exogenous shifts in the state of confidence parameter ρ. The “no-crisis” equilibrium is characterized by all agents having a strong confidence into the economy, indicated by a comparatively “high” level of ρ, causing comparatively “low” interest rate levels of i and j, and “high” levels of u, r and q. The shift from the “no-crisis” to the “crisis-equilibrium” is caused by a sudden downward shift in ρ, causing comparatively “high” interest rates j and i, and “low” values in u, r and q. As Krugman argues, in “normal” times, the low confidence equilibrium could be left by the central bank cutting interest rates, being represented by a large increase in high-powered money h, reducing j and stimulating u, r and q. If however, the confidence parameter ρ is at very low levels, a sharp increase in h can only reduce the loan rate j to zero, but has no influence on u, r and q. Furthermore, since the economy is in depression, a shrinking value of u causes deflation $\dot{p} < 0$, increasing the real
interest rate on loans \( j \) at a constant nominal rate \( j = 0 \), and therethrough leading to a further decline in \( q, r \) and \( u \).

### 4.5.5 Endogenous Financial Crisis Models

**The Financial Instability Hypothesis by H. P. Minsky.** Minsky’s (1972, 1975, 1977, 1978, 1980a, 1980b, 1982a, 1982b, 1986) financial instability hypothesis\(^{62}\) differs from all models reviewed so far as to four important aspects. Firstly, Minsky’s theory, which is restricted to closed industrialized economies, argues that market economies are inherently unstable, and that systemic financial crises, driven by an endogenous build-up of financial fragility, are an unavoidable and endogenous outcome of modern capitalist systems if there are no government or central bank interventions to prevent financial crises, or to dampen their adverse effects on goods and financial markets. Secondly, Minsky claims that financial crises are inseparably linked to business cycle fluctuations, where financial instability is built up endogenously during the upswing and evolves into a systemic financial crises when the economy enters the downswing period. Thirdly, Minsky’s approach is built on a balance sheet approach considering explicitly liquidity and net worth positions. Fourthly, notwithstanding the fact that the financial instability hypothesis is dynamic in nature, Minsky’s theory is formulated as a qualitative-descriptive and comparative-static approach.\(^{63}\)

Minsky’s financial instability hypothesis consists of five theoretical components. The first component, Minsky’s theory of financial stability, which has been discussed in detail in sections 2.3.2.1 and 2.3.2.2, distinguishes financially fragile from financially stable economies by the ratio of hedge finance to speculative finance and Ponzi finance units. If the ratio is comparatively high, the economy’s financial structure is stable, whereas a low ratio indicates a fragile financial structure. The second component, Minsky’s theory of the determinants of aggregate profits, is based on M. Kalecki’s (1971) theory of profits which is outlined in more detail in appendix E. According to Kalecki’s approach, the amount of investment determines the amount of profits, i.e. rising/declining investment expenditures generate higher/lower profits. The third component, Minsky’s theory of investment, is largely based on Keynes’ (1936, 1937) theory of investment, stating, in a very simplified way, that the aggregate level of investment is positively dependent on the ratio of the expected profit rate to the debt interest rate.\(^{64}\) Accordingly, investment increases/decreases if there is a rise/fall in the expected profit rate, and/or if there is a fall/rise in the debt interest rate. The fourth component, Minsky’s view of the formation of financial crises, has been applied by C. Kindleberger (2000) to explain various historical episodes of financial crises and is therefore often designated as the Minsky-Kindleberger approach to financial crises.

\(^{62}\)Minsky’s financial instability hypothesis has been applied by C. Kindleberger (2000) to explain various historical episodes of financial crises and is therefore often designated as the Minsky-Kindleberger approach to financial crises.

\(^{63}\)Some formal treatments of Minsky’s financial instability hypothesis can be found in Taylor and O’Connell (1985), Palley (1996), chapter 12, and Nasica (2000).

\(^{64}\)Minsky’s, or Keynes’ investment function is an early version of Tobin’s \( q \) theory of investment, since investment is assumed to be positively dependent on the difference between the demand price of capital (price of existing capital goods), being largely dependent on expected profits, and the supply price of capital (reproduction costs of investment goods). Moreover, as capital markets are assumed to be imperfect due to asymmetric information, investment is assumed to be determined additionally by subjective assessments of borrower’s and lender’s risk which are both dependent on aggregate actual and expected profits. For further details on Minsky’s theory of investment, see especially Minsky (1975), chapters IV and V.
of profit expectations, has not been explicitly considered by Minsky, but relies largely on Keynes’ beauty contest theory, i.e. profit expectations are determined according to a chartist-type behaviour of agents. The fifth component, Minsky’s theory of the financial structure, states that the degree of indebtedness is determined by the relation of profits to investment. Hence, if actual profits exceed/fall short of investment expenditures, there is a fall/rise in overall indebtedness. Furthermore, a given degree of indebtedness can be only maintained in case actual profits are viewed to be sufficient to repay debt in the future.

The second, third, and fourth component give rise to the emergence of cumulative upward and downward processes in goods and financial markets which are driven by the interaction of actual profits, expected profits, and investment. A rise/fall in investment causes a rise/fall in actual profits, leading to a rise/fall in expected profits generating a further increase/decrease in investment, and so on. The fifth component determines how long a cumulative upward or downward process is sustainable. If the expansionary process is characterized by a faster increase in expected profits and investment than in actual profits, the increase in indebtedness is maintained as long as actual profits are expected to rise to future levels which enable debt to be repaid; otherwise the expansionary process is reversed into a contractionary cumulative downward process with decreasing indebtedness which comes to a halt if investors realize that actual profits have fallen less than expected.

A typical Minsky cycle begins with the recovery phase of the last business cycle when indebtedness has returned to sustainable levels, i.e. when the ratio of hedge finance units to speculative finance and Ponzi finance units has increased. Such a financially robust structure is characterized by short-term interest rates being lower than long-term rates, and by the expected profit rate being higher than long-term interest rates. The fact that short-term interest rates are lower than long-term interest rates during the recovery phase of the last business cycles, i.e. during tranquil times, can be explained either by expectations theory of the term structure of interest rates, or by the liquidity premium theory. Moreover, since debt restructuring after the last financial crisis is generally characterized by transforming short-term debt into long-term debt, the financial structure is characterized by a large fraction of liquid assets, by a low share of short-term debt, and by a much higher share of long-term debt (due to rising hedge finance arrangements), giving rise to very low short-term interest rates. The fact that the expected profit rate is larger than the long-term interest rate can be explained by very low aggregate investment and profits due to the last financial crisis. Consequently, only a small rise in investment expenditures leads very quickly to an increase in actual profits.

According to Minsky, this relation between short-term rates, long-term rates, and the expected profit rate induces an endogenous build-up of financial fragility, as profits can be made by increasing investment expenditures which are financed by “cheap” short-term debt. That is, profit opportunities which stem from a robust financial structure cause an endogenous shift from financial stability to financial instability. Accordingly, the recovery phase of the last business cycle is followed by a boom phase which is driven by a cumulative upward process, stemming from the interaction of actual profits, investment, and expected profits, which leads to a significant fall in the ratio of hedge finance units to speculative finance and Ponzi finance units due to a significant rise in speculative and Ponzi finance units. Furthermore, as expectations are driven by chartist-type behaviour, there is a large
rise in overall indebtedness as profit expectations and investment expenditures grow faster than actual profits.

The boom phase comes to an end at the upper turning point due to an endogenous, and general rise in interest rates which is caused by a steadily rising demand for financing, and by a limited supply of financing. The positive growth in actual profits is dampened or even reversed by rising wages and factor costs as capacity utilization reaches its maximum. Furthermore, rising wages and factor costs lead to contractionary monetary policies by central banks to fight inflationary pressures. Rising interest rates and declining profits lead, according to sections 2.3.2.1 and 2.3.2.2, to present value reversals and to financial posture downgrading, which cause a sharp decline in asset prices and a large rise in bankruptcies among firms and banks, evolving into a deep systemic banking crisis which is accompanied by a liquidity trap situation and deflationary pressures as emphasized by Fisher (1933, 1932), if there are no effective lender of last resort interventions by the central bank. In case monetary authorities do not prevent a full-fledged systemic financial crisis, the depression phase can be only left in case there is large rise in the government budget deficit which leads to a rise in aggregate profits (see appendix E for details) and to a decline in overall indebtedness, as there are no endogenous mechanisms which induce a recovery.

In terms of the present model, Minsky’s financial instability hypothesis can be illustrated by the dynamic Keynesian version depicted in figure 4.9, and characterized by a pure chartist-type behaviour of agents. As mentioned in section 4.4.6, under pure chartist-type behaviour, there arises the possibility that each business cycle gives rise to financial crises, corresponding exactly to Minsky’s results.

Other Approaches. There are similar approaches, as e.g. works of George (1879), Robbins (1934), Galbraith (1972), Borio, Furfine and Lowe (2001), Villa (2001), and Borio and Lowe (2002), which explain systemic financial crises as an outcome of excessive debt-led, and expectations-led business cycle fluctuations. However, most of these approaches are formulated as qualitative descriptions, or as empirical studies of historical episodes of financial crises and do not provide a comparable theoretical foundation as Minsky. Furthermore, as these approaches mainly rely on specific historical episodes, it is not clear whether financial crises are considered as an endogenous outcome, or as an event having been caused by exogenous shocks.

4.5.6 An Assessment

After having set out the most important standard approaches to financial crises, this section compares standard theory of financial crises with the industrial country model by elaborating the differences and common grounds, and by highlighting new elements of the present approach which have been neglected so far by standard models of financial crises.

A Comparison with Inconsistent Macroeconomic Policy Models. Respecting the common grounds of the present approach with inconsistent macroeconomic policy models, there are four similarities to be mentioned. Firstly, both approaches show that rising nominal interest rates, dropping asset prices and debt deflation, being associated with rising real interest rates, cause a substantial rise in financial fragility by deteriorating
solvency and liquidity positions. Secondly, both types of models argue that both currency and twin crises are preceded by large capital outflows and depreciation expectations of the home currency. Thirdly, both approaches claim that, in case of twin crises, the banking crisis precedes the currency crisis which deepens the banking crisis. Fourthly, both types of models assume that financial crises are caused by exogenous factors, where inconsistent macroeconomic policy models stress excessive expansionary monetary and fiscal policies, and the present approach an exogenous positive shock to expectations.

Regarding the differences, there are four issues to be named. Firstly, inconsistent macroeconomic policy models do not consider the link between endogenous business cycle fluctuations and the occurrence of financial crises. Secondly, inconsistent macroeconomic policy models do not consider endogenous fluctuations in the debt-asset ratio and in profit expectations as the driving forces of tranquil and financial crises business cycles. Thirdly, inconsistent macroeconomic policy models only consider exogenous policy factors causing financial crises, and abstract from mechanisms inducing an endogenous build-up of financial fragility leading unavoidably to the occurrence of financial crises. Fourthly, inconsistent macroeconomic policy models generally assume the rational expectations hypothesis to hold, and abstract from market sentiment-driven expectations giving rise to cumulative processes.

A Comparison with Self-Fulfilling Expectations Models. As regards the common grounds, there are three similarities to be mentioned. Firstly, both approaches show that expectations are a crucial determinant of real economic activity and financial stability, as expectations are self-fulfilling and induce cumulative processes. Secondly, both types of models illustrate that stable financial conditions are associated with optimistic expectations as to real and financial sector variables, whereas financial instability is associated with pessimistic expectations. Thirdly, in both approaches, financial crises are induced by exogenous shocks to expectations.

As to the differences, there are five issues to be named. Firstly, self-fulfilling expectations models do not consider the link between business cycle fluctuations and financial crises as the present approach. Secondly, the approach of self-fulfilling expectations does not explain the endogenous build-up of financial fragility by endogenous interactions of expectations and overindebtedness, as both (rational) expectations and the degree of indebtedness are treated as exogenous variables, and do only change in case of random shocks. Thirdly, though both approaches claim that financial crises are caused by exogenous shocks to expectations, self-fulfilling expectations models argue that crises are caused by a shift from optimistic towards pessimistic expectations, whereas the industrial country model argues that financial distress is caused by a shift from pessimistic towards optimistic expectations. Fourthly, according to self-fulfilling expectations models, financial crises are unpredictable, random events which are not preceded by a deterioration of fundamentals, whereas the industrial country model shows that financial crises are preceded by a deterioration of almost all economic fundamentals, and that financial crises are the consequence of a past build-up of financial fragility. Fifthly, self-fulfilling expectations models assume the rational expectations hypothesis to hold, and do not consider chartist-type expectations which induce cumulative processes.
A Comparison with Asymmetric Information Models. As regards the common grounds of the industrial country model with asymmetric information models, there are four issues to be mentioned. Firstly, both approaches argue that financial crises are preceded by a boom phase which is driven by overly optimistic expectations, leading to overinvestment, overborrowing and to a considerable build-up of financial fragility. Secondly, both approaches show that financial crises are associated with both deteriorating fundamentals and collapsing expectations. Thirdly, especially self-fulfilling expectations-driven moral hazard models show, like the present approach, that stable financial market conditions are associated with optimistic expectations, whereas financial crises are associated with pessimistic expectations. Fourthly, both approaches argue that financial crises are induced by exogenous shocks.

Respecting the differences, there are six issues to be named. Firstly, moral hazard models do not consider the link between tranquil business cycle fluctuations and financial crises cycles. Secondly, moral hazard models do not explain the build-up of financial fragility by endogenous mechanisms, but by exogenously given government guarantees. Thirdly, moral hazard models assume that financial crises can be only triggered by exogenous shocks to fundamentals, or by self-fulfilling expectations with regard to the maintenance of government guarantees, and exclude the possibility of endogenously caused financial distress despite a considerable build-up of financial fragility during the boom phase. Fourthly, though both approaches argue that financial crises are caused by exogenous shocks to expectations (especially self-fulfilling expectations-driven moral hazard models), moral hazard models assume that financial crises are driven by a switch from optimistic to pessimistic expectations, whereas the industrial country model argues that crises are driven by a switch from pessimistic to optimistic expectations. Fifthly, following self-fulfilling expectations-driven moral hazard models, financial crises are an unpredictable event which are not preceded by deteriorating fundamentals, whereas the industrial country model is characterized by an endogenous deterioration of all fundamentals before the outbreak of the crisis. Sixthly, moral hazard models generally assume the rational expectations hypothesis to hold, and abstract from market sentiment-driven expectation formation schemes.

A Comparison with Credit Constraint and Balance Sheet Models. As regards the common grounds, there are three similarities to be mentioned. Firstly, both approaches argue that financial crises and subsequent recessions are caused by a considerable reduction in domestic and foreign debt finance, i.e. by financial constraints which become binding. Secondly, both approaches argue that financial crises are accompanied by both deteriorating fundamentals and collapsing profit expectations. Thirdly, both approaches argue that financial crises are caused by exogenous shocks. Fourthly, especially self-fulfilling expectations-driven credit constraint models show, as the industrial country model, that both financial stability and a macroeconomic activity depend crucially on the state of profit expectations.

Respecting the differences, there are six issues to be named. Firstly, credit constraint and balance sheet models do not consider the link between business cycle fluctuations and financial crises. Secondly, credit constraint and balance sheet models are not subject to endogenous fluctuations in expectations and in indebtedness. Thirdly, credit constraint and balance sheet models do not explain the build-up of financial fragility by endogenous
processes, but by exogenous shocks to fundamentals and by shifts towards self-fulfilling pessimistic expectations. Fourthly, especially self-fulfilling expectations-driven credit constraint models argue that financial crises are caused by a shift from optimistic towards pessimistic expectations, whereas the present approach emphasizes the shift from pessimistic towards optimistic expectations as the triggering event. Fifthly, especially self-fulfilling expectations-driven credit constraint models argue that financial crises are an unpredictable event, while the industrial country model is subject to an endogenous deterioration of all fundamentals before the outbreak of the crisis. Sixthly, credit constraint and balance sheet models assume the rational expectations hypothesis to hold and do not consider market sentiment-driven expectations giving rise to cumulative upward and downward processes.

A Comparison with Endogenous Financial Crisis Models. Regarding the common grounds, there are two similarities. Firstly, both approaches show that financial crises and business cycles are inseparably linked to each other. Secondly, financial crises are caused by endogenous debt and expectation dynamics.

As for the differences, there are four issues to be mentioned. Firstly, endogenous financial crisis models argue that every business cycle can lead to financial crises, i.e. that capitalist economies are inherently unstable, whereas the industrial country model indicates that capitalist economies are inherently cyclically stable, and that financial crises are an exogenous event. Secondly, endogenous financial crisis models argue that expectations are solely driven by market sentiments and neglect a long-run rational behaviour of agents. Thirdly, endogenous financial crisis models argue that there are no endogenous mechanisms inducing a recovery of an economy which has been hit by a financial crisis, whereas the industrial country model points out that even in case of a financial crisis, market economies are stable as there exists an endogenous recovery mechanism which however, can take a very long time. Fourthly, in contrast to endogenous financial crisis models, the present approach provides a sophisticated theoretical foundation and distinguishes explicitly between a “normal” degree of financial fragility being associated with tranquil business cycles, and “excess” financial fragility causing systemic financial distress.

New Elements. The comparison of standard models of financial crises with the industrial country models has shown that the present “cyclical” approach to financial crises provides important extensions for further research on financial crises both from a methodological-theoretical, and from an empirical perspective.

Regarding the methodological-theoretical perspective, the present approach offers six innovations. Firstly, the model contains a strict dynamic framework for an open economy, being not restricted to few periods, or to a closed economy. Secondly, the model is based on a sophisticated financial structure being developed from balance sheets with many assets, and contains a banking sector being the most important institution for the allocation of credit. Furthermore, the model emphasizes the important role of net worth and collateral both for business cycle fluctuations and for financial crises, being often neglected by standard models. Thirdly, the model structure considers explicitly, in contrast to standard models, various important transmission mechanisms (interest rate channel, exchange rate channel, asset price channel, bank lending channel, balance sheet
channel) between the real and the financial sphere in an open economy, allowing for an illustration how financial disturbances can generate real sector or systemic financial crises. Fourthly, the model provides a synthesis between the rational expectations school and the Keynesian view of the formation of expectations, fitting much better the stylized facts of the behaviour of expectations than each theory on its own. Fifthly, the model provides a theoretical link between business cycle fluctuations and financial crises which has been generally omitted by standard approaches except for Minsky’s theory, which however, provides no quantitative foundation, and assumes that each business cycle is accompanied by a financial crisis. Sixthly, the present approach provides a theoretical synthesis with respect to the financial stability of capitalist market economies, and with respect to the nature of triggers of financial crises. The industrial country model illustrates that capitalist economies are cyclically stable, though each business cycle is accompanied by a weak form of endogenous financial fragility, and that financial crises are caused by exogenous positive shocks to expectations which induce an endogenous process of above-average financial fragility and financial crises. By way of contrast, standard theory offers only two polar views. Standard theory of exogenous financial crises argues that capitalist economies are inherently stable without any appearance of financial fragility, and that financial crises can be only triggered by adverse shocks to fundamentals and expectations, whereas standard theory of endogenous financial crises argues that capitalist economies are inherently unstable, and that financial crises occur purely endogenously.

Regarding the empirical perspective, the present approach to financial crises offers two innovations. Firstly, in contrast to all other financial crisis models, the present approach contains most of the major indicators as variables which are used by empirical research to describe the influence of financial distress on various macroeconomic variables, and to develop early warning systems, as e.g. the debt-asset ratio, business firms’ and banks’ profit rate, net cash flows, Tobin’s q, loan rates, bond and stock prices, etc. Secondly, the model’s predictions of the behaviour of macroeconomic variables before, during, and after financial crises fits very closely the stylized facts of financial crises, whereas predictions by standard approaches very often only refer to the post-crisis period, and are restricted to a limited number of variables. Furthermore, predictions made by standard model in some cases do not fit the stylized facts, as e.g. the prediction by self-fulfilling expectations models that financial crises are not preceded by a deterioration of fundamentals.

4.6 A Comparison with Standard Business Cycle Theory

The dynamic version of the present model provides both a dynamic theory of financial crises and a theory of endogenous fluctuations in aggregate economic activity. After having assessed the differences, as well as the common grounds of the present approach with standard theory of financial crises, this section compares the model’s mechanisms giving rise to fluctuations in real and financial markets with recent work on business cycle theory. The theoretical literature on business cycles can be classified in two broad categories, namely theories explaining cyclical fluctuations by endogenous mechanisms, and theories interpreting the business cycle as a cyclical response to exogenous financial or real disturbances. As opposed to the analysis of standard theory of financial crisis, the following
description does not contain a detailed description, as well as a comparative-static examination of various business cycles theories, but only a short comparative analysis of the “main driving forces” of cyclical fluctuations in aggregate economic activity.

4.6.1 Theories of Endogenous Business Cycles

Fluctuations in Bank Credit as the Main Source of Aggregate Volatility. Early theories on business cycles explain the cumulative processes of inflationary expansions and deflationary contractions by money and bank credit fluctuations giving rise to fluctuations in investment, and thereby in aggregate economic activity. Wicksell ((1898) 1936) explains fluctuations in bank credit by discrepancies between the “natural interest rate”, being equivalent to the expected marginal profit rate on new investment which determines aggregate investment, and the “market rate”, being equivalent to the interest rate on bank loans which determines aggregate savings. Though interest rate differentials can be theoretically caused by both variations in the natural and in the market rate, Wicksell argues that differentials are predominantly caused by shocks to the natural rate. In case the natural rate is higher than the market rate, arising profit opportunities cause an expansion in bank credit, and a large rise in investment expenditures generating excess demand on goods markets (investment larger than savings) and inflation. However, an increasing price level forces banks to increase the interest rate on bank loans due to inflation-induced reserve (deposit) outflows, causing interest rate convergence and a tendency towards goods market equilibrium in the long-run. By way of contrast, in case the natural rate is lower than the market rate, declining profit opportunities lead to a decline in investment expenditures and to a contraction in bank credit causing deflation. Deflation-induced excess reserves with banks cause a reduction of the market rate towards the natural rate reducing excess supply in the goods market. Summing up, cumulative movements in the absolute price level induced by interest rate divergence guarantee a convergence of the natural and the market rate, and thereby a tendency towards goods market equilibrium, whereas the old and the new equilibrium differ by the absolute price level. As a result, relative prices are stable in the long-run, whereas the absolute price level is unstable, implying that the monetary equilibrium, i.e. the equality of the natural and the market rate, is also unstable since there is no mechanism guaranteeing a perfect adjustment of the market to the natural rate. For example, the market rate can over- or undershoot the natural rate inducing a new cumulative process in the reverse direction. Furthermore, there exists also the possibility of a changing natural rate during the adjustment process, inducing a new interest rate divergence. Regarding monetary policy conclusions, Wickell's theory states that if zero inflation is accepted to be the main goal of monetary policy, the prime rate has to be stabilized at the the level of the natural rate. Hayek’s (1933, 1939, (1935) 1967) theory of business cycles also explains fluctuations in investment and aggregate economic activity by the divergence of the natural and the market rate as Wicksell. However, as opposed to Wicksell, interest rate differentials are caused mainly by monetary disturbances, and long-run equilibrium is guaranteed by the price structure between investment and consumption goods. At below-equilibrium market rates, an expansion in bank credit creates overinvestment in capital goods industries and “forced saving” by inflation, which is mainly caused by an excess demand for consumption goods resulting from the shift of resources from consumption to capital goods industries.
Rising inflation causes banks to increase the market rate, leading to a declining interest rate differential and to a reduction in the supply of loans. Rising market rates, a reduction in credit, as well as rising consumption goods prices lead to an abrupt decline of capital goods' discounted present value causing losses and bankruptcies in the capital goods sector. Consequently, there is an abrupt stop in the capital goods production and a shift to consumption goods production. However, capital goods having been used in the capital goods sector cannot be used in the consumption goods sector due to lacking complementarities. As a result, the sudden stop of the traverse causes real capital shortages, a deflationary downturn, and an adjustment of the market rate to the natural rate. Summing up, monetary changes lead to distortions in the vertical structure of production, i.e. to imbalances between the production of consumption and capital goods, causing a "crisis" in order to return to the "old equilibrium" structure of production.\(^{65}\) Unlike Wicksell's theory, distortions in the price structure, not cumulative movements of the price level, guarantee a return to the equilibrium.

Despite the fact that both authors explain the discrepancies between the natural and the market rate by exogenous shocks, both approaches can be classified as endogenous business cycle theories since they focus on the internal (price) mechanisms which guarantee a stable tendency towards equilibrium in the long-run. Hence, both Wicksell and Hayek viewed the role of exogenous factors as secondary, though they admit that exogenous shocks are the triggers for evolving disequilibria.\(^{66}\)

**Uncertain and Self-Fulfilling Expectations as the Source of Fluctuations in Investment, Bank Credit, and Aggregate Economic Activity.** While early theories explain fluctuations in credit and investment by productivity and/or monetary shocks, there are other authors emphasizing that volatility in finance and investment results mainly from unstable expectations about the future. Keynes (1936, 1937) argues that aggregate instability is largely caused by fluctuations in investment, whereas volatility of investment is due to agents' expectations about an uncertain future being subject to large fluctuations which might be unrelated to changes in anything other than "market psychology" itself.\(^{67}\) In a similar vein, Lavington (1921) attributes volatility of aggregate economic activity to the inherent instability of business confidence which can become self-fulfilling. For example, a rise in business confidence, which can be justified by fundamentals or not, leads to actions which are a real cause of increased confidence resulting in a boom. Consequently, a drop in confidence, which can be purely random, can lead to an economic downturn.

While Keynes and Lavington stress the interaction of expectations and investment neglecting more or less the question of investment finance, Hawtrey (1913, 1926) 1950) emphasizes the role of volatile expectations as the main source of fluctuations in bank credit determining the aggregate level of investment. He attributes the trade cycle to the inherent stability of credit which is mainly caused by unstable, self-fulfilling expectations of two sorts. Firstly, by volatile expectations of businessmen regarding the level of

\(^{65}\) For business cycle theories caused by distortions in the vertical structure of production, see also Tugan-Baranovskii ((1894) 1913) and Spiethoff (1925).

\(^{66}\) For details on Wicksell's and Hayek's business cycle theories, see e.g. Hagemann (1994, 2002), Hagemann and Trautwein (1996), and Trautwein (1998).

\(^{67}\) See also section 4.4.1 for a detailed discussion of Keynes' theory of the formation of expectations.
aggregate demand which can be self-fulfilling, since banks are assumed to accommodate very passively changes in the demand for credit; as a result, an increase in expected demand causes an increasing demand for credit and investment goods, thereby validating the initial increase in expected demand. Secondly, by volatile expectations of bankers regarding the extent to which they can expand the supply of loans without causing a dangerous deterioration of reserves, depending upon the rate at which other banks expand their loan supply. In the same way, Leijonhufvud (1968, 1981) argues that serious macroeconomic instability occurs only if the exhaustion of "liquid buffer stocks" causes liquidity constraints to bind which causes instability, as revisions of expectations about future incomes become self-fulfilling.

In contrast to these early theories, which were not founded on quantitative analysis, recent research on expectations-driven endogenous business cycles, as e.g., models by Benhabib and Day (1982), Benhabib and Nishimura (1985), Grandmont (1985, 1986), and Grandmont and Laroque (1986), rely on an explicit formal modelling of intertemporal optimizing behaviour of agents in order to analyze precisely the influence of expectations on macroeconomic variables, giving rise to autonomous fluctuations without the occurrence of exogenous shocks. These models claim that even if the real fundamental characteristics of an economy do not change over time, prices and quantities are subject to cyclical fluctuations under laissez-faire in case agents expect them to fluctuate. Consequently, endogenous macroeconomic fluctuations caused by self-fulfilling expectations arise even in a world with individual intertemporal optimization, laissez-faire policy, and competitive market clearing. Formally, these models rely on the theory of deterministic nonlinear dynamical systems including bifurcation theory. A new similar formal approach, the so-called "stationary sunspot equilibrium" approach, to be discussed in the following section, working also under the assumptions of individual intertemporal optimization, laissez-faire policy, and competitive market clearing, explains aggregate fluctuations also by revisions of self-fulfilling expectations, which are however, caused by random shocks and not by internal mechanisms as described above. In contrast to models of endogenous business cycles, the "stationary sunspot equilibrium" approach models fluctuations by linear but stochastic dynamics.

**Keynesian Multiplier-Accelerator Models.** The Keynesian tradition of business cycle modelling started with Kalecki (1935, 1937), Harrod (1939, 1948) and Domar (1946, 1957) who emphasized the inherent dynamic instability of economic growth. Their work was followed by business cycle models by Samuelson (1939), Kaldor (1940), Metzler (1941), Hicks (1950), Goodwin (1951), and Rose (1967) who explain the emergence of endogenous fluctuations by an interaction of the consumption multiplier and of various versions of the investment accelerator. One branch of these models considers net investment as a positive function of changes in output so that fluctuations in consumption are transmitted with increasing amplitude to fluctuations in investment. Other models are based on the capital stock adjustment principle, the so-called "flexible accelerator" mechanism. According to this principle, current investment is determined by the difference between the desired and the actual capital stock where the desired capital stock is positively dependent on output. As a result, net investment depends positively on output and negatively on the initially available stock of capital. The distinguishing feature of these models is the explanation of income fluctuations on the basis of demand side factors. However, in contrast to all
other endogenous theories on business cycles, these models ignore monetary, financial and expectational factors due to a restriction of the analysis to real factors.

4.6.2 Theories of Exogenous Shock-Driven Business Cycles

Exogenous Real and Monetary Shocks as the Main Source of Fluctuations. Common to all theories explaining business cycles as a result of exogenous events, whether originating from policy or from random external shocks, is the belief that economic systems are fundamentally stable at the stationary equilibrium, and that fluctuations in macro variables are the result of the economic system’s reaction to frequent exogenous shocks to real or financial variables. The classification of a shock-driven business cycle theory as “real” or “monetary” is linked to the distinction between the impulses and the propagation mechanisms first introduced by Frisch (1933), since there are models with real shocks and monetary propagations, models with monetary shocks and real propagations, and combinations of both. The work on exogenous shock-driven business cycles, which goes back mainly to Slutsky (1927) and Frisch (1933), can be subdivided into two different approaches, namely the “Equilibrium Business Cycle” approach, which is of neoclassical derivation, and “New Keynesian” approach which moves within the Keynesian tradition.

“Equilibrium Business Cycle” theory, which is based on the intertemporal Walrasian general equilibrium setting, perfect markets, rational behaviour of agents and instantaneous market-clearing, assumes that the long-run equilibrium of a competitive monetary economy that does not experience any exogenous shocks is characterized by a state which is stationary, or growing at a constant rate. As a result, any departure from the long-run Walrasian equilibrium is viewed as purely transitory being caused either by monetary or real shocks. Monetary shock-driven models mainly go back to Lucas' (1972, 1975, 1977b, 1980, 1981) business cycle theory68 stating that all persistent monetary changes, inasmuch as they are predictable, will be correctly anticipated and met directly by proportional changes in prices and related nominal variables having no influence on real variables as e.g. output. Only random monetary shocks can lead to price surprises and miscalculations by agents inducing false production decisions since agents are not able to distinguish relative price changes from changes in the aggregate price level due to incomplete information about economy-wide aggregates such as the money stock and the overall price level. For example, in case there is a random unanticipated monetary expansion leading to aggregate inflation, producers wrongly interpret the unanticipated increase in the aggregate price level as an increase in relative prices, i.e. in selling prices, boosting the real rate of return and causing an expansion in output; after some time, when outside price data has become available, producers suddenly realize that their interpretation of the price increase has been wrong and start to reduce production which involves time and costs. Real-shock driven business cycle models, as e.g. by Kydland and Prescott (1980, 1982) and by Long and Plosser (1983) which are also labelled as “Real Business Cycle Theory”, state that disturbances from the intertemporal Walrasian equilibrium are mainly caused by exogenous random shocks to preferences and technology.

68Other similar approaches can be found in Sargent and Wallace (1975), McCallum (1980), and Barro (1981).
The "New Keynesian" approach on business cycles is built upon the criticism of "Equilibrium Business Cycle" theory\(^{69}\), stating that markets are not perfect and do not clear permanently since the "real world" is characterized by imperfect competition and asymmetric information, resulting in nominal rigidities, i.e. sticky prices. The "New Keynesian" view on business cycles, being reviewed and summarized e.g. in Mankiw (1989) and Mankiw and Romer (eds.), aims at providing a theoretical microfoundation of the different behaviour of goods, labour and financial markets under agents' intertemporal optimizing behaviour from the Walrasian theory. According to New Keynesians, business cycles are caused by exogenous shocks generating cycles due to the aforementioned nominal rigidities.

Stationary Sunspot Equilibria - Self-Fulfilling Rational Expectations as the Main Source of Aggregate Fluctuations. "Equilibrium Business Cycle" theory as well as the "New Keynesian" approach, both working under the assumption of rational expectations, explain aggregate fluctuations by shocks to the fundamentals of an economy, i.e. by shocks to preferences, technology, and monetary variables. By way of contrast, stationary sunspot models, e.g. by Azariadis (1981), Cass and Shell (1983, 1988), Azariadis and Guesnerie (1986), and Woodford (1986, 1987, 1988, 1989), which also work under the intertemporal Walrasian equilibrium setting, laissez-faire and rational expectations, explain macro fluctuations by unpredictable changes in so-called "sunspot" variables which are unrelated to fundamentals but which influence agents' rational expectations. Generally, sunspot variables are modelled as random variables being subject to a stationary stochastic process which agents observe, though sunspot variables do not contain information about fundamentals as e.g. preferences, resources and technology. For example, the unforecastable change in expectations of businessmen regarding income from production in a given period to which the desired level of investment expenditure is adjusted, could serve as a typical sunspot variable which does not influence fundamentals but agents' rational expectations. The introduction of sunspot variables in an explicit equilibrium setting generates under certain conditions so-called stationary rational expectations equilibria, or "sunspot equilibria" in which expectations vary in response to sunspot-state variables that do not provide, as aforementioned, any information about changes in fundamentals. These equilibria can be interpreted as representations of repetitive fluctuations in which sudden and random revisions of agents' expectations, due to sudden and random changes in the sunspot variable, become self-fulfilling. Changing expectations caused by random shocks to the sunspot variable cause a change in the outcome so that the initial change in expectations is validated ex post. As a result, the stationary sunspot equilibrium approach emphasizes the role of volatile expectations as an independent and causal factor of macro fluctuations, even if fundamentals are constant over time. These models postulate that even in an intertemporal Walrasian equilibrium setting under laissez-faire and rational expectations, there exists an inherent instability of market economies which has been already emphasized by early authors as Keynes, Lavington, Hawtrey who, however, did not explain changes in business confidence or animal spirits by individual rational behaviour which led, before the introduction of the sunspot equilibrium approach, to the conclusion by contemporary business cycle theory that self-fulfilling revisions of expectations were irrational and inconsistent with individual rational choice.

\(^{69}\) For criticism on "Equilibrium Business Cycle" theory, see e.g. Summers (1986).
4.6.3 An Assessment

After having outlined the most important theories of business cycles, both in a historical and in a methodological perspective, the following discussion compares the present approach with standard theory of business cycles by elaborating the common grounds and differences, and by highlighting new elements of the present model which have not been considered yet by standard theories.

A Comparison with Theories of Endogenous Business Cycles. Regarding the common grounds of the present approach with standard theory of endogenous business cycles, there are seven striking similarities. Firstly, in the present model, fluctuations in bank credit, i.e. in the debt-asset ratio $\lambda$, as emphasized by Wicksell and Hayek, as well as uncertain and self-fulfilling (profit) expectations $\rho$ as emphasized by Keynes, Lavington, and Hawtrey, being the main determinant of investment demand and bank credit, are the two “driving” forces of endogenous fluctuations in macro variables. Secondly, endogenous fluctuations are also driven by the investment accelerator as emphasized by Kaldor, Hicks, and Samuelson, i.e. by investment demand $\eta(q)$ steering the debt-asset ratio $\lambda$ by equation 4.18, where Tobin's $q$ depends on the profit rate $r$, and thereby indirectly on capacity utilization $u$. Thirdly, profit expectations $\rho$ are driven by “mass psychology” or “animal spirits” as emphasized by Keynes, and allow for self-fulling revisions even though agents are assumed to be rational (at least in the long-run) as highlighted by modern authors as Benhabib, Day, Grandmont, Laroque, and Nishimura. Fourthly, endogenous fluctuations arise completely under laissez-faire as stressed by Benhabib, Day, Grandmont, Laroque, and Nishimura, since fiscal policy is excluded and monetary policy is passive by holding $m$ and $h$ constant over the business cycle; consequently, there are no policy shocks which could induce aggregate fluctuations. Fifthly, both recessions as well as financial crises are caused by overinvestment and overindebtedness as highlighted by Wicksell and Hayek. Sixthly, cycles are mainly driven by the profit rate differential $r^e - r = \rho$, and by the “fundamental” risk premium $\sigma = r - (i - \hat{p})$ which corresponds to Wicksell's and Hayek's interest rate differential. Seventhly, the model economy is only cyclically stable being guaranteed by correcting actions of $\rho, \lambda, r, i$ and $f$ as in Wicksell, and does not converge to a stationary steady state.

Concerning the differences of the present approach to standard endogenous business cycle theory, there are three important issues to be mentioned. Firstly, the present model does not contain a sophisticated production structure, as e.g. Hayek's vertical production structure which differentiates explicitly between the production of investment and consumption goods. Secondly, though the model contains an indirect form of the investment accelerator, there is no consumption multiplier with which the investment accelerator could interact to generate endogenous fluctuations as stressed by Kaldor, Hicks, and Samuelson. Thirdly, the present approach is not built upon an intertemporal Walrasian equilibrium setting as latest endogenous business cycle models by Benhabib, Day, Grandmont, Laroque, and Nishimura.

A Comparison with Theories of Exogenous Shock-Driven Business Cycles. Respecting the common grounds with standard theory of shock-driven business cycles, there arise three similarities. Firstly, though the present model exhibits endogenous fluc-
tuations, business cycles are additionally driven by direct shocks to business confidence $\rho$, becoming self-fulfilling and leading to "jumps" in other macro variables. Secondly, shocks to expectations can be of a pure sunspot type as mentioned by Azariadis, Cass, Guesnerie Shell, and Woodford, or stem from real (productivity shock) or financial shocks (financial liberalization) as highlighted by "Equilibrium Business Cycle" theory and by the "New Keynesian" approach. Thirdly, the present model works under the assumption of (at least long-run) rationality as all exogenous shock-driven models.

Respecting the differences, there are three issues to be named. Firstly, in the present approach business cycles evolve endogenously, i.e. there is no need of exogenous shocks to generate aggregate fluctuations. Secondly, though there exists a stationary state in the present model as in all shock-driven models, it is dynamically unstable whereas global dynamics are cyclically stable. Thirdly, only direct shocks to the state of confidence $\rho$ can alter the amplitude of the business cycle instantaneously, whereas other types of (indirect) real or monetary shocks only change the vector field and do not lead to "jumps" in macro variables.

New Elements. The present approach to business cycles and financial crises constitutes a further development in business cycle research both from a methodological-theoretical and from an empirical perspective. Regarding the methodological-theoretical perspective, there are three innovations. Firstly, the present approach provides a broad synthesis between endogenous and exogenous business cycle theories since it (a) contains a complex interaction between the real and the financial sector due to a sophisticated financial structure and a rich set of transmission mechanisms, (b) uses an innovative theory of expectations which are driven by mass psychology, fundamentals, as well as by rational behaviour, (c) highlights that business cycles can be caused both by endogenous and by exogenous mechanisms, and (d) contains almost all nonlinear time profiles mentioned in models of endogenous business cycles.70 Secondly, the present model provides a new formal theory of the formation of expectations which postulates a weaker form of rationality to hold in reality than current rational expectations models do. Furthermore, the introduction of long-run rationality allows both for a stationary state to exist and for the emergence of endogenous cycles under rational behaviour. Thirdly, the model makes a clear distinction between "tranquil" business cycles and financial crises by the introduction of the degree of financial fragility, which has not been considered in other standard theories on business cycles, often speaking of crises and recessions synonymously, as e.g. Hayek.

Respecting the empirical perspective, the model provides two innovations. Firstly, in contrast to many business cycle models, the present approach contains major real and financial indicators as variables and parameters, which are used by empirical research to describe and to forecast business cycles, as e.g. business confidence, rate of capacity utilization, investment, bond and stock prices, total corporate profits, net cash flow, labour share in national income, total private borrowing, real money supply, short-term interest rates, bond yields, commercial and industrial loans outstanding, etc. Furthermore, the time patterns of these variables predicted by the model correspond in most cases to the

---

70For a summary of the main nonlinear relationships in endogenous business cycle models, see Zarnowitz (1992), p. 11-14.
stylized facts of business cycles.\textsuperscript{71} Secondly, the predictions of the time patterns of the model's endogenous variables during episodes of financial crises and their close link to business cycles fits very closely the stylized facts as already outlined in section 4.5.6.\textsuperscript{72}

\textsuperscript{71}For an overview of major economic indicators used in empirical analysis' of business cycles and their stylized time patterns, see Moore (1983), chapter 6, and Zarnowitz (1992), pp. 23-28. For major indicators used for business cycle forecasting, see Zarnowitz (1992), chapter 9.

\textsuperscript{72}See also Zarnowitz (1992), pp. 105-109 for the close link between business cycles and financial crises, as well as for the behaviour of macro variables during episodes of financial distress in the U.S. from 1818-1982.
4.7 Mathematical Supplements

All partial derivatives summarized qualitatively in table 4.1 are given explicitly below.

Response of Capacity Utilization \( u \) to Various Shocks.\(^{73}\)

\[
\begin{align*}
\frac{\partial u}{\partial \lambda} &= \frac{1}{|J|} d_{r+\rho} n x_{\delta-\rho} (\lambda + j \lambda_{j-\rho}^g - j \lambda_q^g) < 0 \\
\frac{\partial u}{\partial \rho} &= \frac{1}{|J|} (-n x_{\delta-\rho}) d_{r+\rho} (\lambda_{j-\rho}^g - \lambda_q^g) + d_{i-\rho} \beta_p (\lambda_{j-\rho}^g - (1 + \lambda) \lambda_q^g)) > 0 \\
\frac{\partial u}{\partial h} &= \frac{1}{|J|} \left((-m) n x_{\delta-\rho} (-\lambda_{j-\rho}^g + \lambda d_{r+\rho} \lambda_{m h}^g + (1 + \lambda) \lambda_q^g) > 0 \\
\frac{\partial u}{\partial m} &= \frac{1}{|J|} \left((-h) n x_{\delta-\rho} (-\lambda_{j-\rho}^g + \lambda d_{r+\rho} \lambda_{m h}^g + (1 + \lambda) \lambda_q^g) > 0 \\
\frac{\partial u}{\partial \alpha} &= \frac{1}{|J|} (-\lambda) d_{r+\rho} n x_{\delta-\rho} \lambda_{\alpha} > 0 \\
\frac{\partial u}{\partial i^*} &= \frac{1}{|J|} \left((-d_{i-\rho}) n x_{\delta-\rho} (\lambda_{j-\rho}^g - (1 + \lambda) \lambda_q^g) > 0 \\
\frac{\partial u}{\partial \delta} &= \frac{1}{|J|} u d_{r+\rho} n x_{\delta-\rho} (\lambda_{j-\rho}^g - \lambda_q^g) < 0 \\
\frac{\partial u}{\partial \delta} &= \frac{1}{|J|} d_{r+\rho} n x_{\delta-\rho} (\lambda_{j-\rho}^g - \lambda_q^g) < 0 \\
\end{align*}
\]

\(^{73}\)For all following partial derivatives, it has been additionally assumed that economic agents' reaction of money demand with respect to the expected profit rate is larger in absolute terms than their reaction as to the real interest rate on government bonds, i.e. it holds that \(|d_{r+\rho}| > |d_{i-\rho}|\), respectively \(|d_m| > |d_{r+\rho}| > |d_{i-\rho}|\). Furthermore, it has been assumed that it holds that \(d_{r+\rho} + d_{i-\rho} \beta_p < 0\) (see e.g. \(\partial u/\partial \rho\)).
Response of the Profit Rate $r$ to Various Shocks.

$$\frac{\partial r}{\partial \lambda} = \frac{1}{|J|} (-nx_{\hat{s}-p})(\lambda + j\lambda_{j-p}^{s} - j\lambda_{q}^{s})(d_{u} + d_{\hat{p}_{u}}\psi_{u}) < 0$$

$$\frac{\partial r}{\partial \rho} = \frac{1}{|J|} nx_{\hat{s}-p}(d_{r+p}(\lambda_{j-p}^{s} - \lambda_{q}^{s})(-1 + v + \lambda\psi_{u})$$

$$+ d_{i-p}\beta_{\rho}(\lambda_{j-p}^{s} - \lambda_{q}^{s})(-1 + v + \lambda\psi_{u}) + \lambda \lambda_{q}^{s}(d_{u} + d_{\hat{p}_{u}}\psi_{u})) > 0$$

$$\frac{\partial r}{\partial h} = \frac{1}{|J|} m nx_{\hat{s}-p}(\lambda d_{u} \lambda_{mh}^{s} - (-1 + v)(\lambda_{j-p}^{s} - \lambda_{q}^{s}) + \lambda(-\lambda_{j-p}^{s} + d_{\hat{p}_{u}} \lambda_{mh}^{s} + \lambda_{q}^{s}) \psi_{u}) > 0$$

$$\frac{\partial r}{\partial m} = \frac{1}{|J|} h nx_{\hat{s}-p}(\lambda d_{u} \lambda_{mh}^{s} - (-1 + v)(\lambda_{j-p}^{s} - \lambda_{q}^{s}) + \lambda(-\lambda_{j-p}^{s} + d_{\hat{p}_{u}} \lambda_{mh}^{s} + \lambda_{q}^{s}) \psi_{u}) > 0$$

$$\frac{\partial r}{\partial \alpha} = \frac{1}{|J|} \lambda nx_{\hat{s}-p}\lambda_{u}^{s}(d_{u} + d_{\hat{p}_{u}}\psi_{u}) < 0$$

$$\frac{\partial r}{\partial i^{*}} = \frac{1}{|J|} d_{i-p} nx_{\hat{s}-p}(\lambda_{j-p}^{s} - \lambda_{q}^{s})(-1 + v + \lambda\psi_{u}) > 0$$

$$\frac{\partial r}{\partial v} = \frac{1}{|J|} (-u) nx_{\hat{s}-p}(\lambda_{j-p}^{s} - \lambda_{q}^{s})(d_{u} + d_{\hat{p}_{u}}\psi_{u}) < 0$$

$$\frac{\partial r}{\partial \delta} = \frac{1}{|J|} (-nx_{\hat{s}-p})(\lambda_{j-p}^{s} - \lambda_{q}^{s})(d_{u} + d_{\hat{p}_{u}}\psi_{u}) < 0$$

Response of Price Level’s Growth Rate $\hat{p}$ to Various Shocks.

$$\frac{\partial \hat{p}}{\partial \lambda} = \frac{1}{|J|} d_{r+p} nx_{\hat{s}-p}(\lambda + j\lambda_{j-p}^{s} - j\lambda_{q}^{s}) \psi_{u} < 0$$

$$\frac{\partial \hat{p}}{\partial \rho} = \frac{1}{|J|} nx_{\hat{s}-p}(d_{r+p}(-\lambda_{j-p}^{s} + \lambda_{q}^{s}) + d_{i-p}\beta_{\rho}(-\lambda_{j-p}^{s} + (1 + \lambda)\lambda_{q}^{s})) \psi_{u} > 0$$

$$\frac{\partial \hat{p}}{\partial h} = \frac{1}{|J|} m nx_{\hat{s}-p}(\lambda_{j-p}^{s} - \lambda d_{r+p} \lambda_{mh}^{s} - (1 + \lambda)\lambda_{q}^{s}) \psi_{u} > 0$$

$$\frac{\partial \hat{p}}{\partial m} = \frac{1}{|J|} h nx_{\hat{s}-p}(\lambda_{j-p}^{s} - \lambda d_{r+p} \lambda_{mh}^{s} - (1 + \lambda)\lambda_{q}^{s}) \psi_{u} > 0$$

$$\frac{\partial \hat{p}}{\partial \alpha} = \frac{1}{|J|} (-\lambda) d_{r+p} nx_{\hat{s}-p}\lambda_{u}^{s} \psi_{u} < 0$$

$$\frac{\partial \hat{p}}{\partial i^{*}} = \frac{1}{|J|} (-d_{i-p}) nx_{\hat{s}-p}(\lambda_{j-p}^{s} - (1 + \lambda)\lambda_{q}^{s}) \psi_{u} > 0$$

$$\frac{\partial \hat{p}}{\partial v} = \frac{1}{|J|} u d_{r+p} nx_{\hat{s}-p}(\lambda_{j-p}^{s} - \lambda_{q}^{s}) \psi_{u} < 0$$

$$\frac{\partial \hat{p}}{\partial \delta} = \frac{1}{|J|} d_{r+p} nx_{\hat{s}-p}(\lambda_{j-p}^{s} - \lambda_{q}^{s}) \psi_{u} < 0$$
Response of Tobin's $q$ to Various Shocks.

\[
\frac{\partial q}{\partial \lambda} = \frac{1}{|J|} nx_{j-\beta} (d_{r+\rho}(-1 + v + \lambda \psi_u) - (1 + \lambda \lambda_{j-\rho}^s)(d_u + d_{\rho} \psi_u)) < 0
\]

\[
\frac{\partial q}{\partial \rho} = \frac{1}{|J|} nx_{j-\beta} \lambda_{j-\rho}^s (d_u + d_{\rho} \psi_u + d_{r+\rho} \beta_{\rho}(-1 + v + \lambda \psi_u)) > 0
\]

\[
\frac{\partial q}{\partial h} = \frac{1}{|J|} mn x_{j-\beta} (-\lambda_{j-\rho}^s (-1 + v + \lambda \psi_u)
\]

\[
+ \lambda_{m\rho}^s (-d_{r+\rho}(-1 + v + \lambda \psi_u) + (1 + \lambda)(d_u + d_{\rho} \psi_u))) > 0
\]

\[
\frac{\partial q}{\partial m} = \frac{1}{|J|} hn x_{j-\beta} (-\lambda_{j-\rho}^s (-1 + v + \lambda \psi_u)
\]

\[
+ \lambda_{m\rho}^s (-d_{r+\rho}(-1 + v + \lambda \psi_u) + (1 + \lambda)(d_u + d_{\rho} \psi_u))) > 0
\]

\[
\frac{\partial q}{\partial \alpha} = \frac{1}{|J|} nx_{j-\beta} \lambda_{\alpha}^s (-d_{r+\rho}(-1 + v + \lambda \psi_u) + (1 + \lambda)(d_u + d_{\rho} \psi_u)) < 0
\]

\[
\frac{\partial q}{\partial t^*} = \frac{1}{|J|} d_{r+\rho} nx_{j-\beta} \lambda_{j-\rho}^s (-1 + v + \lambda \psi_u) > 0
\]

\[
\frac{\partial q}{\partial v} = \frac{1}{|J|} (-u) nx_{j-\beta} \lambda_{j-\rho}^s (d_u + d_{\rho} \psi_u) < 0
\]

\[
\frac{\partial q}{\partial \delta} = \frac{1}{|J|} (-nx_{j-\beta}) \lambda_{j-\rho}^s (d_u + d_{\rho} \psi_u) < 0
\]

Response of the Interest Rate on Loans $j$ to Various Shocks.

\[
\frac{\partial j}{\partial \lambda} = \frac{1}{|J|} nx_{\beta} ((1 + j \lambda_q^s)(d_u + d_{\rho} \psi_u) - d_{r+\rho}(-1 + v + j(-\lambda_{j-\rho}^s + \lambda_q^s) \psi_u)) > 0
\]

\[
\frac{\partial j}{\partial \rho} = \frac{1}{|J|} nx_{\beta} (-d_u \lambda_q^s - (d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_q^s) + d_{\rho} \lambda_q^s) \psi_u)
\]

\[
+ d_{r+\rho} \beta_{\rho}(-\lambda_{j-\rho}^s \psi_u + \lambda_q^s(1 - v - \psi_u))) < 0
\]

\[
\frac{\partial j}{\partial h} = \frac{1}{|J|} (-m) nx_{\beta} ((1 - v) d_{r+\rho} \lambda_{m\rho}^s
\]

\[
+ d_u \lambda_{m\rho}^s - (-1 + v) \lambda_q^s + (-\lambda_{j-\rho}^s + d_{\rho} \lambda_{m\rho}^s + \lambda_q^s) \psi_u) < 0
\]

\[
\frac{\partial j}{\partial m} = \frac{1}{|J|} (-h) nx_{\beta} ((1 - v) d_{r+\rho} \lambda_{m\rho}^s
\]

\[
+ d_u \lambda_{m\rho}^s - (-1 + v) \lambda_q^s + (-\lambda_{j-\rho}^s + d_{\rho} \lambda_{m\rho}^s + \lambda_q^s) \psi_u) < 0
\]

\[
\frac{\partial j}{\partial \alpha} = \frac{1}{|J|} nx_{\beta} \lambda_{\alpha}^s ((-1 + v) d_{r+\rho} - d_u - d_{\rho} \psi_u) > 0
\]

\[
\frac{\partial j}{\partial t^*} = \frac{1}{|J|} d_{r+\rho} nx_{\beta} (-\lambda_{j-\rho}^s \psi_u + \lambda_q^s(1 - v + \psi_u)) < 0
\]

\[
\frac{\partial j}{\partial v} = \frac{1}{|J|} u nx_{\beta} (d_u \lambda_q^s + (d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_q^s) + d_{\rho} \lambda_q^s) \psi_u) > 0
\]

\[
\frac{\partial j}{\partial \delta} = \frac{1}{|J|} nx_{\beta}(d_u \lambda_q^s + (d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_q^s) + d_{\rho} \lambda_q^s) \psi_u) > 0
\]
Response of the Domestic Interest Rate on Bonds \( i \) to Various Shocks.

\[
\begin{align*}
\frac{\partial i}{\partial \lambda} &= 0 \\
\frac{\partial i}{\partial \rho} &= \beta_p < 0 \\
\frac{\partial i}{\partial h} &= 0 \\
\frac{\partial i}{\partial m} &= 0 \\
\frac{\partial i}{\partial \alpha} &= 0 \\
\frac{\partial i}{\partial i^*} &= 1 \\
\frac{\partial i}{\partial v} &= 0 \\
\frac{\partial i}{\partial \delta} &= 0
\end{align*}
\]
Response of the Exchange Rate’s Growth Rate $\dot{s}$ to Various Shocks.$^{74}$

$$
\frac{\partial \dot{s}}{\partial \lambda} = \frac{1}{|J|} \eta_q (1 + \lambda + j \lambda_{j-\rho})(d_u + d_{\rho_a} \psi_u)
$$

$$
- d_{r+\rho}(\eta_q (-1 + v + \lambda \psi_u) + (\lambda + j \lambda_{j-\rho} - j \lambda_q)(-1 + u_{\rho_a} \psi_u))
$$

$$
\frac{\partial \dot{s}}{\partial p} = \frac{1}{|J|} (-1) (\eta_q \lambda_{j-\rho}^s + g_{i-\rho} \beta_p (\lambda_{j-\rho}^s - (1 + \lambda) \lambda_{q}^s))(d_u + d_{\rho_a} \psi_u)
$$

$$
+ d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_{q}^s)(-1 + u_{\rho_a} \psi_u + g_{i-\rho} \beta_p (-1 + v + \lambda \psi_u))
$$

$$
+ d_{i-\rho} \beta_p ((1 + \lambda) \lambda_{q}^s(-1 + u_{\rho_a} \psi_u) + \lambda_{j-\rho}^s(-1 + u_{\rho_a} \psi_u - \eta_q (-1 + v + \lambda \psi_u)))
$$

$$
\frac{\partial \dot{s}}{\partial h} = \frac{1}{|J|} m (-1 - \lambda)(d_u \eta_q \lambda_{m+}^s + \lambda_{q}^s + d_{\rho_a} \eta_q \lambda_{m+}^s \psi_u - u_{\rho_a} \lambda_{q}^s \psi_u)
$$

$$
+ \lambda_{j-\rho}^s(1 - u_{\rho_a} \psi_u + \eta_q (-1 + v + \lambda \psi_u))
$$

$$
+ d_{r+\rho} \lambda_{m+}^s(\eta_q (-1 + v + \lambda \psi_u) + \lambda(-1 + u_{\rho_a} \psi_u)))
$$

$$
\frac{\partial \dot{s}}{\partial m} = \frac{1}{|J|} h (-1 - \lambda)(d_u \eta_q \lambda_{m+}^s + \lambda_{q}^s + d_{\rho_a} \eta_q \lambda_{m+}^s \psi_u - u_{\rho_a} \lambda_{q}^s \psi_u)
$$

$$
+ \lambda_{j-\rho}^s(1 - u_{\rho_a} \psi_u + \eta_q (-1 + v + \lambda \psi_u))
$$

$$
+ d_{r+\rho} \lambda_{m+}^s(\eta_q (-1 + v + \lambda \psi_u) + \lambda(-1 + u_{\rho_a} \psi_u)))
$$

$$
\frac{\partial \dot{s}}{\partial \alpha} = \frac{1}{|J|} \lambda_{q}^s ((-1 - \lambda) d_u \eta_q + d_{r+\rho}(\eta_q (-1 + v + \lambda \psi_u) + \lambda(-1 + u_{\rho_a} \psi_u)))
$$

$$
< 0
$$

$$
\frac{\partial \dot{s}}{\partial t^*} = \frac{1}{|J|} g_{i-\rho}(d_u (-\lambda_{j-\rho}^s + (1 + \lambda) \lambda_{q}^s) + d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_{q}^s)(-1 + v + \lambda \psi_u))
$$

$$
- d_{i-\rho}((1 + \lambda) \lambda_{q}^s(-1 + u_{\rho_a} \psi_u) + \lambda_{j-\rho}^s(1 - u_{\rho_a} + \eta_q (-1 + v + \lambda \psi_u)))
$$

$$
\frac{\partial \dot{s}}{\partial v} = \frac{1}{|J|} (-u)(-\eta_q \lambda_{j-\rho}^s(d_u + d_{\rho_a} \psi_u) + d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_{q}^s)(-1 + u_{\rho_a} \psi_u))
$$

$$
< 0
$$

$$
\frac{\partial \dot{s}}{\partial \delta} = \frac{1}{|J|} \eta_q \lambda_{j-\rho}^s(d_u + d_{\rho_a} \psi_u) - d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_{q}^s)(-1 + u_{\rho_a} \psi_u)
$$

$$
< 0
$$

$^{74}$For $\partial \dot{s}/\partial \alpha$, it has been assumed that $((-1 - \lambda) d_u \eta_q + d_{r+\rho}(\eta_q (-1 + v + \lambda \psi_u) + \lambda(-1 + u_{\rho_a} \psi_u))) > 0$. For $\partial \dot{s}/\partial v$ and for $\partial \dot{s}/\partial \delta$, it has been assumed that $(-\eta_q \lambda_{j-\rho}^s(d_u + d_{\rho_a} \psi_u) + d_{r+\rho}(\lambda_{j-\rho}^s - \lambda_{q}^s)(-1 + u_{\rho_a} \psi_u)) > 0$. 

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Chapter 5

A Model of Financial Crises and Endogenous Fluctuations in Emerging Market Countries

The empirical analysis has demonstrated that financial crises both in industrial and in emerging market countries in the post Bretton-Woods era were characterized by extensive boom-bust cycles and exhibited similar time patterns of almost all macroeconomic variables which were investigated in chapter 3. Though lots of financial crises in emerging markets in the 1980s were caused by inconsistent macroeconomic policies (especially in some Latin American countries in the late 1970s, having triggered the international debt crisis in the 1980s), latest financial crises in the 1990s (Mexico, Asia, Brazil) happened without any severe macroeconomic mismanagement. As a result, boom-bust cycles and the subsequent and unavoidable financial collapse were not anymore caused by expansionary macroeconomic policy but by other factors.

In order to find an explanation of latest crises' episodes, economic theory started to analyze financial crises in emerging markets like crises in industrial countries by moral hazard and balance sheet models, having been already set out in sections 3.5, 4.5.3 and 4.5.4. The critical assessment of standard theories of financial crises in industrial countries however, has suggested the view that financial crises are not solely caused by self-fulfilling expectations or exogenous shocks, but can be also viewed as a part of an extensive business cycle which generates financial instability endogenously, especially after financial liberalization. Since particularly emerging markets have been subject to large-scale Washington Consensus liberalization policies both in the real and in the financial sector since the 1980s, it could be argued that financial crises in emerging markets can be explained as well by positive exogenous shocks to expectations, giving rise to an endogenous above-average build-up of financial fragility by overshooting expectations and overindebtedness, leading finally to systemic financial (twin) crises. This view of financial crises suggests that emerging market crises are comparable to financial crises in industrial countries with the only exception that overindebtedness in emerging markets is mainly caused by capital inflows in foreign currency, and not directly by overlending via the domestic banking system. It must be noted however, that in case of large-scale capital inflows, the domestic financial system also plays a central role for the generation of excessive cycles by transforming foreign capital into domestic credit, even if the financial system still suffers from past financial repression.
Following the cyclical approach to financial crises in industrial countries, this chapter develops a theoretical model of financial crises in emerging markets, being a modified version of the crisis model of industrial countries given in chapter 4. Since the model structure and assumptions are similar, the following description only highlights the differences and refers to the explanations given in chapter 4.

5.1 The Real Side

Consider a small emerging market economy having pegged its currency to an international reserve currency like the US-$ or the Euro in order to stabilize inflation, or to support an export-led growth strategy.

Output is assumed to be demand determined, and goods market equilibrium expressed in terms of the numéraire \( PK \), where \( P \) denotes the domestic price level and \( K \) the capital stock, is given by

\[
\frac{PY}{PK} = \frac{Y}{K} = \eta(q) + g(i - \hat{p}) + nx(\hat{s} + \hat{p}^* - \hat{p}),
\]

stating that in equilibrium capacity utilization \( u = Y/K \), where \( Y \) denotes real output, equals aggregate demand adjusted for the numéraire being composed of three components. The first demand component is the “warranted” growth rate of the capital stock \( I/K = \eta(\cdot) \), being positively dependent on Tobin’s \( q \). The second demand component is normalized real government expenditure \( G/K = g(\cdot) \), being negatively dependent on the real interest rate on government bonds \( i - \hat{p} \), where \( i \) denotes the nominal interest rate on bonds, and \( \hat{p} = \hat{P}/P \) the growth rate of the domestic price level \( P \). The third demand component consists of normalized real net exports \( NX/K = nx(\cdot) \), being positively dependent on the growth rate of the real exchange rate \( \hat{s} + \hat{p}^* - \hat{p} \), i.e. the Robinson condition is assumed to be fulfilled, where \( \hat{s} = s/s \) denotes the growth rate of the nominal exchange rate, expressing the rate of change of the price of one unit foreign currency in domestic currency; \( \hat{p}^* = \hat{P}^*/P^* \) denotes the growth rate of the foreign price level which is assumed to be zero throughout the analysis. In a fixed exchange rate system it holds that \( \hat{s} = 0 \), though the exchange rate can be either used as a macroeconomic policy instrument, or changes suddenly during exchange rate crises. Consequently, \( \hat{s} \) will be treated as a parameter in the model.

The overall impact of the price level’s growth rate \( \hat{p} \) on capacity utilization \( u \), being denoted by \( \partial u/\partial \hat{p} \), is not clear since an increase in \( \hat{p} \) lowers the real interest rate on government bonds leading to an expansion in \( g(\cdot) \) and in \( u \), but at the same time deteriorates the real exchange rate leading to a drop in \( nx(\cdot) \) and in \( u \). In the crisis model for industrial countries, the overall influence has been positive, i.e. \( \partial u/\partial \hat{p} > 0 \), because government expenditure has been assumed as having a greater influence on capacity utilization than net exports. In emerging market countries however, being much more dependent on trade, net exports have a much greater influence on capacity utilization than in industrial countries, though there are countries in which government expenditure represents a large fraction of aggregate demand as well. Consequently, since there is no clear answer on the sign of \( \partial u/\partial \hat{p} \), it is assumed that the influence is zero, which is consistent with the fact that net exports have a much greater influence on \( u \) in emerging market countries than
in industrial countries, i.e. in the following it holds that

\[
\frac{\partial u}{\partial \hat{\delta}} = - \frac{\partial g}{\partial (\hat{\delta} - \hat{\rho})} - \frac{\partial n}{\partial (\hat{\delta} - \hat{\rho})} = 0.
\]

Empirical data have shown that investment finance in emerging market countries depends heavily on foreign capital. There are two main forms of foreign debt finance in emerging markets which differ mainly with respect to the sectoral allocation, i.e. with respect to the question of which sector in the economy receives and allocates foreign capital in the domestic economy. On the one hand, there is a “direct” form of finance, according to which domestic business firms directly receive foreign capital from international financial institutions; as to this direct form of finance, firms have to book debt denominated in foreign currency in their balance sheets which exposes them directly to foreign exchange risk. On the other hand, there exists also an “indirect” form of finance, being characterized by domestic banks receiving foreign debt, and creating loans to domestic business firms in domestic currency; according to this indirect form of finance, banks, not firms, are directly exposed to foreign exchange risk, though in case of a sharp devaluation, banks are going to cut their credit lines to domestic firms because of a sharp reduction in their net worth and foreign loan withdrawals, exposing firms indirectly to foreign exchange rate risk.

The present model assumes a “direct” way of finance, assuming that the capital account is fully liberalized, i.e. that international transactions as to bonds, shares, and granting loans denominated in foreign currency to domestic agents no longer underly any restrictions, like e.g. capital controls. The domestic financial sector however, is modelled as still being underdeveloped and suffering from past financial repression, but being in transition to a fully liberalized scheme. Consequently, the domestic financial sector cannot attract sufficient financial means (deposits) to serve the financial needs of the private business sector in the form of loans, and in most cases offers much higher loan rates than international financial institutions.\(^1\)

Owing to the transition process from financial repression to a fully liberalized scheme, domestic firms’ debt side contains both loans in domestic currency \(L\) priced at the nominal domestic loan rate \(j\), having been allocated by the domestic financial sector during the financial repression period, and loans in foreign currency \(L^*\) priced at a nominal international interest rate on loans \(j^*\), having been allocated by international financial institutions after financial sector and capital account liberalization. As firms are exposed to exchange rate risk in case of sudden changes in \(s\), interest rate costs on foreign loans have to be adjusted for the growth rate of the exchange rate \(s\), resulting in an “actual” nominal interest rate on foreign loans \(j^* + s\). Business firms’ net profits \(Q\) are then given formally as

\[
Q = PY - wN - \delta PK - jL - (j^* + s)sL^*,
\]

that is, net profits are determined by earnings \(PY\) less labour costs \(wN\), where \(w\) denotes the nominal wage rate and \(N\) labour input, less depreciation on capital \(\delta PK\), where \(\delta\) denotes the depreciation rate, less interest rate costs on the stock of domestic loans \(jL\), less interest rate costs on the foreign stock of loans \((j^* + s)sL^*\), where \(s\) denotes the initial

\(^1\)By way of contrast, the financial crisis calibration model for emerging markets presented in chapter 6 assumes an indirect way of finance, according to which banks play the central role in allocating foreign capital to domestic firms.
fixed nominal exchange rate.\(^2\) Dividing both sides of the profit equation by \(PK\) results in the net profit rate, given by

\[
r = \frac{PY}{PK} - wN \frac{P}{PK} - \delta L \frac{LP}{PK} - \frac{(j^* + \delta)SL^*}{PK} = u(1 - v) - \delta - j\lambda - (j^* + \delta)\lambda^*,
\]

where \(v = wN/(PY)\) denotes the wage share with respect to gross nominal product\(^3\) being treated as a parameter in the model, \(\lambda = L/(PK)\) the “domestic” debt-asset ratio relating the stock of domestic loans outstanding to the capital stock valued at replacement costs, and \(\lambda^* = L^*/(PK)\) the “foreign” debt-asset ratio in foreign currency relating the stock of foreign loans outstanding to the capital stock valued at replacement costs. In the following, it is assumed that the initial value of the fixed exchange rate amounts to \(\delta = 1\); therefore, the rate of change of the exchange rate \(\delta\) is always expressed for a given value of \(\delta = 1\). As a result, the profit rate on capital reads as

\[
r = u(1 - v) - \delta - j\lambda - (j^* + \delta)\lambda^*.
\] (5.2)

The supply side of the model is described by a simplified Phillips curve relationship, formally expressed as

\[
\dot{p} = \psi(u - u^*),
\] (5.3)

stating that in case actual capacity utilization \(u\) exceeds the “natural full employment level of capacity utilization” \(u^* > 0\) there is inflation, and in case \(u < u^*\) the economy is in a state of deflation. As in the industrial crisis model, inflation and deflation expectations are incorporated in the state of confidence parameter \(\rho\). Likewise, equation 5.3 neglects a direct influence of foreign prices and the nominal exchange on domestic prices, though emerging market countries are considered as being much more open economies than industrial countries. This assumption can be justified by assuming a very restrictive nominal wage setting behaviour as a part of domestic macroeconomic stabilization and liberalization policies, in order to prevent wage indexation from generating excessive wage-price spirals due to foreign price and exchange rate changes, counteracting the aims of stabilization and liberalization policies. Still, the model incorporates an indirect influence of \(\delta\) on \(\dot{p}\) by the fact that an increase in \(\delta\) leads, via an expansion of net exports \(nx\), to an increase in capacity utilization \(u\), and thereby to a higher value of the growth rate of the price level \(\dot{p}\).

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\(^2\)Note that after the foreign loan amount of \(L^*\) has been exchanged at a fixed nominal exchange rate \(\delta\) into domestic currency, a change in \(\delta\) influences the effective interest rate and thereby interest payments on foreign loans in domestic currency, but not in foreign currency. For example, given a loan in foreign currency \(L^* = 100\ \text{US-}\$\) at an international interest rate of \(j^* = 5\%\) yields 5 US-\$ interest payments in foreign currency, and at a fixed nominal exchange rate of \(\delta = 1\ \text{Peso/US-}\$, 5 Pesos nominal interest rate payments in domestic currency. After a devaluation of 100\% of the Peso, the new fixed nominal exchange rate is \(\delta = 2\ \text{Peso/US-}\$, resulting in interest payments of 5 US-\$ in foreign currency, but in 10 Pesos in domestic currency which increases the nominal effective interest rate on foreign loans in domestic currency to \(j^* + \delta = 5\% + \frac{10-\delta}{5} = 105\%\), whereas the nominal effective interest rate on foreign loans in foreign currency remains at \(j^* = 5\%\). It is important to note that the profit equation only refers to interest payments on loans (foreign and domestic), but not to redemption payments of loans. Consequently, the adverse impact of increasing redemption payments of foreign loans on firms' profits in case of a devaluation of the home currency is excluded. Yet, an increase in the foreign debt burden due to a devaluation of the home currency, and its influence on investment and expectations is treated in the dynamic version of the model in section 5.4.

\(^3\)Note that \(\frac{wN}{PK} = \frac{wN}{PY} \frac{P}{PK} = vu\).
5.2 The Financial Side

5.2.1 A Stylized Financial Structure

A highly simplified and stylized domestic financial structure of emerging market economies with an underdeveloped, but fully liberalized domestic financial sector is given in figure 5.1. There are seven types of agents in the economy: households, firms, domestic banks, government, central bank, foreign private agents and foreign banks. It is assumed that especially foreign banks dominate the domestic financial system with respect to the allocation of capital from international savers to domestic investors.

![Stylized Financial Structure in Emerging Market Countries](image)

There are eight sorts of assets which are prized at their current market or discounted present values, i.e. there is no distinction between book and market values. The terminology regarding the designation of nominal and real stocks, as well as market prices of bonds, equities and of the capital stock is based on the terminology introduced in section 4.2.1. The first sort of assets are deposits $D$, the second sort are domestic government bonds $P_{BD}B_D$, where $B_D$ denotes the real stock of bonds, and $P_{BD}$ the market price in domestic currency per real unit of domestic government bonds. Foreign government bonds which are denoted in domestic currency $\bar{B}P_{BF}B_F$, where $B_F$ represents the real stock of foreign bonds, $P_{BF}$ the market price per real unit in foreign currency, and $\bar{B}$ the fixed nominal

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exchange rate, constitute asset type three. Domestic and foreign government bonds are assumed as being imperfect substitutes since domestic bonds bear a risk premium reflecting the emerging market country’s risk of default. Asset type four is the capital stock, where $K$ denotes the real stock of capital, and $P_K$ the demand price of capital implying a nominal market value of $P_KK$. The capital stock is partly financed by the issuance of equities representing asset type five where the nominal market value equals $P_EE$, where $E$ denotes the real stock of equities which is assumed as being constant throughout the analysis, and whose market market price is represented by $P_E$ denoting the price per real unit of equities in domestic currency. The remaining part of the capital stock is financed on the one hand by domestic loans from domestic banks to firms $L$ constituting asset type six, and on the other hand by foreign loans from foreign banks to domestic firms $L^*$ making up asset type seven, whose nominal value in domestic currency amounts to $sL^*$. Asset type eight is high powered money $M$ held by domestic banks as required reserves in the form of interest-free deposits $D_{BA} = \tau D = M$ at the central bank, where $\tau$ denotes the required reserve ratio. High-powered money $M$ consists of the domestic credit component $H$ being issued by the central bank to domestic commercial banks, foreign reserves stemming from exchanging foreign loans into domestic currency $R$, and foreign reserves exclusive foreign loans $B$. The explicit separation of foreign reserves into reserves stemming from foreign loans $R$, and reserves stemming from other international monetary transactions $B$ is necessary to describe the indebtedness of the domestic firm sector in foreign currency, and to separate private capital flows for investment finance from other international financial transactions.

Regarding central bank reserves $R$, there are two possible ways of transforming foreign loans into high-powered money. The first “direct” way assumes that firms directly sell foreign loans in the foreign exchange market which is controlled by the central bank, and receive domestic high powered money which is immediately spent for new investment, and transformed into domestic deposits with banks since cash is excluded. The second “indirect” way assumes that firms act through domestic banks by selling their foreign loan amounts to banks, receiving deposits in domestic currency which are immediately spent for investment and transformed into households’ deposits in the end; in order to pay firms in domestic currency, banks sell firms’ loan amount in foreign currency in the foreign exchange market to the central bank and receive high powered money.

Changes in foreign reserves exclusive foreign loans $B$ cover imbalances in the foreign exchange market arising from current or capital account disequilibria. It must be noted that there are cases in which $B$ can take a negative value, meaning that overall foreign reserves do not suffice to cover all liabilities of the firm sector, i.e. in these cases it holds that $R + B < R$.

Households hold their nominal wealth $NW_{HH}$ in the form of deposits $D$, domestic government bonds $P_{DB}B_D$, foreign government bonds $sP_{BF}B_F$, and equities $P_EE$. Though domestic and foreign government bonds are assumed to be imperfect substitutes being traded internationally, equities are assumed to be not tradable internationally due to information asymmetries.

Firms finance the capital stock by issuing equities $E$, and by taking domestic $L$ and foreign loans expressed in domestic currency as $sL^*$. Since the real stock of equities $E$ is assumed as being constant, new investment is financed by a combination of retained
earnings and taking new (foreign) loans. Assuming instantaneous adjustments to bring the stock market into equilibrium, which implies a zero net worth of firms, results in the demand price of capital being determined by the equity market, the domestic loan market, the foreign loan market, and by the level of the fixed nominal exchange rate, formally

\[ P_K = \frac{P_E E + L + \delta L^*}{K}. \]

Domestic banks create deposits \( D \) as a multiple of high powered money \( M \) (monetary base) which is held by banks as required reserves in the form of deposits \( D_{BA} = M \) at the central bank. Neglecting cash and excess reserves of banks, demand for high powered money stems only from the required reserve ratio \( \tau \) controlled by the central bank, resulting in the exogenous money multiplier \( m = 1/\tau \). Summing up, it holds that \( M = D_{BA} = \tau D = \frac{1}{m} D \). Since the domestic banking sector is assumed as being underdeveloped and cannot invest in other assets than loans, banks’ adding-up constraint is formally given as

\[ (1 - \tau)D + NW_{BA} = L, \quad \text{where} \quad \tau D = D_{BA} = M, \]

stating that banks’ input for the creation of loans \( L \) consists of deposits adjusted for required reserves plus banks’ net worth \( NW_{BA} \). Though domestic firms are assumed to finance new investment by foreign loans, domestic banks are still vulnerable to adverse shocks hitting the firm sector due to an increase in the amount of non-performing domestic loans, resulting from the existing stock of domestic loans \( L \). If, for example, there is an international real or financial shock reducing firms’ collateral values and profits drastically, e.g. by a drop in the terms-of-trade or by a foreign interest rate increase, domestic firms’ illiquidity and insolvency does not only lead to an increasing amount of foreign non-performing loans, but also to an augmenting stock of domestic non-performing loans, which in severe cases can lead to a systemic international and domestic banking crisis.

The domestic government issues bonds being held by domestic households and foreign agents in order to finance budget deficits. The market value of government bonds amounts to \( P_{DB} B_D \), where the real stock of bonds \( B_D \) is assumed as being constant throughout the analysis. There are no government assets, resulting in a negative government net worth \( NW_{Gov} \). The foreign government also issues bonds for budget deficit finance, where market price of foreign government bonds in domestic currency amounts to \( \delta P_{BF} B_F \).

Monetary policy takes the form of controlling the required reserve ratio \( \tau \), the domestic credit component \( H \), and foreign reserves \( B \) by interventions in the foreign exchange

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4 Though the comparative-static version of the model considers explicitly changes in the stock of domestic loans \( L \) in order to describe the overall macroeconomic effects of future domestic credit variations, the dynamic version assumes that new investment is exclusively financed by foreign loans \( L^* \), which is consistent with the view of a current underdeveloped domestic banking sector.

5 For details, see section 4.2.1.

6 See e.g. Bernanke and Blinder (1988) for the explicit introduction of banks’ excess reserves, resulting in an interest rate dependent money multiplier.

7 The problem of a high and increasing level of government debt in domestic and in foreign currency due to past and current inconsistent expansionary fiscal and monetary policies (like e.g. in many Latin American countries as Argentina, Brazil or Mexico) is neglected in the model, since the present explanation of financial crises focuses more on inherent market mechanisms generating financial instability, than on inconsistent macroeconomic policies.
market. Furthermore, the central bank can engage in active exchange rate policy by official revaluations or devaluations of the exchange rate, i.e. by variations in \( \bar{s} \) or \( \bar{\bar{s}} \).

Though the model is based on the assumptions of complete capital account liberalization and instantaneous portfolio adjustments, there is no perfect capital mobility since firstly, not all assets are traded internationally (e.g. equities), and secondly, because assets being traded internationally are viewed as being only imperfect substitutes, differing by a risk premium (e.g. government bonds). Furthermore, domestic assets are also considered as being only imperfect substitutes, like e.g. equities and domestic government bonds whose rate of returns do not have to be equal in equilibrium.

Private domestic wealth \( W_p \) (government and central bank excluded) is given as

\[
W_p = NW_{HH} + NW_{BA} = P_K K + (H + B) + P_{DB} B_D + \bar{s} P_{BF} B_F,
\]

that is, by the sum of the capital stock valued at the demand price of capital, required reserves of domestic banks at the central bank less reserves stemming from foreign loans\(^8\), domestic government bonds and foreign government bonds; inside debt like deposits and domestic loans cancel out. Overall domestic wealth (government and central bank included) is given as

\[
W = NW_{HH} + NW_{BA} + NW_{Gov} = P_K K + (H + B) + \bar{s} P_{BF} B_F,
\]

stating that overall wealth consists of the capital stock valued at the demand price of capital, high powered money less foreign reserves from foreign loans, and foreign government bonds.

### 5.2.2 Financial Market Equilibria

All financial market equations refer to the portfolio structure given in figure 5.1, whereas financial market equilibria are not modelled as a standardized portfolio approach in order to keep the model formally tractable.\(^9\)

Deposit market equilibrium being normalized by the numéraire \( PK \) is formally given as

\[
m(h + b + \lambda^*) = d(u, \hat{p}, i - \hat{p}, r + \rho),
\]

where \( m = 1/\tau \) denotes the money multiplier treated as a parameter in the model, \( h = H/(PK) \) the normalized domestic credit component, \( b = B/PK \) normalized foreign reserves excluding reserves stemming from foreign loans, and \( \lambda^* = \bar{s}\lambda^* \) (where \( \bar{s} = 1 \)) the foreign debt-asset ratio in domestic currency being equivalent to normalized foreign reserves expressed in domestic currency \( R \), i.e. \( \lambda^* = \bar{s}\lambda^* = L^*/(PK) = R/(PK) \), stemming from foreign loans to domestic firms, and \( d(\cdot) = D(\cdot)/(PK) \) normalized demand for deposits. The expression \( 1/(h + b + \lambda^*) \) stands for the "velocity" of high-powered money with respect to the value of the capital stock. Households' demand for deposits is positively dependent on capacity utilization \( u \) representing the transaction motive for money demand, and negatively dependent on the growth rate of the price level \( \hat{p} \), i.e. households flee ceteris paribus from money in case of inflation, and go into money in case

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\(^8\)Foreign loans cancel out since it holds that \( R = \bar{s}L^* \).

\(^9\)For a discussion of the pros and cons of standardized portfolio approaches, see section 4.2.2.
of deflation. Since households divide their nominal wealth, apart from deposits, among domestic bonds, foreign bonds, and equities, deposit demand is negatively dependent on the real interest rate on domestic government bonds \(i - \hat{p}\) (where the nominal interest rate on government bonds \(i\) is determined by uncovered interest rate parity adjusted for a risk premium being derived below), and positively dependent on the expected rate of return on capital \(\tau + \rho\), where \(\rho\) represents the "state of confidence" expressing the difference between the expected and the actual profit rate.\(^{10}\) Like in the financial crisis model for industrial countries, the overall influence of \(\hat{p}\) on \(d(\cdot)\), being indicated as \(\partial d/\partial \hat{p}_a\), is not clear since e.g. a rise in \(\hat{p}\) on the one hand reduces deposit demand, but on the other hand lowers the real interest rate on domestic government bonds \(i - \hat{p}\), increasing the demand for deposits. In order to overcome this theoretical as well as empirical tradeoff, the following analysis assumes that the overall influence of \(\hat{p}\) on \(d(\cdot)\) is positive; formally it holds that

\[
\frac{\partial d}{\partial \hat{p}_a} = \frac{\partial d}{\partial \hat{p}} + \frac{\partial d}{\partial (i - \hat{p})} \frac{\partial (i - \hat{p})}{\partial \hat{p}} = \frac{\partial d}{\partial \hat{p}} - \frac{\partial d}{\partial (i - \hat{p})} > 0,
\]

implying that the indirect influence of the real interest rate on domestic bonds as to variations in \(\hat{p}\) dominates the direct influence of \(\hat{p}\) on deposit demand.

Owing to the assumption of imperfect capital mobility in the market for government bonds, UIP does not hold and has to be adjusted for the country’s risk of default. As a result, the domestic nominal interest rate on bonds \(i\) is determined by the nominal interest rate on foreign bonds \(i^*\) adjusted for expected exchange rate changes \(\delta^e\), and for a country specific risk premium \(rp\), formally

\[
i = i^* + \delta^e + rp.
\]

As in the industrial country model, exchange rate expectations and the risk premium are assumed as being negatively dependent on the “state of confidence” parameter \(\rho\), i.e. a rise in \(\rho\) increases overall credibility, leading to shrinking values of \(\delta^e\) and \(rp\) due to appreciation expectations of the home currency and due to a lower country default risk, whereas a fall in \(\rho\) leads to lower credibility and to increases in \(\delta^e\) and \(rp\).\(^{11}\) Summing up, equilibrium in the international market for bonds is given formally by

\[
i = i^* + \beta(\rho),
\]

implying that in case \(\rho > 0\), implying \(\beta < 0\), it holds that \(i < i^*\), in case \(\rho < 0\), implying \(\beta > 0\), it holds that \(i > i^*\), and that in case \(\rho = 0\), implying \(\beta = 0\), it holds that \(i = i^*\).

Equilibrium in the equity market is represented by the equilibrium condition in the market for real capital, because assuming a constant real stock of equities \(E\), a constant capital stock \(K\), a given fixed exchange rate value of \(\bar{e} = 1\), and treating the domestic and the foreign loan stock \(L\) and \(L^*\) as parameters implies that the equity market can be subsumed, according to the definition of the demand price for capital \(P_K = (P_EE + L + \bar{e}L^*)/K\), under the market for real capital.\(^{12}\) Equilibrium in the market for real capital can be simplified by making use of a modified version of Tobin’s \(q\), given formally as

\[
q = \frac{\tau + \rho}{\bar{e}^* + \delta^e + rp},
\]

\(^{10}\)For further details on the “state of confidence”, see section 4.2.2.

\(^{11}\)The arguments for assuming \(\delta^e + rp = \beta(\rho)\) are discussed in detail in section 4.2.2.

\(^{12}\)For details of this procedure, see section 4.2.2.
stating that $q$ is the ratio of expected net profits to a risk adjusted \textit{expected} reference interest rate domestic investors demand for holding capital assets. Because investment is mainly financed by foreign loans, the reference interest rate is approximated by the risk-adjusted foreign loan rate in terms of domestic currency. Hence, the reference interest rate consist of the nominal interest rate on foreign loans $j^*$ adjusted for expected exchange rate changes $\hat{s}$, and for the country specific risk premium $rp$ representing default risk. Since Tobin's $q$ incorporates expectations on future developments, the nominal foreign interest rate is adjusted for \textit{expected} exchange rate changes, and not for the actual rate of change. In order to simplify the analysis it is assumed, like in equation 5.5 defining equilibrium in the international bond market, that expected exchange rate changes and the country specific risk premium can be expressed by the same function $\beta(\rho)$, being negatively dependent on the state of confidence, formally

$$q = \frac{r + \rho}{j^* + \beta(\rho)}.$$  

This version of Tobin's $q$ can be further simplified by linearization, being used in the model as

$$q = r + \rho - (j^* + \beta(\rho)). \quad (5.6)$$  

Since Tobin's $q$ is both and indicator for the liquidity and the solvency position of business firms, financial distress in the firm sector caused by real sector or financial sector shocks, being indicated by a fall in $q$, can be caused by shrinking values of $r$ and $\rho$, or by an increase in $j^*$.

The domestic market for loans is neglected owing to the assumption of an underdeveloped banking sector; consequently, $L$ and $\lambda$, respectively, as well as $j$ are treated as parameters in the model. By way of contrast, the market for foreign loans is explicitly considered according to the "credit view" of macroeconomic activity. Since loans are longer term contracts which can be only adjusted with some time lags, it is assumed that the stock of foreign loans $L^*$, i.e. the "foreign" debt-asset ratio $\lambda^* = L^*/(PK)$, is predetermined in the short run, and that foreign banks fully satisfy firms' loan demand $L^d$ which is equivalent to the actual stock of loans, i.e. it holds that $L^d = L^*$, or equivalently expressed in term of the numéraire $PK$, firms' "warranted" or demanded foreign debt-asset ratio $\lambda^d$ coincides with the actual foreign debt-asset ratio, i.e. it holds that $\lambda^d = \lambda^*$. Consequently, the comparative static version of the model considers $\lambda^*$ as a parameter, whereas the dynamic version treats $\lambda^*$ as an endogenous variable which is adjusted over time. Since there arise situations in which foreign banks' supply of loans $L^{ss}$ does not coincide with the actual stock or demanded stock of foreign loans, equilibrium is assumed to be reached by variations in the nominal interest rate on foreign loans $j^*$ which adjusts foreign banks' loan supply to the actual stock of foreign loans. Accordingly, equilibrium in the foreign loan market can be expressed as

$$L^* = L^{ss}(\cdot)$$  

where foreign banks' loan supply $L^{ss}(\cdot)$ depends, among $j^*$, on other variables being determined below. Dividing both sides by the numéraire transforms the equilibrium condition into debt-asset ratio terms

$$\lambda^* = \lambda^{ss}(\cdot),$$
where \( \lambda^* = \frac{L^*}{PK} \) is banks' "warranted" supply of the foreign debt-asset ratio. 

Banks' loan supply, or warranted supply of the foreign debt-asset ratio, is assumed to depend on three determinants. Firstly, though the nominal interest rate on foreign loans \( j^* \) is assumed to equilibrate the foreign loan market, foreign banks' supply of loans depends on the real interest rate on foreign loans \( j^* - \hat{p}^* \), which is however equivalent with the nominal rate because it has been assumed that \( \hat{p}^* = 0 \). As a result, the loan supply is positively dependent on \( j^* \), because, for a given stock of loans, a higher interest rate generates higher profits for banks. Secondly, foreign banks' loan supply depends positively on Tobin's \( q \), reflecting the level of domestic firms' collateral varying positively with \( q \), and thereby the risk of business firms' default. Moreover, Tobin's \( q \) is also an indicator for banks' net worth position since banks' profits, and thereby net worth is determined mainly by the amount of non-performing loans in the firm sector which is a negative function of \( q \). Consequently, a higher value of \( q \) leads to higher profits and a higher level of banks' net worth and allows to expand the loan supply, since under international risk standards a bank's supply of loans has to be a positive function of its net worth. As a result, an indicator for a banking crisis, both domestic and international, in the model is a sharp drop in the value of \( q \), implying a drop in business firms' profits and net worth leading to an increase in non-performing domestic and foreign loans, generating a reduction in banks' profits and banks' net worth. The third determinant of banks' loan supply is the degree of domestic and international financial regulation indicated by the parameter \( \alpha \), where an increase in \( \alpha \) means stronger financial regulation for foreign banks which reduces their supply of loans. For example, the establishment of capital controls by an emerging market economy would lead to an increase in \( \alpha \) and thereby to a decline in the loan supply of international banks. Summing up, equilibrium in the foreign loan market is given by

\[
\lambda^* = \lambda^*(j^*, q, \alpha), \quad (5.7)
\]

stating that, e.g. an increase in Tobin's \( q \), or financial liberalization indicated by a fall in \( \alpha \), lead to an excess supply of loans, or equivalently to a higher supplied debt-asset ratio \( \lambda^* (\cdot) \) at a constant stock of \( \lambda^* \), which reduces the price of foreign loans \( j^* \), and thereby the supply of loans until loan market equilibrium is restored.

### 5.3 Short-Run Comparative-Static Analysis

#### 5.3.1 General Results

The macromodel is described by equations 5.1 to 5.7, containing seven endogenous variables \( b, q, j^*, \hat{p}, r, u \) and \( i \), and eleven parameters \( \lambda, j, \lambda^*, \rho, h, m, \hat{s}, v, \delta, \alpha \) and \( i^* \). Assuming that the implicit function theorem is fulfilled, partial derivatives of all endogenous variables with respect to all parameter can be obtained by solving the linear system given as

\[
J \cdot \mathbf{v} = \mathbf{z}
\]

for \( \mathbf{v} \), where \( J \) denotes the Jacobian matrix containing all partial derivatives of system 5.1 to 5.7 with respect to all endogenous variables, \( \mathbf{v} \) the vector of differentials of all

---

13For details, see section 4.2.2.
endogenous variables, and \( z \) the vector of differentials with respect all parameters of system 5.1 to 5.7. In explicit terms, the basic linear system to be solved reads as

\[
\begin{bmatrix}
0 & -\eta_q & 0 & 0 & 0 & 1 & -g_{i-\rho} \\
0 & 0 & \lambda^* & 0 & 1 & v-1 & 0 \\
0 & 0 & 0 & 1 & 0 & -\psi_u & 0 \\
m & 0 & 0 & -d_{\rho a} & -d_{r+\rho} & -d_u & -d_{i-\rho} \\
0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 1 & 1 & 0 & 0 & 0 & 0 \\
0 & -\lambda_{q}^{**} & -\lambda_{j}^{**} & 0 & 0 & 0 & 0 \\
\end{bmatrix}
\begin{bmatrix}
db \\
dq \\
dj \\
dp \\
dr \\
du \\
di \\
\end{bmatrix}
\]

where partial derivatives are denoted by \( x_i = \partial x / \partial i \); for example, \( d_{r+\rho} = \partial d / \partial (r + \rho) \) denotes the partial derivative of deposits demand \( d(\cdot) \) with respect to the expected profit rate \( r + \rho \). The determinant of the Jacobian matrix of system 5.8 reads as

\[
|J| = m((v-1)\eta_q + 1)\lambda_j^{**} - (\lambda^* + 1)\lambda_q^{**},
\]

whose sign can be shown to be positive under three assumptions. Firstly, it is assumed that foreign banks' reaction to interest rate changes with respect to the warranted supply of the debt-asset ratio is much larger than their reaction to changes in Tobin's \( q \) with respect to the loan supply, i.e. it holds that \( \lambda_j^{**} \gg \lambda_q^{**} \). \(^{14}\) Secondly, empirical estimates have shown that the reaction of the growth rate of the capital stock with respect to changes in Tobin's \( q \) is a number much smaller than one, i.e. it holds that \( v / q < 1 \). \(^{15}\) Thirdly, a realistic range for the foreign debt-asset ratio is \( 0 < \lambda^* < 1 \), though values of \( \lambda^* > 1 \) are possible; in this case however, the entire firm sector would be bankrupt which is a very unrealistic scenario. Note that a necessary and sufficient condition for the firm sector to be solvent is \( \lambda + \lambda^* < 1 \). A negative value of the foreign debt-asset ratio is excluded because in this case the firm sector would own claims against the foreign banking sector. Under these assumptions, and taking into consideration that \( v < 1 \) and \( m > 0 \), the signs of the different parts of the Jacobian's determinant are given by

\[
((v-1)\eta_q + 1) > 0 \quad \text{and} \quad ((v-1)\eta_q + 1)\lambda_j^{**} - (\lambda^* + 1)\lambda_q^{**} > 0,
\]

implying a positive sign of the determinant of the Jacobian, i.e.

\[
|J| > 0.
\]

\(^{14}\) For further details and justification of this assumption, see section 4.3.1; the only difference compared with the industrial crisis model is that emerging markets rely on foreign loans by foreign banks.

\(^{15}\) For example, an econometric estimation of the determinants of the capital stock's growth rate by the IMF has detected a value range for the influence of Tobin's \( q \) on \( I/K \) of \( 0.01 < \eta_q < 0.03 \); see International Monetary Fund (2003b), pp. 26-28.
All partial derivatives are given explicitly in section 5.7, whereas table 5.1 summarizes the results as to the signs of qualitative impact effects. Since the signs of partial derivatives with respect to the exchange rate’s growth rate \( \hat{s} \) depend on the level of the foreign debt-asset ratio \( \lambda^* \), there have been introduced two different rows in table 5.1 for \( \hat{s} \), where \( \hat{s}^\dagger \) represents the signs when the foreign debt-asset ratio is comparatively high, and \( \hat{s}^\ddagger \) the signs when the foreign debt-asset ratio is comparatively low.

**Table 5.1: Signs of Qualitative Impact Effects on Temporary Variables**

<table>
<thead>
<tr>
<th>Response in</th>
<th>( u )</th>
<th>( r )</th>
<th>( \dot{p} )</th>
<th>( q )</th>
<th>( j^* )</th>
<th>( i )</th>
<th>( b )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lambda )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( j )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( \lambda^* )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-$</td>
</tr>
<tr>
<td>( \rho )</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>( h )</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( m )</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( \hat{s}^\dagger )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( \hat{s}^\ddagger )</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>( v )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( \delta )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( \alpha )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>( i^\ast )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

\$: Explicit sign ambiguous, i.e. \( \forall \lambda \geq 0 \) (see section 5.7). Sign in table chosen by assumption.

Except for one partial derivative, all signs are unambiguous. It must be noted however, that there are lots of counteracting interdependencies being incorporated in each derivative which are illustrated by the explicit forms given in section 5.7. Consequently, the following qualitative discussion of the signs highlights only the most important nexus between a parameter and an endogenous variable, and is definitely not complete.

A rise in the domestic debt-asset ratio \( \lambda \) leads to a decline in the profit rate on capital \( r \) according to equation 5.2, lowering Tobin’s \( q \), investment demand \( \eta(q) \), and capacity utilization \( u \) according to equations 5.6 and 5.1, inducing a further decline in \( r, q \) and \( u \). Due to the domestic economic contraction, the price level’s growth rate \( \dot{p} \) declines according to equation 5.3, leading in severe cases even to deflation. Since there is an overall decline in asset prices, firms’ shrinking collateral values induce foreign banks to demand a higher loan rate \( j^* \) on foreign loans to compensate for higher risk of default according to equation 5.7. A fall in \( q \) also raises the amount of non-performing loans which reduces on the one hand foreign banks’ profits, and on the other hand domestic banks’ profits. As a result, a higher domestic indebtedness creates both liquidity and solvency problems for international, as well as for domestic banks. Since the domestic interest rate on government bonds \( i \) solely depends on the foreign interest rate on bonds \( i^\ast \) and on the state of confidence parameter \( \rho \) according to equation 5.5, the effect of \( \lambda \) on \( i \) is zero. However, a rise in \( \lambda \) creating a fall in \( u \), causes ceteris paribus a decline in the demand for
deposits according to equation 5.4, and a rising demand for domestic and international bonds, generating a downward pressure on \( i \) which induces capital outflows (capital flows from foreign loans are zero since the foreign debt-asset ratio \( \lambda^* \) is treated as a parameter in the comparative-static version of the model), i.e. a fall in \( b \) according to equation 5.4, in order to restore equilibrium in the market for international bonds according to equation 5.5.

A rise in the domestic interest rate on domestic loans to firms \( j \), and a rise in the foreign debt-asset ratio \( \lambda^* \) operate in the same way like an increase in the domestic debt-asset ratio \( \lambda \), inducing a reduction in \( r, q, u \) and \( \dot{p} \) according to equations 5.2, 5.6, 5.1 and 5.3. Falling asset prices cause shrinking collateral values, an increasing number of non-performing loans, and a fall in domestic and foreign banks' profits, inducing foreign banks to demand a higher interest rate on loans \( j^* \) to compensate for a higher risk of default according to equation 5.7. There is no influence of \( j \) and \( \lambda^* \) on \( i \) according to equation 5.5, whereas the economic contraction puts a downward pressure on \( i \) by increasing domestic and international bond demand, generating capital outflows and shrinking central bank reserves \( b \) according to equation 5.4.\(^{16}\)

An increase in the state of confidence \( \rho \) acts in the opposite direction in comparison with increases in \( \lambda, j \) and \( \lambda^* \). A rising \( \rho \) leads to an increase in \( r, q, u \) and \( \dot{p} \) according to equations 5.2, 5.6, 5.1 and 5.3. Increasing asset prices and collateral values reduce the risk of default of domestic firms inducing foreign banks to demand a lower interest rate \( j^* \) on foreign bank loans according to equation 5.7, leading to further increases in \( r, q, u \) and \( \dot{p} \). A rising \( q \) lowers the amount of non-performing loans and increases profits of domestic and foreign banks. Due to the domestic economic expansion, the country risk premium decreases and economic agents expect a future appreciation or a lower devaluation of the home currency, leading to a decline in the interest rate on government bonds \( i \) according to equation 5.5. A rising value in \( u \) increases ceteris paribus the demand for deposits, and lowers the demand for domestic and international bonds according to equation 5.4, leading to an upward pressure on \( i \) which induces capital inflows and increasing central bank reserves \( b \).

Monetary policy represented by variations in the domestic credit component \( h \), and in the money multiplier \( m \) caused by variations in the required reserve ratio \( \tau \), do not have both any real sector and financial sector consequences, validating the Mundell-Fleming result that monetary policy under fixed exchange rates is ineffective. The reason for the ineffectiveness of monetary policy stems from the fact that there is no disturbance of the deposit market equilibrium according to equation 5.4, since changes in \( h \) and \( m \) are immediately offset by counteracting changes to the same amount in central bank reserves \( b \), leading to a constant amount of high powered money which is reflected in partial derivative values \( \partial b / \partial h = -1 \), and \( \partial b / \partial m = -(b + h + \lambda^*)/(m) \), causing a constant deposit supply \( m(h + b + \lambda^*) \) (see section 5.7) and a constant interest rate on government bonds \( i \). Since there is no influence of \( h \) and \( m \) on the interest rate on foreign loans to domestic firms \( j^* \), there are no variations in \( r, u, q \) and \( \dot{p} \).

Exchange rate policy being indicated by variations in the exchange rate's growth rate \( \dot{s} \) depends crucially on the level of foreign debt of domestic firms, i.e. on the level of the

\(^{16}\)Though the influence of \( \lambda^* \) on \( b \) is not clear (see section 5.7), it has been assumed that an increase in the foreign debt-asset ratio \( \lambda^* \) has the same effect on central bank reserves \( b \) like an increase in the domestic debt-asset ratio \( \lambda \).
foreign debt-asset ratio $\lambda^*$. If there is a comparatively low level of foreign debt, i.e. in case domestic firms finance most of the capital stock by domestic loans, a devaluation of the exchange rate $s^d$ is expansionary like in the standard Mundell-Fleming model, since the negative effect of rising interest rate payments on foreign loans on the profit rate according to equation 5.2, is overcompensated by an increase in capacity utilization $u$ stemming from an increase in net exports $nx(s - \bar{p})$ according to equation 5.1, rising $r$ according to equation 5.2. Owing to rising values in $r$ and $u$ there is a rise in asset prices and Tobin’s $q$ according to equation 5.6, leading to higher collateral values and to a decrease in the interest rate on foreign loans $j^*$, inducing a further rise in $u$, $r$ and $q$ and in the price level’s growth rate $\bar{p}$ according to equation 5.3. Since there is no influence of $\dot{s}$ on $\rho$, the domestic interest rate on government bonds $i$ remains constant according to equation 5.5, though a rising value of $u$ causes an upward pressure on $i$ according to equation 5.4, inducing a rise in central bank reserves $b$. It must be noted however, that in spite of an economic expansion in case of a devaluation, the expansion is very small due to the limited ability of the domestic financial sector to provide sufficient financial means, and due to restricted commitment of foreign banks; i.e. an increase in $q$ stimulating domestic investment, cannot be fully realized since investment demand is rationed by available credit $\lambda$ and $\lambda^*$. Accordingly, financial liberalization, allowing domestic firms to take foreign debt, promotes domestic growth since investment is not rationed any more by available credit.

Yet, a higher level of foreign debt $\lambda^*$ induced by financial liberalization makes the domestic economy much more vulnerable to exchange rate variations and to changes in available foreign credit. If the foreign debt-asset ratio has become comparatively high due to financial liberalization, a devaluation of the exchange rate is no longer expansionary, but contractionary since a rise in $s^d$ leads to a large increase in interest payments on foreign debt, and to a decline in the profit rate $r$ according to equation 5.2, though a devaluation leads to an increase in net exports and to an increase in capacity utilization $u$ according to equation 5.1. However, the negative effect of a lower $r$ on Tobin’s $q$ and on $u$ overcompensates the positive influence of $nx$ on $u$, because there is a sharp drop in investment demand according to equation 5.1. Falling asset prices and collateral values induce foreign banks to demand a higher interest rate on foreign loans $j^*$ according to equation 5.7, leading to further declines in $r$, $q$ and $u$. Owing to the economic contraction, the domestic price level decreases, i.e. there is a fall in $\bar{p}$ according to equation 5.3, which in severe cases even leads to deflation worsening firms’ profits, since among rising interest rate payments on foreign debts, real interest payments on domestic debt and the real stock of domestic debt increase, leading to a further decline in $r$, $u$, $q$, $\bar{p}$ and to a rising $j^*$. Because of the economic contraction, there is a downward pressure on $i$ according to equation 5.4, leading to shrinking central bank reserves $b$, contradicting the standard view that devaluations stop reserve outflows, because devaluations cause a recession and not a recovery of the domestic economy.

A higher wage share with respect to gross nominal product $v$, being caused either by a negative shock to labour productivity $Y/N$ or by a higher nominal wage $w$, and a negative technology shock indicated by a higher depreciation rate $\delta$, both lead to the same qualitative results.\(^{17}\) According to equations 5.2, 5.6, 5.1 and 5.3, a rise in $v$ or $\delta$ leads to a

\(^{17}\) All partial derivatives with respect to $v$ and $\delta$ are almost identical, and differ only by multiplication with $u$; see section 5.7 for details.
decline in the profit rate $r$, in Tobin’s $q$, in investment demand $\eta(q)$, in capacity utilization $u$, and in the price level’s growth rate $\dot{p}$. Falling asset prices and collateral values cause a higher share of non-performing loans and lower profits for both domestic and foreign banks, inducing foreign banks to increase the interest rate on foreign loans $j^*$ according to equation 5.7, generating further declines in $r, q, u$ and $\dot{p}$. There is no influence of $v$ and $\delta$ on $i$, though the economic contraction leads to a decline in deposit demand and to an increase in domestic and international bond demand, putting a downward pressure on $i$, and causing a decline in central bank reserves $b$ according to equation 5.4.

Stronger international financial regulation (e.g. the establishment of quantitative restrictions on the amount of foreign loans, a (Tobin-) tax on international transactions, a tax on international interest rate payments or simply the introduction of capital controls) being indicated by a rising value in $\alpha$, leads to a domestic economic contraction due to a higher loan rate on foreign loans $j^*$ according to equation 5.7, inducing a fall in the profit rate $r$, in Tobin’s $q$, in capacity utilization $u$ and in the growth rate of the domestic price level $\dot{p}$ according to equations 5.2, 5.6, 5.1 and 5.3. Falling asset prices and shrinking collateral values induce an additional increase in the foreign interest rate on loans $j^*$ according to equation 5.7, leading to a further contraction in $r, q, u$ and $\dot{p}$. Because of the fall in $u$, there is fall in deposit demand according to equation 5.4, generating a downward pressure on $i$ which induces capital outflows and shrinking central bank reserves $b$.

An increase in the foreign interest rate on government bonds $i^*$ leads to capital outflows and to a loss in central bank reserves $b$ which reduces the amount of high powered money, and induces a rise in the domestic interest rate on government bonds $i$ until equilibrium in the international bond market is restored according to equation 5.5, where $\partial i^*/\partial i = 1$ (see section 5.7 for details). A rise in $i$ reduces government expenditure $g(i - \dot{p})$, capacity utilization $u$, the profit rate $r$, Tobin’s $q$ and the price level’s growth rate $\dot{p}$ according to equations 5.1, 5.2, 5.6 and 5.3. Reductions in collateral values induce an increase in the foreign interest rate on loans $j^*$ according to equation 5.7, leading to further declines in $r, q, u$ and $\dot{p}$.

5.3.2 A Comparative-Static View of Financial Crises

Empirical studies of financial crises in emerging market countries in the Post-Bretton Woods era confirm that emerging market crises are characterized by almost the same stylized facts as crises in industrial countries, as e.g. by the link between extensive boom-bust cycles in goods and financial markets, and the occurrence of financial crises on the cycle’s upper turning point, having been outlined in chapter 3. Analyzing the dynamic behaviour of macroeconomic variables during business cycles containing financial crises results in the identification of a highly stylized boom-bust cycle being described in the following paragraphs, and being formally outlined by the comparative-static version of the model according to table 5.1. As mentioned in section 4.3.2, the following theoretical comparative-static description of financial crises is only a qualitative approach in order to describe the behaviour of the core “driving” forces of financial crises, serving a theoretical base for the dynamic analysis which is able to confirm the comparative-static results by endogenous model mechanisms.
The Boom Phase. Most boom periods in emerging markets culminating in a full-fledged financial crisis begin with extraordinary positive expectations as to future macroeconomic performance. In most cases, this increase in the overall “state of confidence” in the economy has its roots in “Washington Consensus” style macroeconomic programmes and/or in orthodox macroeconomic stabilization policies having been described in detail in chapter 3.3.2. The most important components of these macroeconomic policies making countries vulnerable to financial crises are firstly, the establishment of a fixed exchange rate regime to stabilize inflation or to support an export-led growth strategy by an undervalued currency, and secondly, domestic and international financial liberalization including deregulation of the domestic financial sector and the liberalization of international capital flows.

Due to past financial repression of the domestic financial sector, an economic expansion can be only financed by capital inflows which are in most cases “pulled” by high profit expectations due to far-reaching economic reforms and a stable exchange rate, and “pushed” by low interest rates and low growth in industrial capital exporting countries. Due to the “original sin” hypothesis, capital inflows are generally denominated in foreign currency. In most cases (see e.g. Latin America in the mid 1970s and in the 1990s, and Asia in the 1990s), macroeconomic reforms in emerging markets induce huge volumes of capital inflows which exhibit at first long-term maturities, but then become more short-term over time. The surge in capital inflows is mostly supported by implicit or explicit government guarantees to stabilize the exchange rate and/or to bail-out troubled banks in order to minimize the loss of foreign investors in case of a banking or currency crisis, leading in lots of cases to moral hazard and overborrowing being described in the next paragraph.

The transformation of capital inflows in foreign currency into domestic investment projects (or consumption) can take, as outlined above, either a direct form in which firms take loans from abroad, or an indirect form in which domestic banks take foreign loans and transform their liabilities into domestic loans in domestic currency to firms and households. Independently of the kind of capital inflow transformation, rising profit expectations and an increasing supply of foreign finance cause a credit boom by decreasing international and domestic interest rates which lead to a domestic economic expansion and increasing leverage of firms and financial institutions in foreign currency. Rising aggregate demand leads to higher profits increasing firms’ and banks’ net worth and stock market valuations, making their balance sheets look sounder and inducing further capital inflows due to higher collateral values and lower risk premiums.

Translating these empirical facts of boom phases, including increasing profits, rising stock market valuations, augmenting GDP growth, decreasing domestic and international interest rates, increasing domestic and foreign leverage by firms and banks, to the comparative-static version of the model, the initial “Washington Consensus” financial liberalization shock can be indicated by a fall in $\alpha$ representing the liberalization of international capital flows, and by an increase in $m$ representing domestic financial liberalization by a much lower required reserve ratio than in financial repression times. Low international interest rates in capital exporting countries are indicated by a fall in $i^*$. Financial liberalization policies and favourable international financial market conditions cause an increase in $\rho$. Capital inflows and rising foreign leverage by taking directly loans from foreign financial institutions is represented by an increase in the foreign debt-asset ratio.
ratio $\lambda^*$. Though the domestic banking sector does not receive foreign loans, the transformation of foreign financial means into aggregate demand, and thereby into deposits, enables domestic banks to supply an increasing amount of loans in domestic currency. Accordingly, there is also a rising domestic leverage of firms by taking loans from domestic financial institutions being indicated by an increase in the domestic debt-asset ratio $\lambda$. Though rising domestic and foreign leverage cause ceteris paribus a domestic macroeconomic contraction with decreasing capacity utilization $u$, a lower profit rate $r$, a decreasing Tobin’s $q$, lower growth in the price level $\hat{p}$, and an increase in the interest rate on foreign loans $j^*$, the positive effects of changes in $\alpha, m, i^*$ and $\rho$, causing a macroeconomic expansion, dominate the boom phase. As a result, overall macroeconomic effects are an increase in capacity utilization $u$ caused by a rising profit rate $r$ and a rising Tobin’s $q$, decreases in the foreign loan rate $j^*$ and in the domestic bond rate $i$, a higher growth rate of the price level $\hat{p}$, and increasing international central bank reserves $b$.

The Overborrowing Symptom. The expansion phase of a business cycle is generally characterized by profit expectations growing much faster than actual profits, implying that domestic agents have to increase their fraction of external funds in domestic, and mainly in foreign currency to finance new investment projects. Since financial systems in emerging markets are more bank-based due to the absence of deep and well-developed capital markets, economic agents have to rely more on foreign loans than on equity placements, increasing business firms’ and banks’ leverage in foreign currency. This process of overborrowing, being defined as a situation in which an increase in indebtedness is mainly based on overly optimistic expectations which cannot be justified by the development of actual profits, is supported predominantly by foreign investors through a rising volume of capital inflows. The growth in profit expectations is driven by rising actual gross profits (profits before external financing costs) owing to boosting aggregate demand induced by the domestic credit boom, and by herding behaviour of investors. Overborrowing increases the overall financial fragility in the economy since both domestic agents and international creditors become more vulnerable to shocks in financial, as well as in goods markets. Domestic debtors depend increasingly on the willingness of international investors to roll over or to increase debt, whereas international investors become more and more dependent on the ability of domestic agents to fulfill their payment commitments hinging upon a further growth in aggregate demand.

In terms of the model, the overborrowing process can be described by an increase in the domestic and in the foreign debt-asset ratio $\lambda$ and $\lambda^*$, and by an increase in the state of confidence parameter $\rho$, the growth in $\rho$ being much larger than the growth in $\lambda$ and $\lambda^*$. Macroeconomically, the net effect results in a general expansion in domestic activity, being described by an increase in capacity utilization $u$, an increase in Tobin’s $q$ mainly driven by an increasing $\rho$, a decrease in the foreign loan rate $j^*$ owing to higher collateral values, a decrease in the domestic bond rate $i$, an increase in the growth rate of the domestic price level $\hat{p}$, and by an increase in central bank reserves $b$. During this stage of the business cycle, the (net) profit rate $r$ cannot increase due to growing external financing costs, though capacity utilization $u$ and thereby gross profits increase. In order to distinguish the overborrowing phase from a state of “irrational exuberance” being described in the following paragraph, it seems reasonable to assume a positive constant value of $r$. 

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The Upper Turning Point and "Irrational Exuberance". The upper turning point of the business cycle is characterized by a steady deterioration of cash flows and the profit rate, since the growth of external finance costs is larger than the growth of actual gross profits (profits less external financing costs), increasing overall financial fragility. However, profit expectations, asset prices, and the degree of indebtedness tend to grow further though their increase cannot be validated by the development of net actual profits, driving the economy into a state of "irrational exuberance" since profit expectations are no longer based on economic fundamentals. The "bubble" in financial markets is closely linked to a general overheating in the real sector, being characterized by excess demand and almost full capacity utilization causing domestic inflation to rise. Owing to an acceleration in inflation, the real exchange rate deteriorates generating or magnifying a current account deficit which is financed by capital inflows, making the economy more vulnerable to a reversal of international capital flows since the stock of international reserves is becoming smaller than the stock of foreign claims, though international reserves as a whole are still increasing in this stage of the business cycle. In case international investors lose confidence in the performance of the domestic economy and withdraw collectively their funds, the exchange rate collapses since the central bank has not sufficient foreign reserves to serve all claims by foreign investors. In order to stabilize the real exchange rate and the balance of payments by fighting domestic inflation, central banks generally sterilize capital inflows to prevent a further expansion in domestic credit and in capacity utilization. Sterilization of capital inflows however, has only a limited capacity to slow down the domestic boom since a rising supply of central bank assets (mostly bonds) causes domestic interest rates to rise inducing further capital inflows. Under fixed exchange rates there is no possibility for central banks to increase the discount rate in order to slow down the boom, since a rising level of domestic interest rates would cause a further increase in capital inflows at this stage of the business cycle.

In terms of the model, the upper turning point is characterized by the same conditions like the overborrowing phase, namely by an increase in the debt-asset ratios $\lambda$ and $\lambda^*$ and by an increase in the state of confidence parameter $\rho$. As in the state of overborrowing, all endogenous variables behave as in a macroeconomic expansion except for the profit rate $r$ which is decreasing, distinguishing the conditions at the upper turning point from conditions during the overborrowing process. This "irrational" result stems from the fact that the negative effect of increasing values of $\lambda$ and $\lambda^*$ on $r$ dominate the positive effect of $\rho$ on $r$, resulting in a decline in the profit rate due to rising debt costs. However, as to the influence on Tobin's $q$, the positive influence of an increasing value of $\rho$ dominates the negative effect of a decreasing $r$, leading to an overall rising value of Tobin's $q$ and giving rise to an increase in capacity utilization $u$, an increase in the growth rate of the domestic price level $\bar{p}$, and to decreases in the foreign interest rate on loans $j^*$ and in the domestic interest rate on bonds $i$. As to central bank reserves, overall normalized reserves $b + \lambda^*$ increase though the reserve component $b$ is decreasing due to rising current account deficits. Sterilization of capital inflows, being the result of an increase in the foreign debt-asset ratio $\lambda^*$, by a decrease in the normalized domestic credit component $h$ has no real sector and financial market effects since a decreasing $h$ is offset by a rising $b$, limiting capital outflows generated by current account deficits.
The Burst of the Bubble. The exuberance in real, as well as in financial markets comes to halt when investors realize that profit expectations cannot be validated by the actual development of net profits. The triggering event of a collapse of profit expectations can be either a failure of an important corporate or financial business firm, or a foreign exogenous shock as e.g. an increase in foreign interest rates, or a negative terms of trade shock. It must be noted that especially foreign exogenous shocks can be the trigger of the bubble's burst, but can also only magnify the initial collapse of expectations. Consequently, exogenous shocks are not the main cause of a disruption in financial markets causing widespread illiquidity and insolvency; they can be better interpreted as a "wake-up" call for investors to realize that the existing financial structure has become fragile endogenously by overborrowing, and to revise expectations downwards on actual economic fundamentals. The reason why exogenous shocks are often viewed as main sources of financial crises is the fact that firstly, these shocks cause the beginning of financial crises, and secondly, aggravate already existing financial fragility by being the trigger for falling asset prices, and by deteriorating already fragile cash flow positions. Irrespective of the triggering event, the financial market bubble's burst leads to a sudden and large decline in asset prices, and to an increase in domestic as well as in foreign interest rates since the risk of default, being represented by largely dropping collateral values, increases. Regarding capital flows, the steady inflow of foreign capital comes to a sudden stop, and marks the beginning of an reversal of capital flows, i.e. the beginning of huge volumes of capital outflows.

In terms of the model, the drop in profit expectations is represented by a sharp fall in the state of confidence \( \rho \), causing a reduction in Tobin's \( q \), an increase in the foreign interest rate on loans \( j^* \) due to falling collateral values, an increase in the domestic interest rate on government bonds \( i \) due to depreciation expectations, and owing to an increase in the country risk premium. Regarding international capital flows, there are two mechanisms causing a reversal in capital flows. Firstly, the "sudden stop problem", i.e. the halt of inflows of foreign loans is represented by a fall of the growth rate of \( \lambda^* \) to zero. Secondly, depreciation expectations and an increasing country risk premium caused by a fall in \( \rho \) mark the beginning of capital outflows being indicated by a fall in \( b \). In case an exogenous shock, as e.g. a foreign interest rate increase being indicated by a rise in \( i^* \), triggers the collapse of expectations, the fall in asset prices, the rise in interest rates, and the reversal of capital flows are amplified because a rising value of \( i^* \) causes a rise in \( i \), a fall in \( b \), a decline in Tobin's \( q \) and thereby an increase in \( j^* \).

The Bust Cycle, Financial and Twin Crisis, Debt Deflation and the Liquidity Trap. Whether a large drop in asset prices causes a systemic financial crisis, containing widespread bankruptcies among firms and financial institutions inducing a deep recession and deflationary spirals, or simply readjusts expectations to economic fundamentals without any negative repercussions on the real sector, depends upon the initial degree of financial fragility when an asset bubble bursts, as well as on the extent of the initial asset price decline. If firms and financial institutions have become highly leveraged both in domestic as well as in foreign currency during the boom phase, and if their collateral values react very sensitively to asset price fluctuations, an asset bubble's burst is likely going to cause a full-fledged financial crisis, being characterized by a domestic and
perhaps a foreign banking crisis, a currency crisis (generating a twin crisis), and by a large contraction in the real sector.

Regarding systemic financial crises, the initial fall in expectations and the resulting decline in asset prices causes collateral values to drop sharply, initiating a large rise in domestic and international interest rates due to increasing default risk. Liquidity problems then emerge on the one hand through rising debt costs, and on the other hand by a sharp fall in earnings caused by a drop in aggregate demand. In order to meet due payment obligations business firms, as well as banks have to engage in widespread fire-sales of assets since liquidity in capital markets has dried up, and rolling over or increasing debt becomes impossible. Domestic and foreign financial institutions incur losses by an increasing amount of non-performing loans, causing a widespread domestic banking crisis and also failures among foreign financial institutions. Foreign investors start to withdraw their funds which are in most cases short-term, causing further liquidity needs in foreign currency for business firms and for banks, resulting in further fire-sales of assets since foreign exchange reserves cannot be obtained by debt-finance.

Owing to large current account deficits having been financed by capital inflows during the boom phase, central banks face a liquidity problem in foreign currency since the stock of existing reserves falls short of the stock of foreign claims. In order to cope with large capital outflows and a limited stock of foreign reserves, central banks generally have the choice between two alternatives which are both “bad” alike. In order to prevent a devaluation by reducing further capital outflows, central banks have to pursue contractionary monetary policy, leading to high domestic interest rates to compensate investors for increasing default risk. A monetary contraction however, increases banks’ refinancing costs and leads quickly to an increase in loan rates, causing a further deterioration of corporate and bank balance sheets due to higher debt costs, and leading to a further drop in expectations and perhaps to further capital outflows. If, on the other hand, central banks do not want to act contractionary in order to prevent further bankruptcies among domestic business firms and banks, large-scale capital outflows and a limited stock of foreign reserves inevitably lead to a devaluation of the domestic currency and thereby to a twin crisis, engendering a “debt-explosion” of foreign debt (valued in domestic currency) being equivalent to a Fisherian debt deflation process in domestic currency which is caused by deflation. Increasing foreign interest payments and an increasing stock of foreign debt in domestic currency terms causes further liquidity and solvency problems among banks and business firms, magnifying the real and the banking crisis, and inducing further capital outflows.

In case central banks abandon the fixed exchange rate system and establish a flexible post-crisis exchange rate regime, the gain in monetary independence can be possibly undermined either by the emergence of a liquidity trap situation, or by accelerating domestic inflation. Regarding the emergence of a liquidity trap, relaxing monetary conditions cannot turn the economy into a recovery since balance sheet conditions and credit shortages both in domestic and in international financial markets cannot be removed. In severe cases, a liquidity trap situation can turn the economy into a deep depression with deflationary spirals aggravating the debt-deflation process. If, on the other hand, the domestic economy depends heavily on imports which are denominated in most cases in foreign currency, the transition to a flexible exchange rate system including an initial large devaluation of the domestic currency, can cause high domestic inflation, compelling the central
bank to raise domestic interest rates, inducing a further macroeconomic contraction in order to prevent accelerating inflation or even hyperinflation.

Comparing systemic financial crises in emerging market economies with full-fledged financial crises in industrial countries, it is obvious that the macroeconomic contraction in the real sector in emerging markets is much deeper than in industrialized economies which is caused by two factors. Firstly, the reversal of foreign capital flows, leading either to a sharp increase in interest rates and/or to devaluation, causes much larger and much quicker liquidity and solvency problems for firms and financial institutions than in industrialized countries. Secondly, due to the higher degree of openness of emerging market economies in goods markets and due to dependence on foreign capital, monetary authorities are forced to act more contractionary to stabilize domestic inflation or the exchange rate.

In terms of the model, a systemic financial crisis is caused by a further decline in the state of confidence \( \rho \), leading to a decrease in Tobin’s \( q \), in the profit rate \( r \), in capacity utilization \( u \), in the price level’s growth rate \( \dot{p} \), and in foreign exchange reserves \( b \), whereas the increase in the risk of default in the corporate sector leads to a higher foreign loan rate \( j^* \). Depreciation expectations and increases in the country risk premium cause a higher domestic bond rate \( i \) and capital outflows \( b \). Foreign financial institutions withdraw foreign loans to firms, thereby inducing further capital outflows being indicated by a fall in \( \lambda^* \). Though generally, a reduction in \( \lambda^* \) leads ceteris paribus to a macroeconomic expansion, the deleveraging process cannot turn the economy into a recovery since the effect of a falling \( \rho \) dominates. Central banks’ attempt to stop capital outflows, thereby preventing a devaluation, is represented by a reduction in \( m \) or \( h \), however having only a compensating effect on \( b \) which increases, but having no effect on capital outflows caused by withdrawing foreign loans indicated by a fall in \( \lambda^* \). As a result, if there is no possibility to stop the reduction in capital outflows stemming from a decline in \( \lambda^* \), central banks have to devalue the domestic currency when foreign exchange reserves are used up. Since foreign reserves \( b + \lambda^* \) tend to be smaller than \( \lambda^* \) since \( b < 0 \), at the time of devaluation the foreign debt-asset ratio is large enough to cause a contractionary devaluation indicated by a large rise in \( \delta \), causing a sudden deterioration of \( r \) by increasing foreign interest rate costs, leading to declines in \( q, u, \dot{p} \) and to a rise in \( j^* \).\(^{18}\) The emergence of a liquidity trap situation after the abolition of the fixed exchange rate regime cannot be shown by the model since the partial derivatives are only calculated for a fixed exchange rate and for given changes in \( s \). If, however, central banks only engage in a unique (contractionary) devaluation in order to stabilize the exchange rate, there is no possibility to turn the economy into recovery due to the ineffectiveness of monetary policy under fixed exchange rates, which is consistent with a liquidity trap situation.

The Recovery Phase. At the beginning of the bust cycle, firms and financial institutions start to consolidate their balance sheets and cash flows by reducing the level of domestic and foreign debt which requires investment spending to decline. A recovery, which in most cases has to be financed again by foreign capital inflows because of the domestic disintermediation process caused by the domestic banking crisis, can begin only

\(^{18}\)An increase in domestic inflation caused by devaluation, i.e. by an increase in \( \delta \), cannot be shown by the model since the Phillips curve equation 5.3 does not contain foreign prices and the exchange rate by assumption.
if balance sheets, cash flows, and profits are viewed as being strong enough to fulfill payment obligations resulting from new loans in foreign currency. Furthermore, new capital inflows will start only if exchange rate expectations have been stabilized which can be obtained in most cases only by a new fixed exchange rate system, or by a strictly managed floating regime.

In terms of the model, a macroeconomic expansion is going to start only if reductions in the debt-asset ratios $\lambda$ and $\lambda^*$ have led to a recovery in the state of confidence $\rho$, initiating a new expansion phase being indicated by a rise in $u, r, \hat{p}, q, b$ and declines in $i$ and $j^*$.

5.4 Long-Run Dynamic Analysis

5.4.1 Finance, Investment and Long-Run Profit Expectations

The main limitation of the comparative-static analysis of financial crises by the static version of the model is the fact that it provides only a qualitative description of the stylized facts without giving an explanation of the causes of variations in parameters. This theoretical gap can be closed by endogenizing the two core parameters of the model, the state of confidence parameter $\rho$ and the foreign debt-asset ratio $\lambda^*$, “driving” an emerging market economy, and being predominantly responsible for the emergence of financial crises. The dynamic version of the model describes, in a similar fashion as the financial crisis model for industrial countries, that financial fragility is an endogenous phenomenon being inherently linked to each business cycle, but that the degree of financial fragility deciding upon the occurrence of a financial crises is determined by exogenous events.

The Dynamic Behaviour of Long-Run Profit Expectations. Empirical studies of business cycles and financial crises have identified a stylized behaviour of profit expectations being characterized firstly, by cumulative upward and downward movements during the boom and bust cycle, and secondly, by reversals of cumulative processes at the upper and the lower turning point induced by a readjustment of expectations to fundamental data.

Translating these observations into a dynamic equation for the state of confidence parameter requires to take into account different expectation formation schemes. In order to describe cumulative upward and downward movements in expectations, the model refers to Keynes’ beauty contest theory explaining the formation of a general market convention by “chartist-type” behaviour. Following general market sentiments, i.e. bulls and bears in financial markets, can be considered as being rational since speculating against general market conventions results in lower returns, even if actual market psychology cannot be justified by economic fundamentals. Formally, “chartist-type” behaviour can be expressed as

$$\dot{\rho} = z(\rho),$$

stating that the time derivative of $\rho$, being denoted as $\dot{\rho} = \partial \rho / \partial t$, is positively dependent on the actual state of confidence $\rho$. Accordingly, “chartist-type” dynamics generate a
positive/negative feedback loop or a cumulative upward/downward movement, since positive/negative profit expectations \((\rho > 0, \rho < 0)\) are going to increase/decrease further.

The reversal of expectations at the upper and the lower turning point of the business cycle can be explained by “fundamentalist-type” behaviour, and/or by a kind of long-run “rationality” of investors. Regarding fundamentalist behaviour, a reversal in expectations at the end of the boom and the bust phase is likely going to occur since an increasing divergence of expectations and economic fundamentals cannot be maintained forever. An increasing trade-off between expectations and actual data reduces the share of “chartist-type” investors, and increases the weight of “fundamentalist-type” investors emphasizing that expectations cannot be justified any longer. When a critical mass of investors relying on fundamental data, and recognizing that expectations have been overly optimistic or pessimistic is reached general market sentiment shifts into the reverse direction.

There are various variables which could serve as economic fundamental data investors refer to. Potential fundamentals reach from macrodata like interest rates, terms of trade etc., up to microdata as sales or profits. Since the present model concentrates on the explanation of endogenous financial fragility, suitable fundamentals should focus on the financial structure of the model economy. For present purposes, the two core fundamentals influencing the state of confidence parameter \(\rho\) are assumed as being on the one hand, current profitability being an indicator for liquidity, and on the other hand the debt-asset structure being an indicator for solvency.

Regarding the construction of an indicator for current profitability, the actual profit rate \(r\) could serve as a reliable variable. However, restricting current profitability to \(r\) would neglect the influence of general economic conditions on firms' profitability and would also not allow to make any assessment on the question of whether profits are comparatively "high" or "low". As a result, the current profit rate \(r\) has to be compared with a riskless (expected) domestic reference rate of return, being represented by the real interest rate on domestic government bonds \(i - \hat{p}\) which, according to UIP given in equation 5.5, can be expressed alternatively as \(i^* + \beta(\rho) - \hat{p}\). Thus, current profitability is measured as the difference between the profit and the real interest rate on domestic bonds denoted as \(\sigma^*\), and formally given as

\[
\sigma^* = r - (i^* + \beta(\rho) - \hat{p}).
\]

The difference \(\sigma^*\) can be interpreted as a risk premium firms have to pay to equity holders in order to compensate for the risk of default. As regards the influence of \(\sigma^*\) on \(\hat{p}\), it is assumed that an increasing \(\sigma^*\) caused by a rise in \(r, \rho, \hat{p}\) or by a decline in \(i^*\) increases current profitability, and thereby leads to a rising value of \(\hat{p}\), i.e. in mathematical terms it holds that \(\partial\hat{p}/\partial\sigma^* > 0\). It has to be emphasized that despite the fact that only domestic investors are able to hold equities, foreign investors also use the difference between the domestic profit rate and the real interest rate on domestic government bonds as an indicator for current profitability and for the liquidity status of domestic firms when making their decisions on the supply of foreign loans, which emphasizes the fact that domestic as well as foreign agents' formation of expectations and actions are based on the same economic data.

Concerning an indicator for solvency risk, the degree of indebtedness is a reasonable economic fundamental. Since a large fraction of debt in emerging markets is denominated in foreign currency, the foreign debt-asset ratio \(\lambda^*\) could suit as a reliable indicator.
However, concentrating solely on $\lambda^*$ would disregard the fact that insolvency can emerge very quickly and easily by a devaluation of the home currency. Consequently, in order to capture exchange rate risk the foreign debt-asset ratio has to be formulated in domestic currency, being defined as

$$\lambda_d^* = \lambda^* s.$$  

Considering the influence of the foreign debt-asset ratio in domestic currency terms $\lambda_d^*$ on $\dot{\lambda}$, it is assumed that an increasing value of $\lambda_d^*$, caused either by a higher foreign debt-asset ratio $\lambda^*$ or by a devaluation of the home currency $\delta > 0$, leads to higher risk of insolvency, and thereby to a fall in $\dot{\lambda}$, i.e. formally it holds that $\partial \dot{\lambda} / \partial \lambda_d^* < 0$.\(^{19}\)

Summing up, the influence of chartist-type and fundamentalist-type behaviour on the change of the confidence parameter results formally in

$$\dot{\rho} = z(\rho, \sigma^*, \lambda_d^*),$$

stating that in boom and bust phases, when expectations are largely driven by mass psychology, the influence of $\rho$ on $\dot{\rho}$ dominates, i.e. $\dot{\rho} > 0$, whereas at the upper and lower turning points, when the difference between actual and expected profitability and solvency reach extreme values, the influence of $\sigma^*$ and $\lambda_d^*$ dominates inducing a reversal in expectations, i.e. $\dot{\rho} < 0$.

As outlined in section 4.4.1, the use of "chartist-fundamentalist" expectation formation schemes has been criticized by the rational expectations school, arguing that assuming a chartist-fundamentalist behaviour excludes rationality by investors. According to the rational expectations school, using chartist techniques and forecasts which are at some points revised by a coming out of "new" fundamental data which could not be foreseen or observed, neglects the fact that agents are rational in the sense that market participants are able to develop a "correct" model of the economy processing all available information on which expectations are based. By way of contrast, the rational expectations hypothesis loses its validity under complete and irreducible uncertainty, making a chartist-fundamentalist-type expectations scheme a more realistic concept.

Regarding the dynamic version of the model, both schools of thought are applicable since equations 5.1 up to 5.7 set up a model on which profit expectations can be based, but the model also assumes explicitly long-run incomplete and irreducible uncertainty making it necessary for investors to rely, next to a rational evaluation of the model, additionally on market sentiments and on economic fundamentals. Accordingly, the model structure unifies both concepts regarding profit expectations, by assuming at least some long-run rationality by investors in the sense that investors believe in the long-run rational expectations equilibrium $\dot{r}^* = 0$, implying a long-run steady state value $\rho_E = 0$. As to the formation of current profit expectations, the assumption of long-run rationality implies that investors believe in the state of confidence $\rho$, irrespective of fundamentals and chartist forecasts, to move in some "corridor" or "normal range" which cannot be left. In reality this corridor can be very large and is going to vary among different business cycles, since a positive technology shock or financial liberalization, which are believed to break past long-run growth trends in an upward direction, generate more optimistic profit expectations.

\(^{19}\)Note that changes in the exchange rate by depreciation or appreciation, and their influence on $\lambda_d^*$ are always expressed for the initial value of the fixed exchange rate $\delta = 1$, i.e. if there is no change in $s$ ($d\delta = 0$), it holds that $\lambda_d^* = \lambda^*$. 

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than a “normal” business cycle without being induced by extraordinary and large positive external shocks.

Long-run rationality, or short-run corridor behaviour of \( \rho \) are implemented formally in a similar way as in equation 4.16 in the industrial country model by a modified function for \( \dot{\rho} \), which reads as

\[
\dot{\rho} = z\left( \rho, \sigma^*, \lambda_d^* \right),
\]

(5.10)

stating that irrespective of \( \sigma^* \) and \( \lambda_d^* \), there exist values for \( \rho \) which induce investors to rely on mass psychology, i.e. \( \partial \dot{\rho} / \partial \rho > 0 \), but there exist also values for \( \rho \) causing investors not to change their expectations, i.e. \( \partial \dot{\rho} / \partial \rho = 0 \), or even to speculate against the trend of mass psychology, i.e. \( \partial \dot{\rho} / \partial \rho < 0 \).\(^{20}\) Regarding the corridor concept, being represented in figure 5.2 which is a slightly modified version of figure 4.2 depicting equation 5.10 for constant values \( \sigma^* \) and \( \lambda_d^* \), it is assumed that there exists a “realistic” or “normal” range for the state of confidence \( \rho_l < \rho < \rho_u \), where \( \rho_l \) and \( \rho_u \) denote the negative lower and the positive upper limit, in which it is reasonable to rely on general market sentiments, i.e. to expect \( \rho \) to continue the past upward or downward trend since speculating against the market trend would result in losses. In formal terms, within the range \( \rho_l < \rho < \rho_u \) it holds that \( \partial \dot{\rho} / \partial \rho > 0 \). However, the closer \( \rho \) moves to the lower and the upper bounds, the more investors doubt \( \rho \) to be consistent with its long-run level \( \rho_E = 0 \); formally, slope \( \partial \dot{\rho} / \partial \rho > 0 \) is decreasing both in range \( 0 < \rho < \rho_u \) for increasing values in \( \rho \), and in range \( 0 > \rho > \rho_l \) for decreasing values in \( \rho \). At the corridor’s “corner points” \( \rho_l \) and \( \rho_u \), investors stop believing in a further decline or rise in \( \rho \) since the state of confidence has reached its minimum or maximum level which can be justified rationally; formally, at \( \rho = \rho_l \) and \( \rho = \rho_u \), it holds that \( \partial \dot{\rho} / \partial \rho = 0 \). In case the state of confidence exceeds \( \rho_u \), or falls short of \( \rho_l \), investors start to speculate against the past development of \( \rho \), since the actual level of \( \rho \) cannot be justified rationally any longer; formally, in ranges \( \rho > \rho_u \) and \( \rho < \rho_l \), it holds that \( \partial \dot{\rho} / \partial \rho < 0 \).

Figure 5.2 indicates that there arise three possible dynamic equilibria \( A, B \) and \( C \) from equation 5.10, where the rational expectations equilibrium \( \rho_E = 0 \) represented by point \( C \) is unstable, and the two outer “irrational” equilibria at points \( A \) and \( B \) are dynamically stable. Points \( A \) and \( B \) are denoted as “irrational” equilibria because settling down dynamically in \( A \) or \( B \) would mean a steady long-run under- or overestimation of profits outside the “realistic” corridor. Figure 5.2 highlights the fact that the dynamic system tends to instability in case rational investors follow general market sentiments, and to stability in case investors rely on the believe in a long-run rational expectations equilibrium \( \rho_E = 0 \) which however, results in an “irrational“ long-run steady state which is stable. As a result, since stylized facts indicate that there is no long-run irrationality of investors, the dynamics of other economic variables, as e.g. the foreign debt-asset ratio, have to guarantee either the existence of a dynamically stable rational expectations equilibrium, or stable cyclical motions around the unstable rational expectations equilibrium.

---

\(^{20}\) Though equation 5.10 and equation 4.16 in the industrial country model seem to be identical, there are two important differences. Firstly, in the industrial country model \( \sigma^* \) refers to the domestic real bond rate, and secondly, since industrial countries are mainly indebted in domestic currency, the financial structure in equation 4.16 is represented by the domestic debt-asset ratio \( \lambda \) neglecting exchange rate variations.
The Dynamic Behaviour of the Foreign Debt-Asset Ratio in Domestic Currency Terms. Since the domestic financial system is assumed to suffer from past financial repression, new investment is financed either by retained earnings or by taking new foreign loans $\dot{L}^*$. Accordingly, the financing condition for new investment reads as

$$PI = s_r r PK + \dot{L}^* s$$

where $s_r$ denotes the retention ratio. Dividing both sides by the numéraire $PK$ and using the fact that $1/(PK) = \lambda^*/L^*$, the financing condition can be transformed into

$$\eta(q) = s_r r + \frac{\dot{L}^*}{L^*} \lambda_d^*.$$ 

The financing condition contains no explicit financial constraint which could serve to describe how credit rationing, i.e. a binding constraint on $L^*$, leads to a drop in real investment spending. However, the financing condition comprehends an implicit form of credit rationing by the investment function $\eta(q)$. In case there is a drop in Tobin’s $q$, which is caused by deteriorating fundamentals or by a sudden decline in the state of confidence, both factors leading generally to a reduction in lending activity by financial institutions, investment spending and thereby an increase in indebtedness is going to be cut. To get a differential equation in $\lambda_d^*$, the growth rate of the foreign debt-asset ratio expressed in domestic currency, given formally as

$$\frac{\dot{\lambda}_d^*}{\lambda_d^*} = \frac{\dot{L}^*}{L^*} + \frac{s}{s} - \frac{\dot{P} - K}{P - K} = \frac{\dot{L}^*}{L^*} + \dot{s} - \dot{\rho} - \eta(q),$$
has to be solved for \( \lambda^*_d \), and combined with the modified nominal financing condition, resulting after some algebra in the second dynamic equation of the system, reading as

\[
\dot{\lambda}^*_d = \eta(q) (1 - \lambda^*_d) - s_r \rho + (\delta - \hat{\rho}) \lambda^*_d. \tag{5.11}
\]

Since the initial fixed exchange rate level has been defined as \( \delta = 1 \), equation 5.11 expresses \( \lambda^*_d \) and \( s \) on the basis of the initial value \( \delta = 1 \).\footnote{Note that since \( \delta = 1 \), it holds that equation 5.11 can be converted into \( \dot{\lambda}^*_d = \eta(q) (1 - \lambda^*) - s_r \rho + (\delta - \hat{\rho}) \lambda^* \).} Regarding equation 5.11, possible causes of an increase in foreign indebtedness for a given stock of \( \lambda^*_d \), are ceteris paribus an increase in the capital stock's growth rate \( \eta(q) \), drops in \( s_r \) and \( r \), and an increase in the real exchange rate \( \delta - \hat{\rho} \). The negative impact of an increase in \( \delta - \hat{\rho} \) on indebtedness in domestic currency captures both the effect of a domestic Fisherian debt deflation process, and the effect of a foreign "debt" deflation process by a devaluation of the home currency.

### 5.4.2 The Local Dynamics of the System

Equations 5.10 and 5.11 set up a nonlinear dynamic system in the two variables \( \lambda^*_d \) and \( \rho \) reading as

\[
\begin{align*}
\dot{\lambda}^*_d &= G_1(\lambda^*_d, \rho) = \eta(q) (1 - \lambda^*_d) - s_r \rho + (\delta - \hat{\rho}) \lambda^*_d \tag{5.12} \\
\dot{\rho} &= G_2(\lambda^*_d, \rho) = z(\rho, \sigma^*, \lambda^*_d). \tag{5.13}
\end{align*}
\]

For local stability analysis purposes, the nonlinear system is going to be linearized by a linear Taylor expansion around the local intertemporal equilibrium point \( \lambda^*_{dE}, \rho_E \) resulting in

\[
\begin{bmatrix} \dot{\lambda}^*_d \\ \dot{\rho} \end{bmatrix} = \begin{bmatrix} \frac{\partial G_1}{\partial \lambda^*_d} & \frac{\partial G_1}{\partial \rho} \\ \frac{\partial G_2}{\partial \lambda^*_d} & \frac{\partial G_2}{\partial \rho} \end{bmatrix} \begin{bmatrix} \lambda^*_d - \lambda^*_{dE} \\ \rho - \rho_E \end{bmatrix} = J_E \begin{bmatrix} \lambda^*_d - \lambda^*_{dE} \\ \rho - \rho_E \end{bmatrix},
\]

where \( J_E \) denotes the Jacobian matrix evaluated at the local dynamic equilibrium \( \lambda^*_{dE}, \rho_E \). In order to derive the local stability matrix properties of the system, the signs of the partial derivatives of the Jacobian matrix \( J_E \) have to be evaluated by making use of the comparative static results given explicitly in section 5.7. The derivative of function \( G_1 \) with respect to \( \lambda^*_d \) reads as

\[
\frac{\partial G_1}{\partial \lambda^*_d} = -\eta(q) + (\delta - \hat{\rho}) + (1 - \lambda^*_d) \frac{d\eta}{dq} \frac{\partial q}{\partial \lambda^*_d} + (-s_r) \frac{\partial r}{\partial \lambda^*_d} + (-\lambda^*_d) \frac{\partial \rho}{\partial \lambda^*_d} < 0,
\]

which is assumed as being negative because firstly, \( s_r \) and \( \partial \rho / \partial \lambda^*_d \) are relatively small in comparison with the other terms, and secondly, because in case the fixed exchange rate prevails it holds that \( \delta = 0 \).\footnote{The effects of a devaluation on the dynamic stability, and possible changes in the relevant functions are discussed in detail in section 5.4.5.} The derivative of function \( G_1 \) with respect to \( \rho \) is given by

\[
\frac{\partial G_1}{\partial \rho} = (1 - \lambda^*_d) \frac{d\eta}{dq} \frac{\partial q}{\partial \rho} + (-s_r) \frac{\partial r}{\partial \rho} + (-\lambda^*_d) \frac{\partial \rho}{\partial \rho} > 0,
\]
which is assumed as being positive, because $s_r$ and $\partial \hat{p}/\partial \rho$ are relatively small in comparison to the other terms being positive. The derivative of function $G_2$ with respect to $\lambda_d^*$ is formally given by

$$\frac{\partial G_2}{\partial \lambda_d^*} = \frac{\partial z}{\partial \lambda_d^*} + \frac{\partial z}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \lambda_d^*} < 0,$$

which is unequivocally negative, and for which it holds that

$$\frac{\partial \sigma^*}{\partial \lambda_d^*} = \frac{\partial r}{\partial \lambda_d^*} + \frac{\partial \sigma^*}{\partial \hat{p}} \frac{\partial \hat{p}}{\partial \lambda_d^*} < 0.\text{23}$$

The derivative of $G_2$ with respect to $\rho$ reads as

$$\frac{\partial G_2}{\partial \rho} = \frac{\partial z}{\partial \rho} + \frac{\partial z}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \rho} \equiv 0,$$

where

$$\frac{\partial z}{\partial \rho} < 0, \quad \frac{\partial \sigma^*}{\partial \rho} = \frac{\partial r}{\partial \rho} + \frac{\partial \sigma^*}{\partial \beta} \frac{\partial \beta}{\partial \rho} + \frac{\partial \hat{p}}{\partial \rho} > 0 \quad \text{and} \quad \frac{\partial z}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \rho} > 0,$$

leading to an equivocal sign of the partial derivative $\partial G_2/\partial \rho$. The sign of $\partial G_2/\partial \rho$ depends on the derivative of function $z$ with respect to $\rho$, i.e. on the actual level of the actual state of confidence $\rho$ and its position relative to the “normal” range $\rho_l < \rho < \rho_u$. Consequently, the signs of the Jacobian matrix for all relevant subcases as to local dynamic stability can be summarized as

$$J = \begin{bmatrix} \frac{\partial G_2}{\partial \lambda_d^*} & \frac{\partial G_2}{\partial \rho} \\ \frac{\partial G_2}{\partial \lambda_d^*} & \frac{\partial G_2}{\partial \rho} \end{bmatrix} = \begin{bmatrix} - & + \\ - & 0, + \end{bmatrix},$$

where local dynamic stability or instability of a fixed point is determined by investors’ behaviour as to further changes in $\rho$, depending on the current position of $\rho$ relative to the “normal” corridor $\rho_l < \rho < \rho_u$, i.e. by the signs of derivatives $\partial z/\partial \rho$ and $\partial G_2/\partial \rho$.

Regarding the local stability of fixed points, there arise three relevant and possible cases as in the financial crisis model for industrial countries. Case 1 refers to the situation when the state of confidence at the fixed point $\rho_E$ is around the two corner points $\rho_l$ and $\rho_u$, i.e. when investors stop to rely on general market sentiments, or when $\rho_E$ is generally outside the normal range $\rho_l < \rho < \rho_u$, i.e. when investors assess the actual value of $\rho$ as being irrationally exaggerated or understated. In these cases, it holds that

$$\frac{\partial z}{\partial \rho} \leq 0, \quad \text{or} \quad \frac{\partial z}{\partial \rho} > 0 \quad \text{but very small},$$

causing $\partial G_2/\partial \rho$ to exhibit a negative, zero or slightly positive sign since

$$\frac{\partial G_2}{\partial \rho} = \frac{\partial z}{\partial \rho} + \frac{\partial z}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \rho},$$

23Note that functions $r = r(\lambda^*)$ and $\hat{p} = \hat{p}(\lambda^*)$ can be simply transformed into $r = r(\lambda_d^*/s)$ and $\hat{p} = \hat{p}(\lambda_d^*/s)$; for a given fixed exchange rate $\bar{s} = 1$ it holds that $r(\lambda^*) = r(\lambda_d^*)$ and $\hat{p}(\lambda^*) = \hat{p}(\lambda_d^*)$.\footnoteref{Note}}
and accordingly,
\[ \frac{\partial G_2}{\partial \rho} \leq 0, \quad \text{or} \quad \frac{\partial G_2}{\partial \rho} > 0 \quad \text{but very small.} \]

Respecting local dynamic stability properties being evaluated by the trace and the determinant of the Jacobian matrix, a local fixed point being characterized by the conditions of case 1 exhibits local asymptotic stability, i.e. the fixed points is either a stable node or a stable focus since the trace's sign is negative and the determinant's sign positive, formally it holds that
\[ \text{tr } J_E = \frac{\partial G_1}{\partial \lambda_d^*} + \frac{\partial G_2}{\partial \rho} < 0, \]
and
\[ |J_E| = \frac{\partial G_1}{\partial \lambda_d^*} \frac{\partial G_2}{\partial \rho} - \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda_d^*} > 0. \]

Case 2 refers to the situation when the state of confidence at the fixed point \( \rho_E \) is located around the rational expectations equilibrium \( \rho_E = 0 \), i.e. when investors largely rely on general market sentiments. This case however, has to be distinguished by investors' sensitivity as to changes in \( \rho \) because it can be assumed that investors either react hypersensibly, i.e. \( \frac{\partial z}{\partial \rho} \gg 0 \), or "normally" around the rational expectations equilibrium \( \rho_E \), i.e. \( \frac{\partial z}{\partial \rho} > 0 \). Case 2 refers to a situation in which investors are assumed to react hypersensitively, i.e. it holds that
\[ \frac{\partial z}{\partial \rho} \gg 0, \]
leading to a largely positive sign of \( \frac{\partial G_2}{\partial \rho} \), formally given by
\[ \frac{\partial G_2}{\partial \rho} = \frac{\partial z}{\partial \rho} + \frac{\partial z}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \rho} \gg 0. \]

Regarding local dynamic stability, such a fixed point exhibits the characteristics of a saddle point, i.e. the fixed point is locally unstable since the sign of the Jacobian's trace is largely positive and the sign of the Jacobian's determinant is negative, which are both formally given as
\[ \text{tr } J_E = \frac{\partial G_1}{\partial \lambda_d^*} + \frac{\partial G_2}{\partial \rho} \gg 0, \]
and
\[ |J_E| = \frac{\partial G_1}{\partial \lambda_d^*} \frac{\partial G_2}{\partial \rho} - \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda_d^*} < 0. \]

Case 3 refers to the same situation as case 2, however, investors are assumed as reacting "normally" near the rational expectations equilibrium \( \rho_E = 0 \). In this case, it holds that
\[ \frac{\partial z}{\partial \rho} > 0, \]
leading to a positive sign of \( \frac{\partial G_2}{\partial \rho} \), but being smaller than the positive sign of \( \frac{\partial G_2}{\partial \rho} \) in case 2; formally,

\[
\frac{\partial G_2}{\partial \rho} = \frac{\partial z}{\partial \rho} + \frac{\partial z}{\partial \sigma^*} \frac{\partial \sigma^*}{\partial \rho} > 0.
\]

With respect to dynamic stability properties, such a fixed point is dynamically unstable, i.e. it exhibits either characteristics of an unstable node or of an unstable focus, since both the trace and the determinant of the Jacobian have a positive sign. The Jacobian's trace is given by

\[
\text{tr } J_E = \frac{\partial G_1}{\partial \lambda^*_d} + \frac{\partial G_2}{\partial \rho} > 0,
\]

exhibiting a positive sign, since condition \( |\frac{\partial G_1}{\partial \lambda^*_d}| < |\frac{\partial G_2}{\partial \rho}| \) is fulfilled which is consistent with the assumptions under case 1 and 2. The sign of the Jacobian's determinant given by

\[
|J_E| = \frac{\partial G_1}{\partial \lambda^*_d} \frac{\partial G_2}{\partial \rho} - \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda^*_d} > 0,
\]

can be only assumed to be positive in case it holds that

\[
\left| \frac{\partial G_1}{\partial \lambda^*_d} \frac{\partial G_2}{\partial \rho} \right| < \left| \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda^*_d} \right|,
\]

which is going to be proved in the ensuing phase diagram analysis.

### 5.4.3 Phase Diagram Analysis

Demarcation curve \( \lambda^*_d = G_1(\lambda^*_a, \rho) = 0 \) has a positive slope over the entire range in the \((\lambda^*_a, \rho)\) space since it holds that

\[
\left( \frac{d \lambda^*_d}{d \rho} \right)_{G_1} = -\frac{\partial G_1}{\partial \rho} > 0.
\]  \(5.14\)

The course of demarcation curve \( \rho = G_2(\lambda^*_a, \rho) = 0 \) is mainly influenced by the course of the function \( \rho = z(\rho, \sigma^*, \lambda^*_a) \) being depicted in figure 5.2. Formally, the slope of demarcation curve \( \rho = G_2(\lambda^*_d, \rho) = 0 \), being denoted as \( (d \lambda^*_d / d \rho)_{G_2} \), is given by

\[
\left( \frac{d \lambda^*_d}{d \rho} \right)_{G_2} = -\frac{-\frac{\partial G_2}{\partial \rho}}{\frac{\partial G_2}{\partial \lambda^*_d}} > 0,
\]  \(5.15\)

whose sign depends on derivative \( \partial G_2 / \partial \rho \) being predominantly determined by derivative \( \partial z / \partial \rho \). Formally, in case \( \partial z / \partial \rho < 0 \) for which it holds that \( |\partial z / \partial \rho| > |(\partial z / \partial \sigma^*) \partial \sigma^*/ \partial \rho)\), derivative \( \partial G_2 / \partial \rho \) becomes negative, i.e. \( \partial G_2 / \partial \rho < 0 \), leading to a negative slope of the demarcation curve \( \rho = 0 \), i.e. \( (\partial \lambda^*_d / \partial \rho)_{G_2} < 0 \). In case derivative \( \partial z / \partial \rho \) takes a value of \( \partial z / \partial \rho = (-\partial z / \partial \sigma^*) \partial \sigma^*/ \partial \rho \), derivative \( \partial G_2 / \partial \rho \) becomes zero, i.e. \( \partial G_2 / \partial \rho = 0 \), leading...
to a zero slope of demarcation curve $\dot{\rho} = 0$, i.e. to $(\partial \lambda_d^* / \partial \rho)_{C_2} = 0$. In case derivative $\partial z/\partial \rho$ takes negative values for which it holds $|\partial z/\partial \rho| < (\partial z/\partial \sigma^*) (\partial \sigma^*/\partial \rho)$, a zero value, or positive values, the sign of derivative $\partial G_2/\partial \rho$ becomes positive, i.e. $\partial G_2/\partial \rho > 0$, leading to a positive slope of demarcation curve $\dot{\rho} = 0$, i.e. $(\partial \lambda_d^* / \partial \rho)_{C_2} > 0$. Though the turning points of demarcation curve $\dot{\rho} = 0$, for which it holds that $(\partial \lambda_d^* / \partial \rho)_{C_2} = 0$, do not correspond exactly to the boundary points of the normal range $\rho_l$ and $\rho_u$, the course of demarcation curve $\dot{\rho} = 0$ can be equivalently described as the course of function $\dot{\rho} = z(\rho, \sigma^*, \lambda_d^*)$. Consequently, demarcation curve $\dot{\rho} = G_2(\sigma^*, \lambda_d^*) = 0$ is going to exhibit a positive slope for values of $\rho$ lying around the normal range, becoming less and shrinking to zero if $\rho$ reaches the area of the corner points $\rho_l$ and $\rho_u$, and becoming negative if $\rho$ lies in the area outside the normal range.

Since the local stability analysis has distinguished between the two cases, investors reacting hypersensibly in the "normal" range of $\rho$ (case 2), i.e. $\partial z/\partial \rho \gg 0$, and investors reacting "normally" in the "normal" range (case 3), i.e. $\partial z/\partial \rho > 0$, there arise also two possible kinds of demarcation curves $\dot{\rho} = 0$, differing with respect to the positive steepness of their slope near the "normal" range of $\rho$. In case investors react hypersensibly, the positive slope around the corridor $\rho_l < \rho < \rho_u$ is steeper than in case investors react "normally". These two different cases are illustrated in figure 5.3, where the dotted demarcation curve $\dot{\rho} = 0$ represents the case of hypersensitive investors in the "normal" range, and the solid demarcation curve the case of normally reacting investors in the "normal" range. It has to be noted that the distinction between normally and hypersensitively reacting investors does not apply to the area outside the normal range, since there is no influence on the local and global dynamics of the system. Consequently, the parts with negative slope of the dotted demarcation curve in figure 4.3 could alternatively run flatter than the negatively sloped parts of the solid demarcation curve without changing the local and global dynamics of the system.

The explicit consideration of different degrees of investors' sensitivity measured by different values of $\partial z/\partial \rho$ is necessary from a formal point of view, since different values of $\partial z/\partial \rho$ decide whether the dynamic system exhibits multiple dynamic equilibria, or a single dynamic equilibrium point. Regarding the case when investors react very sensitively as to changes in $\rho$ in the normal range, there arise three fixed points being depicted in figure 5.4. Points $A$ and $C$ are locally asymptotically stable since demarcation curve $\dot{\rho} = 0$ is negatively locally sloped because $\partial z/\partial \rho < 0$ and $\partial G_2/\partial \rho < 0$, whereas demarcation curve $\dot{\lambda}_d^* = 0$ is positively locally sloped, i.e. it holds that

$$
\begin{align*}
(\partial \lambda_d^* / \partial \rho)_{G_1} &< (\partial \lambda_d^* / \partial \rho)_{G_2} \\
-\frac{\partial G_1}{\partial \rho} &> -\frac{\partial G_2}{\partial \lambda_d^*}
\end{align*}
$$

which after rearranging can be transformed into the determinant of the Jacobian at the fixed points $A$ and $C$, being denoted as $|J|_{(A,C)}$, having a positive sign since

$$
|J|_{(A,C)} = \frac{\partial G_1}{\partial \lambda_d^*} \frac{\partial G_2}{\partial \rho} - \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda_d^*} > 0.
$$
Figure 5.3: Different Demarcation Curves for $\dot{\rho} = 0$ Depending on Investors’ Sensitivity as to Changes in $\rho$

The Jacobian’s trace at $A$ and $C$, being denoted as $tr J_{(A,C)}$, has got a negative sign because

$$tr J_{(A,C)} = \frac{\partial G_1}{\partial \lambda^*_d} + \frac{\partial F_2}{\partial \rho} < 0,$$

classifying points $A$ and $C$ according to case 1 of the local stability analysis as locally stable fixed points.

Fixed point $B$ exhibits the characteristics of a saddle point since both demarcation curves have a positive slope, where demarcation curve $\dot{\rho} = 0$, being subject to $\partial z / \partial \rho \gg 0$ and $\partial G_2 / \partial \rho \gg 0$, is steeper than demarcation curve $\dot{\lambda}_d^* = 0$ at point $B$, formally

$$\left( \frac{\partial \lambda_d^*}{\partial \rho} \right)_{G_1} < \left( \frac{\partial \lambda_d^*}{\partial \rho} \right)_{G_2},$$

$$\frac{\partial G_1}{\partial \lambda_d^*} < -\frac{\partial G_2}{\partial \lambda_d^*},$$

which after rearranging terms yields the Jacobian’s determinant at fixed point $B$, being denoted as $|J|_{(B)}$, whose sign is negative since

$$|J|_{(B)} = \frac{\partial G_1}{\partial \lambda_d^*} \frac{\partial G_2}{\partial \rho} - \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda_d^*} < 0.$$
Figure 5.4: Phase Diagram in Case of Hypersensitively Reacting Investors within the Normal Range of $p$

The Jacobian's trace at $B$, being denoted as $\text{tr} \mathbf{J}_{(B)}$, has a positive sign according to

$$\text{tr} \mathbf{J}_{(B)} = \frac{\partial G_1}{\partial \lambda_d^*} + \frac{\partial G_2}{\partial \rho} > 0,$$

classifying fixed point $B$ as a saddle point according to case 2 of the local stability analysis.

As in the industrial country model, the case of long-run dynamics under hypersensitively reacting investors has no empirical relevance since coming to a long-run halt in points $A$ or $C$ would mean a steady under- or overestimation of profits since $\rho_E \neq 0$ in $A$ and $C$, being located near the boundary points of the normal range of $\rho$. Furthermore, the dynamics of the economy would be subject to path dependent behaviour since reaching point $A$ or $C$ would be solely dependent on the initial starting point of the economy which can be located everywhere in the $(\lambda_d^*, \rho)$ space. Imposing stability by assuming that rational investors can generally jump to the stable arm of the saddle point trajectories, and thereby moving smoothly into point $B$ is not possible since $\rho$ does not exhibit the characteristics of a pure forward looking or jump variable, firstly due to its dependence on the backward looking variables $\sigma^*$ and $\lambda_d^*$, and secondly due to the absence of (short-run) rational expectations.
Though there is no internal mechanism which guarantees a jump of \( \rho \) on the stable branches of the saddle point equilibrium, it is important to note that "jumps" in \( \rho \) are generally possible in case of direct exogenous shocks, solely having an influence on the state of confidence to \( \rho \). As opposed to direct shocks to \( \rho \), both direct exogenous shocks to economic fundamentals \( \lambda_d^* \) and \( \sigma^* \), and indirect shocks to \( \lambda_d^* \) and \( \sigma^* \) via exogenous shocks to other variables influencing \( \lambda_d^* \) and \( \sigma^* \), do not cause a jump in \( \rho \). A very prominent example of a direct exogenous shock to \( \rho \) in emerging market countries, leaving economic fundamentals \( \lambda_d^* \) and \( \sigma^* \) unchanged at the moment of the shock, is the introduction of a "new growth regime" including liberalization of goods and financial markets and stabilization of output and inflation via orthodox stabilization programmes. A direct exogenous shock to \( \rho \) causes a discontinuous jump in the \( \rho \)-coordinate within the \((\lambda_d^*, \rho)\)-space, but leaves both demarcation curves and the vector field unchanged, giving rise to a new dynamic process initiated by a new initial condition. By way of contrast, a direct exogenous shock to \( \sigma^* \), or any shock to variables influencing \( \sigma^* \), leave the current position within the \((\lambda_d^*, \rho)\)-space unchanged, whereas both demarcation curves and the vector field are subject to changes. An exogenous shock to the foreign-debt asset ratio \( \lambda_d^* \) caused by a change in the exchange rate's growth rate \( \dot{s} \), leads both to a jump in the \( \lambda_d^* \)-coordinate, and to a change of both demarcation curves, as well as to a change in the vector field. By way of contrast, a change in \( \lambda_d^* \) caused by an exogenous shock in \( \lambda^* \), causes, as a direct shock to \( \rho \), only a jump in \( \lambda_d^* \), but leaves both demarcation curves and the vector field unchanged.\(^{24}\)

In spite of the existence of jumps in \( \rho \), there is no mechanism guaranteeing, as in rational expectations model, a jump on the stable branch of saddle point equilibrium \( B \). Thus, the dynamic system is likely to settle down in stable fixed points \( A \) and \( C \). Yet, coming to a long-run halt in points \( A \) and \( C \), being characterized by long-run expectation errors, is an unrealistic scenario both from an empirical perspective and from a theoretical perspective, since it is not consistent with the assumption of long-run rational behaviour. Consequently, it seems plausible that in case investors, coming to a halt in points \( A \) or \( C \), are going to adjust their profit expectations subsequently after having realized that current expectations cannot be fulfilled, leading to a readjustment of function \( \dot{\rho} = z(\rho, \sigma^*, \lambda_d^*) \), and thereby to a shift of the demarcation curve \( \rho = 0 \) until in the long-run profit expectations are fulfilled by the actual development of profits. Accordingly, to get an empirically meaningful result, it seems reasonable to assume firstly, that the state of confidence's long-run steady state value settles down in the rational expectations equilibrium \( \rho_E = 0 \) since every long-run divergence \( r^c \neq r \) leads to a readjustment of functions \( \dot{\rho} = z(\rho, \sigma^*, \lambda_d^*) \) and \( \rho = 0 \), and secondly, that there exists only a single intertemporal equilibrium point \((\lambda_{dE}^*, \rho_E)\), where \( \rho_E = 0 \) and \( \lambda_{dE}^* > 0 \) since demarcation curve \( \dot{\lambda} = 0 \) is a strictly monotone increasing function in the \((\lambda_d^*, \rho)\)-space. However, imposing these assumptions requires to assume investors to behave "normally" in the "normal" range of \( \rho \), i.e. \( \partial z / \partial \rho > 0 \), leading to a less steeper demarcation curve \( \dot{\rho} = 0 \), as having been represented by the solid

\(^{24}\)These results were drawn from analyzing the impacts of various forms of exogenous shocks on both demarcation curves, and on the integral curves of system 5.12 and 5.13, given by

\[
\frac{d\lambda_d^*}{d\rho} = \frac{G_1(\lambda_d^*, \rho)}{G_2(\lambda_d^*, \rho)} = \frac{\eta(q) (1 - \lambda_d^*) - s_r r + (\dot{s} - \dot{p}) \lambda_d^*}{z(\rho, \sigma^*, \lambda_d^*)},
\]

and derived from system 5.12 and 5.13 by the elimination of \( dt \).
line in figure 5.3, in order to get only one intersection of the two demarcation curves being depicted in figure 5.5.

Figure 5.5: Phase Diagram for “Normally” Reacting Investors Within the Normal Range of ρ.

Regarding the dynamics when investors behave normally in the normal range for ρ in figure 5.5, there arise two important properties. Firstly, the local fixed point D is locally unstable (unstable node or unstable focus) since both demarcation curves have a positive slope, where demarcation curve $\dot{\lambda}_d = 0$ is steeper than demarcation curve $\dot{\rho} = 0$ because $\frac{\partial z}{\partial \rho} > 0$ and $\frac{\partial G_2}{\partial \rho} > 0$, formally given by

$$\left( \frac{\partial \lambda_d^*}{\partial \rho} \right)_1 > \left( \frac{\partial \lambda_d^*}{\partial \rho} \right)_2,$$

$$-\frac{\partial G_1}{\partial \lambda_d^*} > -\frac{\partial G_2}{\partial \lambda_d^*},$$

which, after rearranging terms, can be transformed into the determinant of the Jacobian at the local equilibrium D which is denoted as $|J|(D)$, having a positive sign since

$$|J|(D) = \frac{\partial G_1}{\partial \lambda_d^*} \frac{\partial G_2}{\partial \rho} - \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda_d^*} > 0.$$
The Jacobian’s trace at point $D$, being denoted as $\text{tr}J(D)$, has a positive sign because

$$\text{tr}J(D) = \frac{\partial G_1}{\partial \lambda_d} + \frac{\partial G_2}{\partial \rho} > 0,$$

classifying fixed point $D$ according to case 3 of the local stability analysis as an unstable fixed point. The second property of the dynamic system under normally reacting investors is the fact that the system exhibits cyclical motions in a counterclockwise direction. Accordingly, a first ad-hoc interpretation would suggest that this result cannot be empirically meaningful since the dynamic system is going to explode. However, as the following section is going to outline, the global dynamics exhibit some form of bounded cyclical fluctuations leading to a cyclically stable dynamic system.

### 5.4.4 The Global Dynamics of the System

**The Emergence of a Globally Stable Closed Orbit.** As in the financial crisis model for industrial countries, it can be shown that the dynamic system in figure 5.5 contains at least one closed orbit which is an attractor, i.e. a limit cycle, by applying the Poincaré-Bendixson theorem. One prerequisite for the emergence of a limit cycle is the existence of a compact set $\mathcal{D}$ from which trajectories once having entered cannot escape. However, constructing a compact set requires some definitions as to the global boundedness of variables $\lambda_d^*$ and $\rho$. Regarding $\lambda_d^*$, values $\lambda_d^* < 0$ are not possible since in this case the firm sector would possess claims on the banking sector, making $\lambda_d^* = 0$ a reasonable lower bound. Realistic values for $\lambda_d^*$ move inside the range $0 < \lambda_d^* < 1$, whereas when dealing with systemic financial crises values $\lambda_d^* > 1$ have also to be considered as possible scenarios, indicating that the entire firm sector is bankrupt, which is however a very rare case. Though considering values $\lambda_d^* > 1$, it seems reasonable that there exists an upper bound for the foreign-debt asset ratio, since in case all borrowers are bankrupt international negotiations regarding debt restructuring, debt relief, etc., will follow. Accordingly, there exists a lower bound $\lambda_d^* = 0$ and an upper bound $\lambda_d^* > 1$. Considering the state of confidence, $\rho$ is allowed to take values largely outside the normal range $p_l < \rho < p_u$, but $\rho$ is also considered as not being able to take infinite positive or negative values. As a result, $\rho$ can also be viewed as a variable with a negative lower and a positive upper bound.

Taking into consideration the upper and lower bounds of $\lambda_d^*$ and $\rho$, figure 5.5 can be modified by adding an invariant set which is represented by the simply connected set $\mathcal{D}$ in figure 5.6 as rectangle $OPQR$. Regarding the trajectories on the boundaries of set $\mathcal{D}$, there arise situations in which trajectories may hit the boundaries, making it necessary to modify them in a natural way according to the assumptions made on the boundary values of $\lambda_d^*$ and $\rho$ in order to guarantee that trajectories once having entered the set cannot leave the set any more.

The second condition for applying the Poincaré-Bendixson theorem requires that the fixed point has to be dynamically unstable. Since figure 5.6 contains only one unstable fixed point $D$, the global dynamics contain at least one closed orbit which is an attractor, i.e. the system possess at least one limit cycle to which all trajectories converge as

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25 For details see section 4.4.4.
Figure 5.6: The Existence of a Limit Cycle

$t \to \infty$, being represented by the solid circle in figure 5.6. Each trajectory starting within the compact set $\mathcal{D}$, being indicated by the two sample trajectories starting in points $E$ and $F$, or starting outside set $\mathcal{D}$ but after some time entering the set $\mathcal{D}$, converges to the limit cycle by either spiraling inward (trajectory starting in $E$) or spiraling outward (trajectory starting in $F$). There is no possibility for the emergence of separatrices being an alternative form of limit sets due to the absence of at least one further fixed point being characterized by saddle point properties.

The Emergence of a Supercritical Hopf Bifurcation. As the Poincaré-Bendixon theorem only provides sufficient conditions for the existence of at least one limit cycle, the dynamics described by equations 5.12 and 5.13 being represented in figure 5.6 could engender multiple closed orbits, with the inner- and the outermost orbits being stable, and the remaining closed orbits alternating between stability and instability with increasing amplitude. As to the emergence of endogenous financial fragility and financial crises, the existence of multiple limit cycles would suggest that there exist “small” limit cycles near the fixed point $D$ where no severe disruptions in financial markets occur next to “large” limit cycles causing a financial crisis on each business cycle whose duration is much longer than those of “small” limit cycles. Accordingly, the question of whether the economy converges to a virtuous or to a vicious cycle depends on the initial condition in
the $(\lambda^*_d, \rho)$-space, being influenced predominantly by exogenous shocks. This view on long-run dynamics would justify permanent market interventions by a social planner in order to guarantee a long-run “virtuous” cyclical behaviour with low business cycle amplitudes and financial stability. In case of an adverse exogenous shock, the social planner would have to catapult the system back by choosing of a favourable initial condition to the basins of attraction of the limit cycle with the lowest amplitude near the unstable fixed point. However, since both the foreign-debt asset ratio $\lambda^*_d$, and the state of confidence $\rho$ show backward looking characteristics, an instantaneous jump induced by the social planner to the most favourable initial condition is almost impossible.

It must be noted however, that the foreign debt-asset ratio $\lambda^*_d$ can be “steered” by a social planner to a certain degree, i.e. to move within a well-defined range, by strict financial market regulation in order to prevent the foreign-debt asset ratio from “tipping” into the basins of attraction of a business cycle giving rise to financial crises. Furthermore, the foreign-debt asset ratio can be subject to social planner induced jumps in case of negotiations regarding debt relief and debt restructuring. Yet, in most cases negotiations on debt relief or restructuring only take place when the economy has already experienced a systemic financial crises followed by a deep depression. As a result, even if there exists the possibility of social planner-induced jumps in $\lambda^*_d$, there is no possibility to prevent negative repercussions by social planner-induced instantaneous jumps in order to neutralize adverse exogenous shocks. The only possibility to protect the economy against negative exogenous shocks to the foreign debt-asset ratio is to impose strict financial market regulation minimizing negative impacts, e.g. by imposing a debt ceiling on foreign debt, so that possible devaluations do not lead to widespread illiquidity and insolvency.

Summing up, the existence of multiple limit cycles implies firstly, that capitalist systems are inherently unstable, secondly, that long-run financial stability or instability is determined by random shocks, thirdly, that in case the economy is subject to business cycles with high amplitudes, each long-run business cycle generates a systemic financial crisis, and fourthly, that in case the economy has converged to a long-run excessive boom-bust cycle, a business cycle with modest amplitudes can be only reached by exogenous events as e.g. debt relief or debt restructuring programmes.

Reality however shows firstly, that capitalist systems tend to be stable in the long-run, secondly, that financial fragility is not a purely exogenous phenomenon, thirdly, that not each business cycle is subject to a excessive boom-bust cycle including financial crises, and fourthly, that economies having been hit by financial crises in lots of cases tend to converge back endogenously to a financially stable equilibrium situation though recovery periods can be very long. As a result, the emergence of multiple limit cycles, some subject to ever lasting financial stability, and some subject to recurrent financial crises which can be both only left by random exogenous events, is a very unrealistic scenario. As a result, to provide empirically meaningful results, the dynamics of equations 5.12 and 5.13 should engender an “equilibrium” business cycle, i.e. a single limit cycle, on which no systemic financial crisis can occur, and on which economies operate during “tranquil” times. The emergence of extraordinary financial fragility in comparison with tranquil times, as well as the occurrence of financial crises on the upper turning point can be explained by a large external shock, like e.g. a technology or liberalization shock, catapulting the economy from its position on the “equilibrium” cycle outside the limit cycle, implying a convergence.
process back to the “equilibrium” cycle with a much larger amplitude including financial fragility and perhaps a financial crisis.

The existence of a single limit cycle can be proved by applying the existence and the stability part of the Hopf bifurcation theorem having been outlined in section 4.4.4. Since the stability of the fixed point, and thereby the dynamic properties of the system depend on investors’ feedback sensitivity regarding the state of confidence, derivative $\partial z/\partial \rho = \partial \rho/\partial \rho = \mu$ is used as the relevant parameter $\mu$ in order to study the nature of bifurcation when $\mu$ is varied.

The existence part of the Hopf bifurcation theorem states that in case the parameter $\mu$ is increased from $\mu < \mu_0$ to $\mu > \mu_0$, where $\mu = \mu_0$ denotes the critical value when the characteristic roots become pure imaginary, the fixed point changes its stability properties from being locally stable into being locally unstable, as the real parts of the characteristic roots $Re \theta (\mu)$ change their sign from being negative for $\mu < \mu_0$ to being positive for $\mu > \mu_0$. Accordingly, the first step to show the reversal of signs of the real parts of the characteristic roots is the emergence of pure imaginary roots at the critical parameter value $\mu = \mu_0$ according to condition $H.1^{26}$ of the Hopf bifurcation existence theorem. The characteristic equation of the nonlinear dynamic system 5.12 and 5.13 reads as

$$\theta^2 + \left( \frac{\partial G_1}{\partial \lambda^*_d} - \frac{\partial G_2}{\partial \rho} \right) \theta + \left( \frac{\partial G_1}{\partial \lambda^*_d} \frac{\partial G_2}{\partial \rho} - \frac{\partial G_1}{\partial \rho} \frac{\partial G_2}{\partial \lambda^*_d} \right) = 0,$$

defining the characteristic roots as

$$\theta_{1,2} = \frac{-a_1 \pm \sqrt{4a_2 - a_1^2}}{2} i.$$

In order to get a pair of pure imaginary roots two conditions have to be fulfilled. Firstly, the determinant of the Jacobian $|J|$ has to be positive, i.e. it must hold that

$$a_2 > 0.$$

Secondly, the trace of the Jacobian $tr J = -a_1$ has to vanish, causing the real part $Re \theta$ to become zero, i.e.

$$Re \theta = \frac{-a_1}{2} = 0,$$

implying $a_1 = 0$.

The first condition $a_2 > 0$ is fulfilled, since both demarcation curves in figure 5.6 have a positive slope, the $\lambda^*_d = 0$ demarcation curve being steeper than the $\dot{\rho} = 0$ demarcation curve, resulting in a positive sign of the Jacobian’s determinant. Generally, condition $a_2 > 0$ is fulfilled for values $\mu = \partial z/\partial \rho \leq 0$ and for $\mu = \partial z/\partial \rho > 0$ (see cases 1 and 3 of the local stability analysis), but not for values $\mu = \partial z/\partial \rho \gg 0$ (see case 2 of the local stability analysis). As a result, condition $a_2 > 0$ holds for all possible values of function 5.13 when investors are assumed as behaving “normally” in the normal range.

The second condition $a_1 = 0$ determines the Hopf bifurcation point $\mu = \mu_0$ when the real parts of the characteristic roots become zero and closed orbits emerge. Since

\[\text{References}\]

\[\text{References}\]

\[\text{References}\]

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26 See section 4.4.4.
∂G_2/∂ρ = ∂z/∂ρ + (∂z/∂σ^*)(∂σ^*/∂ρ), condition a_1 = 0 can be transformed into

\[-\frac{∂G_1}{∂λ_d} - \left(\frac{∂z}{∂ρ} + \frac{∂z}{∂σ^*} \frac{∂σ^*}{∂ρ}\right) = 0,\]

and solved for ∂z/∂ρ determining the critical value μ_0 = (∂z/∂ρ)_0 as

μ_0 = \left(\frac{∂z}{∂ρ}\right)_0 = \frac{∂G_1}{∂λ_d} - \frac{∂z}{∂σ^*} \frac{∂σ^*}{∂ρ}.

In order to determine the sign of the real parts of the characteristic roots for values μ > μ_0 and μ < μ_0, it can be shown that

\[Re \theta = \frac{-a_1}{2} \leq 0\]

implies

a_1 \leq 0

and

\[-\frac{∂G_1}{∂λ_d} - \frac{∂z}{∂σ^*} \frac{∂σ^*}{∂ρ} \leq \frac{∂z}{∂ρ},\]

leading to

μ_0 \leq μ.

Summarizing the results leads to the conclusion that

\[Re \theta \leq 0 \iff a_1 \leq 0 \iff μ \leq μ_0,\]

stating that in case μ < μ_0 there arise no closed orbits and the real parts are negative implying local stability of the fixed point. In case μ > μ_0, there exist closed orbits and the real parts become positive implying local instability of the fixed point. For μ = μ_0, the real parts vanish implying the existence of a pair of pure imaginary roots θ = ±√(a_2i), leading to the emergence of closed orbits.

Considering the second part H.2 of the Hopf bifurcation existence theorem, it holds that

\[\left.\frac{d Re θ(μ)}{d μ}\right|_{μ=μ_0} = \frac{d(-\frac{1}{2} a_1)}{d \left(\frac{∂z}{∂ρ}\right)} \right|_{μ=μ_0} = -\frac{1}{2} \left(\frac{∂G_1}{∂λ} - \left(\frac{∂z}{∂ρ} + \frac{∂z}{∂σ^*} \frac{∂σ^*}{∂ρ}\right)\right) = \frac{1}{2} > 0,\]

stating that condition H.2 is fulfilled, and implying that there exist closed orbits according to the Hopf bifurcation existence theorem.

Regarding stability properties of the closed orbits emerging from variations in μ, it can be shown that the present case illustrated in figure 5.6 is subject to a supercritical Hopf bifurcation, being characterized firstly, by the absence of closed orbits and local stability of the fixed point in case μ < μ_0, and secondly, by the emergence of closed orbits.

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27 See section 4.4.4.
28 For details, see 4.4.4.
being attractors, i.e. limit cycles, and local instability of the fixed point in case $\mu > \mu_0$. Though stability properties of local bifurcations generally can only be investigated by the use of normal forms, there are special cases in which general forms of demarcation curves, being described by parameterized functions and their relative position to other demarcation curves, can be used for analyzing the emergence of supercritical or subcritical Hopf bifurcations. It can be shown for example, that a supercritical Hopf bifurcation in $\mathbb{R}^2$, here in an $(x_1, x_2)$ space, emerges if firstly, one of the demarcation curves, here $\dot{x}_1 = 0$, takes the form of a cubic polynomial of type

$$x_2(x_1) = -b_0 x_1^3 + b_1 x_1^2 \pm b_2 x_1 \pm b_3 \quad \text{where} \quad b_1 > 0,$$

and parameter $b_1$ is chosen sufficiently small, and secondly, if the second demarcation curve, here $\dot{x}_2 = 0$, is steeper at the fixed point than demarcation curve $\dot{x}_1 = 0$ engendering only one fixed point.\(^{29}\) Applying these conditions to the present case illustrated in figure 5.6, it can be seen that the $\dot{\rho} = 0$ demarcation curve can be described by a cubic polynomial of type

$$\lambda(\rho) = -b_0 \rho^3 + b_1 \rho^2 - b_2 \rho + b_3 \quad \text{where} \quad b_1 > 0,$$

and that demarcation curve $\dot{\lambda} = 0$ is steeper at the fixed point $D$ than the non-linear demarcation curve $\dot{\rho} = 0$.\(^{30}\) Accordingly, the Hopf bifurcation emerging from the dynamic system 5.12 and 5.13 is supercritical, implying that for each parameter value $\mu > \mu_0$ there exists only one closed orbit around the unstable fixed point which is an attractor, i.e. for each $\mu > \mu_0$ there exists only one limit cycle to which all trajectories converge for $t \rightarrow \infty$, being illustrated in figure 5.6.

### 5.4.5 A Dynamic View of Financial Crises and Macroeconomic Fluctuations

The comparative static description of financial crises in section 5.3.2 has shown that the two “driving” forces during boom-bust cycles including financial crises are the foreign debt-asset ratio $\lambda^*_y$, i.e. capital flows, and the state of confidence parameter $\rho$. The static version however, has been only in a position to provide a qualitative description of financial crises by the use of the signs of partial derivatives, since there has been no possibility to determine formally the net effect of the two counteracting forces $\lambda^*_y$ and $\rho$ due to the absence of a formal description of why $\lambda^*_y$ and $\rho$ grow or decline by different rates during different stages of the business cycle. By way of contrast, the dynamic version of the model has been able to close this formal gap by deriving endogenous time paths for $\lambda^*_y$ and $\rho$ during different stages of business cycles.

Regarding the evolution of endogenous financial fragility and subsequently following financial crises in emerging markets, the dynamic analysis has to distinguish on the one hand, as the industrial country model, between “tranquil equilibrium business cycles” and cycles involving financial crises, and on the other hand, as opposed to the financial crisis model for industrialized countries, among different types of financial crises. Since

\(^{29}\)For these conditions, see Wiggins (1990) chapter 3.1B, pp. 270-278, Lux (1992), p. 189, and Flaschel, Franke and Semmler (1997), chapter 3, pp. 33-60.

\(^{30}\)The condition choosing $b_1$ sufficiently small is assumed as being fulfilled.
emerging markets’ financial structure is characterized by a large stock of external debt and fixed exchange rate systems, it is possible that a domestic financial crisis including a domestic and perhaps international banking crisis can cause a currency crisis (twin crisis) in case foreign exchange reserves do not suffice to meet capital outflows, thereby deteriorating the original crisis due to increases in foreign interest payments and in the stock of foreign debt, reducing net worth. Accordingly, the following analysis distinguishes firstly, between cycles involving no financial crises and cycles generating financial distress, and secondly, between domestic financial crises without currency crises and twin crises.

5.4.5.1 The Emergence of Endogenous Long-Run Equilibrium Business Cycles

The dynamic version of the model being illustrated in figure 5.6 indicates that economies, after having been hit by an external shock, tend to converge in counterclockwise motions to a kind of “equilibrium business cycle” in the long-run with a constant amplitude indicated by the limit cycle. There are different possibilities of converging to the long-run equilibrium cycle depending on the initial condition, which hinges upon the size and the sign of the exogenous shock having catapulted the economy away from the limit cycle. If a shock catapults the dynamic system from a point on the limit cycle to the inner area of the limit cycle, e.g. to point F in figure 5.6, the system is going to converge with growing amplitudes to the limit cycle, where all amplitudes during the convergence process are smaller than the equilibrium amplitude on the limit cycle. If, by way of contrast, an exogenous shocks catapults the economy to the outer area of the limit cycle, e.g. to point E in figure 5.6, the economy converges with declining amplitudes to the limit cycle, where all amplitudes during the convergence process are larger than the limit cycle’s amplitude. As a result, there are three possible ways of dynamic behaviour of economies predicted by the model (on the limit cycle, converging from the outer region, converging from the inner region), which have to be compared with the stylized facts of financial crises and business cycles in order to determine the feasible regions of the dynamic model.

Empirical studies of financial crises state that firstly, systemic financial crises are commonly linked to extensive boom-bust cycles being subject to much larger amplitudes in goods and financial markets than in “tranquil times”, secondly, that not each business cycle generates a financial crisis, thirdly, that financial crises are often preceded by a large exogenous shock, as e.g. a liberalization shock or technology shock, and fourthly, that crisis frequency in emerging market countries is higher than in industrial countries which could be explained by the first stylized fact since empirical studies of business cycles have shown that business cycles in emerging market countries are subject to higher amplitudes regarding goods and financial market fluctuations than business cycles in industrial countries. Summing up, there exist periods of “tranquil” business cycles without any disruptions in financial markets in which goods and financial market variables fluctuate “normally”, but there arise also periods with business cycles being characterized by large fluctuations in goods and financial markets, and by the emergence of financial crises. In most cases, after the occurrence of a severe financial crisis, economies tend to recover to tranquil period business cycle fluctuations, whereas the recovery period can be very long.

Applying these empirical observations to the dynamic version of the model illustrated in figure 5.7, which is a modified version of figure 5.6, it is obvious that the dynamically stable limit cycle indicated by points A, B, C, D and E describes business fluctuations
during tranquil periods which do not lead to systemic financial crises. Therefore, the limit cycle in figure 5.7 can be viewed as an equilibrium business cycle to which economies converge in the long run. It must be noted however, that this equilibrium cycle also contains overborrowing and financial strains on the upper turning point, yet to a much lesser extent than cycles including financial crises.

The inner area of the limit cycle, which is characterized by increasing fluctuations whose amplitudes are however smaller than those of the equilibrium business cycle, has to be excluded from the feasible region, since there is no correspondence with the stylized facts displaying a change between tranquil equilibrium cycles with modest and constant amplitudes and extensive boom-bust cycles with much larger amplitudes leading to financial crises. By way of contrast, the area between the limit cycle and the outer bounds of the invariant set $\mathcal{D}$ contains business cycles with much larger amplitudes than equilibrium fluctuations. These cycles are characterized by much heavier overborrowing during the upswing, leading to high financial fragility and possibly to systemic financial crises during the bust phase. However, even in case an extensive business cycle has caused a systemic financial crisis, economies tend to converge back to the equilibrium business cycle.

Summing up, there arise three important dynamic properties out of the model. Firstly, the feasible region of the model is defined by the invariant set $\mathcal{D}$ without the inner area
of the limit cycle. Secondly, economies tend to converge to an equilibrium business cycle being characterized by a normal functioning of goods and financial markets. Thirdly, extensive boom-bust cycles including systemic financial crises can only be induced by a large external shock, i.e. economies tend to be dynamically or cyclically stable in the long run.

In order to elaborate the differences between cycles involving financial crises and tranquil time business cycles, the dynamic analysis begins with an explanation of the different stages of the stylized equilibrium business cycle serving as a reference path for non-equilibrium cycles. The equilibrium business cycle starts in point A after the last downturn has ended. The boom phase begins with domestic and foreign agents realizing that economic fundamentals ($\lambda_d^*$ and $\sigma^*$) have returned to historical positive levels, causing profit expectations to rise which leads to higher investment demand and slowly rising capital inflows for investment finance. During this early stage of the boom phase, new investment is mainly financed by profits since profit expectations and investment demand have not gained speed yet which would require to rely mainly on external finance. By making use of the comparative static results according to table 5.1, the early boom phase is marked by an increase in $u, r, \ddot{p}, q,$ and $b,$ and by a decline in $j^*$ and $i$ due to the much faster and larger increase in $p$ than in $\lambda_d^*$. A prosperous economic development causes profit expectations to rise very quickly, which can be justified by positive fundamental data (low $\lambda_d^*$ and high $\sigma^*$), but which is also the consequence of an increased reliance on general market sentiments since chartist behaviour starts to dominate the expectation formation scheme. Though the growth rate of capital inflows during the boom phase, being described by the path from A to B, is less than profit expectations' growth rate, the growth of capital inflows accelerates.

Point B marks the beginning of the overborrowing process, which is however, characterized by much lower foreign debt-asset ratios than business cycles generating systemic financial crises. During the early stage of the overborrowing phase, profit expectations grow much faster than actual profits, implying that the large rise in investment demand has to be financed by an extensive increase in the fraction of external finance. The rise in external finance leads to a decrease in the growth rate or even to a stagnation of actual profits owing to rising debt costs. Despite the fact that the growth rate of $r$ is decreasing, or even becoming zero, the state of confidence increases further, since on the one hand, the expectation formation scheme is dominated by chartist type behaviour, and on the other hand, economic fundamentals provide a neutral picture with both $\lambda_d^*$ and $\sigma^*$ increasing, leading not to a unequivocal deterioration of fundamental data. According to the comparative-static results in table 5.1, the overborrowing phase is marked by increases in $u, \ddot{p}, q,$ and $b,$ declines in $j^*$ and $i,$ and by a constant value in $r$.

The latter stage of the overborrowing phase leading to the upper upper turning point being indicated by point C, is characterized by an accelerating increase in the foreign debt-asset ratio and by a slow down in the growth rate of profit expectations, driving the economy in a state of “irrational” behaviour since the actual profit rate declines due to rising debt costs, causing $\sigma^*$ to shrink considerably, whereas profit expectations are going to rise further since the expectation formation scheme is dominated by chartist type behaviour. In terms of the comparative-static version of the model, the path to the upper turning point C is described by augmentations in $u, \ddot{p}, q,$ and declines in $r, j^*$ and

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$^{31}$ An increase in $\sigma^*$ results from $r$ remaining constant, $\ddot{p}$ increasing and $\beta(\rho)$ decreasing.
i. Overall normalized foreign reserves $\lambda_d^* + b$ increase due to a sharp rise in $\lambda_d^*$, whereas $b$ declines due to rising current account deficits caused by a real overvaluation of the domestic currency due to accelerating domestic inflation.

At the upper turning point $C$, the growth in profit expectations comes to halt at the maximum level of $\rho$ when investors realize on the one hand, that $\rho$ has approached or even exceeded the upper bound of the normal range, and on the other hand that there has been a growing trade-off between $r^*$ and $r$ which cannot be maintained further. Consequently, there follows a sudden switch in the expectation formation scheme from market sentiment-based to fundamental data-based causing a decline in $\rho$, which leads to a drop in asset prices being indicated by a fall in $q$, and to rises in $j^*$ and $i$ according to table 5.1 since collateral and net worth positions have deteriorated. The switch of expectations, as well as the drop in asset prices at $C$ can be caused by very small but endogenous triggering events, like e.g. a downgrading of an important business firm or bank by international rating agencies, or by bankruptcies or illiquidity among some firms or financial institutions. Shrinking collateral values and increasing default risk lead to a sharp decline in capital inflows, and to a much lower, but still positive, growth rate of the foreign debt asset ratio. The rise in the foreign debt-asset ratio on the path from point $C$ to $D$ results mainly from a decline in the profit rate leading, according to equation 5.12, to a liquidity squeeze which is financed by increasing (short-term) foreign debt. By way of contrast, if creditors are not willing to increase debt to finance due payment commitments, banks and business firms are going to become illiquid or even insolvent. Yet, in comparison with systemic financial crises, there are no widespread bankruptcies following the decline in asset prices on path $C$ to $D$, since the extent of the decline is much smaller and financial intermediaries, as well as business firms are much less indebted, and therefore much less exposed to asset price volatility.

The downswing starts in point $D$ being characterized firstly, by expectations being dominated again by pessimistic chartist type behaviour, and secondly, by firms and foreign financial institutions beginning to deleverage their balance sheets, causing capital outflows, i.e. a reduction in $\lambda_d^*$. The viability of the fixed exchange rate system during this stage depends on the level of overall normalized foreign reserves $\lambda_d^* + b$. If large current account deficits during the boom phase have led to $b < 0$, i.e. in case imports were financed by capital inflows, a sharp and sufficient reduction in foreign loans could give rise to a currency crisis since the central bank could possibly not be able to meet the demand for foreign reserves. However, since equilibrium business cycles do not lead to excessive real sector expansion and inflation during the boom phase, the real exchange rate’s deterioration does not cause historical high current account deficits and massive losses of international reserves. Furthermore, since the drop in asset prices and the increase in default risk is moderate in comparison with systemic financial crises, there will be no withdrawal of foreign loans to a large extent. Consequently, during the bust phase of an equilibrium business cycle, the central bank is able to meet all capital outflows, thereby maintaining the fixed exchange rate system. Though the reduction of the foreign debt-asset ratio would lead ceteris paribus to a macroeconomic expansion, there is an economic contraction since the chartist-dominated decline in $\rho$ is larger than the decline in $\lambda_d^*$, causing according to table 5.1 a reduction in $u, r, \hat{p}, q$ and $b$, and a further rise in $j^*$ and $i$. The duration of the bust cycle depends on how fast balance sheets can be restructured, and thereby on the downward amplitude of profit expectations.
The recovery phase is going to begin in case foreign and domestic investors consider firms' balance sheets as having returned to a sustainable level. The expectation formation scheme again switches from pessimistic chartist type behaviour having led to an underestimation of the actual profit rate, i.e. $r^e < r$, to fundamental data-based, since on the one hand, $\rho$ has moved to the lower bound of the normal range, and on the other hand, economic fundamentals ($\lambda$ and $\sigma^*$) have returned to "sound" levels according to investors' perception. The time path to the starting point of a new business cycle, i.e. path $E$ to $A$, is marked by an almost constant foreign debt-asset ratio and fast increasing expectations which again are increasingly based on general market sentiments.

5.4.5.2 Domestic Financial Crisis without Currency Crisis

In contrast to equilibrium business cycles, excessive boom-bust cycles leading to systemic financial crises generally start with a positive exogenous shock, increasing profit expectations substantially after the last business cycle has ended, catapulting the economy from point $A$ in figure 5.7 to point $F$. Examples for such positive shocks in the post Bretton-Woods era in emerging market countries have been large-scale populistic, orthodox and heterodox stabilization and liberalization programs in the 1970s, followed by Washington Consensus-based liberalization programs in the late 1980s and early 1990s in order to overcome the negative repercussions of the international debt crisis in 1982-1983 which had led to liberalization reversals, e.g. by reimposing capital controls. Liberalization policies have been generally believed to improve economic efficiency by a better allocation of resources leading to an acceleration in growth, productivity and profitability. Thus, liberalization policies generally cause a sharp rise in profit expectations and in (international and domestic) investors' willingness to provide sufficient external financial means to finance the expansion process. Positive shocks in the form of the introduction of a new technology regime represent another source of rising profit expectations.

The boom phase of an extensive boom-bust cycle being induced by a shift from point $A$ to point $F$ in figure 5.7 is characterized by the same development of variables as during the equilibrium cycle's boom period. However, the initial change of all variables, and thereby their amplitude during the dynamic adjustment process is much larger, being indicated by the dotted trajectory starting in point $A$ and moving through point $F$. Since profit expectations have risen substantially, which is expressed in a large rise in $\rho$ combined with a very low $\lambda$ and a sustainable $\sigma^*$, there is a much greater expansion in investment, and consequently in actual profits than during an equilibrium business cycle, validating the initial increase in profit expectations. The expectation formation scheme tends to switch very fast from fundamental-based to general market sentiment-based. As most of investment is financed by profits, capital inflows tend to be very modest at the outset of the boom phase. As a result, a large increase in $\rho$ and a moderate increase in $\lambda^*$ lead to sharp increases in $u, r, \dot{p}, q$ and $b$, leading to very favourable financial market conditions, i.e. to large declines in $j^*$ and $i$.

The overborrowing phase starts much earlier and to a much larger extent than on the equilibrium cycle, requiring to finance investment, though there is an large rise in actual profits, by an increasing amount of external debt since profit expectations grow much

32 An excellent overview of different kinds of stabilization programs in the 1970s and 1980s can be found in Agénor and Montiel (1999), chapter 10.
faster than actual profits. The early stage of the overborrowing phase is characterized firstly, by capital inflow’s growth rate accelerating which slows down the increase in the profit rate, and secondly, by profit expectations growing much faster than the degree of indebtedness due to the predominance of chartist type behaviour. Accordingly, there is a further large rise in \(u, r, \hat{p}, q\) and \(b\), and a decline in \(j^*\) and \(i\).

During the latter overborrowing phase leading to the upper turning point, debt-asset ratios reach historical high levels which are mainly caused by “mania” expectations, driving the economy in a state of “irrational exuberance” since the profit rate declines substantially due to rising debt costs, whereas indebtedness and profit expectations keep on growing though economic fundamentals (large \(\lambda_d^*\) and low \(\sigma^*\)) would indicate a downward revision of profit expectations. Due to the fact that the increase \(\rho\) dominates the increase in \(\lambda_d^*\), there is a further rise in \(u, \hat{p}, q\) and another decline in \(j^*\) and \(i\), whereas \(r\) deteriorates substantially. Normalized international reserves \(\lambda_d^* + b\) tend to increase due to the large rise in \(\lambda_d^*\) albeit \(b\) decreases considerably owing to historical high current account deficits which are caused by a large real overvaluation of the domestic currency hinging upon a large increase in domestic inflation.

The upper turning point \(G\) is reached when domestic and international investors realize that profit expectations cannot be validated by actual profits since \(\rho\) has moved significantly out of the normal range, and \(\sigma^*\) and \(\lambda_d^*\) have reached historical poor levels. Accordingly, there is a quick switch from chartist type to fundamental data type behaviour as to the formation of expectations, leading to the burst of the asset price bubble. As during tranquil cycles, the triggering events of the wake-up call may be endogenous failures of important banks or firms, as well as a downgrading by international rating agencies. A rise in international interest rates leading to a further decline in \(r\) and \(\sigma^*\) may be also a trigger for the sudden fall in \(\rho\). The rise in international interest rates can be viewed either as an exogenous shock, or as an endogenous reaction on deteriorating liquidity and solvency positions. However, even if the rise in international interest rates is considered as being an exogenous event, the endogenous collapse of expectations would have occurred as well without this kind of exogenous shock. Consequently, the rise in international interest rates only accelerates the unavoidable endogenous collapse of \(\rho\), and is not in a position to cause a widespread financial crisis alone. The burst of the asset price bubble leads to a sudden decline in \(q\) and to sharp rises in \(j^*\) and \(i\), leading to a sharp fall in \(r\) which causes widespread and sudden bankruptcy and illiquidity among firms. The large increase in nonperforming loans triggers a domestic and possibly an international banking crisis since banks’ net worth and cash flow deteriorate significantly. Accordingly, capital inflows come to a sudden stop since default risk has increased and international investors start to withdraw their funds, causing liquidity and solvency problems for domestic firms due to the fact that meeting due payment obligations requires a fire-sale of assets since rolling-over or increasing debt has become impossible due to a sharp reduction in credit markets’ liquidity. The sudden stop in capital inflows is indicated by a sharp reduction of the growth rate of \(\lambda_d^*\) on path \(GH\), leading to widespread illiquidity and insolvency since due payment commitments cannot be rolled-over. By way of contrast, a drop in profit expectations on the upper turning point of an equilibrium business cycle allows for an increase in \(\lambda_d^*\) to meet due payment obligations which is indicated by path \(CD\).

The bust phase beginning at point \(H\) in figure 5.7 is marked by pessimistic chartist type behaviour gaining momentum, and by large capital outflows causing widespread
illiquidity and bankruptcy. Since the fall in $\lambda^*_d$ is much smaller than the drop in $\rho$, there is a widespread economic contraction, i.e. according to table 5.1, there is a large decline in $u, r, \bar{p}, q$ and $b$, and a sharp rise in $j^*$ and $i$ reflecting tight financial market conditions. The viability of the fixed exchange rate systems depends on the level of $b$, hinging upon the amount of accumulated current account deficits during the boom and the overborrowing process. If large current account deficits have led to $b < 0$, i.e. in case current account deficits have been financed by capital inflows in the form of foreign loans, and foreign investors withdraw an amount which is larger than $\lambda^*_d + b$ where $b < 0$, the central bank is forced to abandon the fixed parity since it is not able to meet the demand for foreign currency. Since the model is not given in explicit form, there is no possibility to determine the time of the currency collapse, as well as the critical amount of reserves like e.g. in first generation currency crisis models.\textsuperscript{33} Yet, in order to elaborate the differences between a financial crisis without a currency crises and a twin crises, it is assumed in the present case that though there arose current account deficits in the past, the central bank is able to meet all capital outflows even if there is no monetary contraction at point $H$ which would cushion the fall in reserves.

In case the central bank tries to limit capital outflows by a monetary contraction, a decline in $h$ or $m$ could only slow down the decrease in $b$, since under fixed exchange rates there is no possibility to influence any other real or financial market variable according to table 5.1, thereby having no effect on $\rho$ and $\lambda^*_d$. As a result, there is no possibility to induce a downward jump from point $H$ to a trajectory lying nearer to the equilibrium cycle by contractionary monetary policy. Likewise, a domestic monetary expansion is not able to induce a downward movement from point $H$ since there is no possibility to influence the foreign debt burden by domestic monetary policy. In graphical terms, the only effects of changes in $h$ and $m$ are a change of the current trajectory’s slope in point $H$, as well as a change of both demarcation curves which are still not going to be analyzed.

Though there is no debt increase induced by a forced devaluation in the present case, the economy enters a severe recession or even a depression accompanied by deflationary spirals, leading to an increase in the real debt burden. Even if the central bank abandoned the fixed parity in order to regain monetary independence, a recovery induced by a monetary expansion would be very unlikely due to a liquidity trap situation which would be additionally amplified by an increase in the foreign debt burden due to a devaluation of the domestic currency. In this case, overindebted balance sheets prevent an economic upswing since there is no sufficient supply of credit to finance new investment projects due to an absence of financial markets’ willingness, or due to disintermediation caused by large-scale bankruptcies among domestic and international banks.

The duration of the bust phase in the present case is much longer than on the equilibrium cycle, since on the one hand, foreign indebtedness is much higher which requires a longer period of balance sheet restructuring, and on the other hand, profit expectations are far more depressed by pessimistic chartist behaviour. The recovery phase begins if $\lambda^*_d$ and $\sigma^*$ have returned to sustainable levels from investors’ perspective who realize that their expectations had been too pessimistic in the past. After having conceived that there has been a steady underestimation of actual profits, i.e. $\bar{r} < r$, the expectation formation

\textsuperscript{33}By way of contrast, the linear calibration model for emerging markets, being an explicit example of the present model, which is going to be analyzed in chapter 6, is able to determine the time of the collapse as well as the critical stock of foreign exchange reserves.
scheme switches quickly from pessimistic chartist behaviour to fundamental data-based behaviour and a new cycle can begin which however, is subject to a lower amplitude than the financial crisis cycle in case there are no exogenous shocks.

5.4.5.3 The Occurrence of a Twin Crisis

This paragraph examines the long-run dynamics in case the central bank is not able to maintain the fixed exchange rate at the upper turning point due to lacking foreign exchange reserves which is depicted in figure 5.8 being a modified version of figure 5.7. The boom and the overborrowing phase of the twin crisis case correspond to the domestic financial crisis case as to the behaviour of \( \lambda_d^* \) and \( \rho \), and consequently, as to the development of all other endogenous variables according to table 5.1. Likewise, it is assumed that large current account deficits having been financed by capital inflows have led to a large depletion of reserves, i.e. it holds that \( b < 0 \) when the system reaches the end of the overborrowing phase. At the upper turning point however, when the asset bubble bursts and capital flight begins, it is assumed that foreign investors' withdrawals exceed the stock of normalized reserves \( \lambda_d^* + b \) where \( b < 0 \), leading to a suspension of the fixed parity. Lacking international reserves can stem firstly, from larger capital outflows at the upper turning point due to a higher risk aversion of investors, secondly, from larger current deficits during the upswing, and thirdly, from a smaller initial stock of international reserves \( b \) at the outset of the cycle.

Regarding currency crises, there are several alternative post-collapse regimes, like e.g. a unique devaluation or a flexible exchange rate regime following the speculative attack. For the present case, it is assumed that in case a currency crisis occurs, the central bank carries out a unique devaluation, which can be justified by the fact that the transition to a fully flexible regime would make the economy more susceptible to fluctuations in the stock of foreign debt valued in domestic currency. A unique devaluation corresponds to a permanent increase in parameter \( \delta \) from \( \delta = 0 \) to \( \delta > 0 \) in the model. It must be noted that a permanent value of \( \delta > 0 \) over more than one period does not correspond to a devaluation in each period following the speculative attack since the growth rate of \( \delta \) is related to an initial value of \( \delta = 1 \). Accordingly, a constant devaluation rate in each period would correspond to increasing values in \( \delta \) for each period.

In order to elaborate the global dynamics of the system in case of a devaluation, the influence of changes in \( \delta \) on the slopes of the two demarcation curves \( \lambda_d^* = G_1(\lambda_d^*, \rho) = 0 \) and \( \rho = G_2(\lambda_d^*, \rho) = 0 \) has to be investigated firstly. According to equation 5.14, and by table 5.1, the change of the slope of demarcation curve \( \lambda_d^* = G_1(\lambda_d^*, \rho) = 0 \) is given by

\[
\frac{d \left( \frac{d \lambda_d^*}{d \rho} \right)}{ds} = -\frac{\partial \left( \frac{\partial G_1}{\partial \rho} \right)}{\partial \delta} \cdot \frac{1}{\left( \frac{\partial G_1}{\partial \lambda_d^*} \right)^2} \cdot \frac{\partial \left( \frac{\partial G_1}{\partial \lambda_d^*} \right)}{\partial \delta} \quad \forall \lambda_d^*>0,
\]

because

\[
\frac{\partial \left( \frac{\partial G_1}{\partial \rho} \right)}{\partial \delta} = -\frac{\partial \lambda_d^*}{\partial \delta} \cdot \frac{\partial \eta}{\partial q} \cdot \frac{\partial \rho}{\partial \eta} < 0,
\]
and

\[
\frac{\partial (\frac{\partial G_1}{\partial s})}{\partial s} = -\frac{d\eta}{dq} \frac{\partial q}{\partial s} + 1 - \frac{\partial \phi}{\partial s} - \frac{\partial \lambda^*_d}{\partial s} \frac{d\eta}{dq} \frac{\partial q}{\partial s} + (1 - \lambda^*_d) \frac{dn}{dq} \frac{\partial (\frac{\partial q}{\partial s})}{\partial s} - \frac{\partial r}{\partial s} \frac{\partial (\frac{\partial r}{\partial s})}{\partial s} - \frac{\partial \lambda^*_d}{\partial s} \frac{\partial \phi}{\partial s} - \lambda^*_d \frac{\partial (\frac{\partial \lambda^*_d}{\partial s})}{\partial s} \geq 0,
\]

being positive if it holds that

\[
-\frac{d\eta}{dq} \frac{\partial q}{\partial s} + 1 - \frac{\partial \phi}{\partial s} - \frac{\partial \lambda^*_d}{\partial s} \frac{d\eta}{dq} \frac{\partial q}{\partial s} + (1 - \lambda^*_d) \frac{dn}{dq} \frac{\partial (\frac{\partial q}{\partial s})}{\partial s} - \frac{\partial r}{\partial s} \frac{\partial (\frac{\partial r}{\partial s})}{\partial s} - \frac{\partial \lambda^*_d}{\partial s} \frac{\partial \phi}{\partial s} - \lambda^*_d \frac{\partial (\frac{\partial \lambda^*_d}{\partial s})}{\partial s} > \left(1 - \lambda^*_d\right) \frac{dn}{dq} \frac{\partial (\frac{\partial q}{\partial s})}{\partial s},
\]

which is assumed to be fulfilled in the present case. As a result, there is no possibility to determine an unequivocal sign for the change of the slope of demarcation curve \( \lambda^*_d = G_1(\lambda^*_d, \rho) = 0 \), so that the change of dynamics cannot be analyzed without making use of assumptions.

It seems reasonable to assume that the slope of demarcation curve \( \lambda^*_d = G_1(\lambda^*_d, \rho) = 0 \) cannot become negative, which would imply a change of the local dynamics from instability to stability, provided that the slope of demarcation curve \( \dot{\rho} = G_2(\lambda^*_d, \rho) = 0 \) remains positive which is going to be proved later on, since empirical evidence shows that economies hit by twin crisis do not converge to a stable long-run fixed point equilibrium. Consequently, demarcation curve \( \lambda^*_d = G_1(\lambda^*_d, \rho) = 0 \) can only take values from zero to plus infinity. However, for reasons of simplicity it is assumed that the slope of demarcation curve \( \lambda^*_d = G_1(\lambda^*_d, \rho) = 0 \) does not change in case of changes in \( \dot{s} \), i.e. formally it holds that

\[
\frac{d \left( \frac{\partial \lambda^*_d}{\partial \rho} \right)_{G_1}}{d \dot{s}} = - \frac{\partial \left( \frac{\partial G_1}{\partial \rho} \right)}{\partial \dot{s}} \frac{1}{\left( \frac{\partial G_1}{\partial \lambda^*_d} \right)^2} + \frac{\partial \left( \frac{\partial G_1}{\partial \lambda^*_d} \right)}{\partial \dot{s}} = 0,
\]

which is indicated in figure 5.8 by demarcation curve \( \lambda^*_d = G_1(\lambda^*_d, \rho) = 0 \) being valid for \( \dot{s} = 0 \) and \( \dot{s} > 0 \).

According to equation 5.15, and by table 5.1, the change of the slope of demarcation curve \( \dot{\rho} = G_2(\lambda^*_d, \rho) = 0 \) for variations in \( \dot{s} \) is given formally by

\[
\frac{d \left( \frac{\partial \lambda^*_d}{\partial \rho} \right)_{G_2}}{d \dot{s}} = - \frac{\partial \left( \frac{\partial G_2}{\partial \rho} \right)}{\partial \dot{s}} \frac{1}{\left( \frac{\partial G_2}{\partial \lambda^*_d} \right)^2} + \frac{\partial \left( \frac{\partial G_2}{\partial \lambda^*_d} \right)}{\partial \dot{s}} ,
\]

\[34\text{Note that it holds that}
\]

\[
\frac{\partial \left( \frac{\partial G_1}{\partial \lambda^*_d} \right)}{\partial \dot{s}} = -m \lambda^*_d \psi \dot{s} < 0, \quad \frac{\partial \left( \frac{\partial G_1}{\partial \lambda^*_d} \right)}{\partial \dot{s}} = m (-\lambda^*_d \psi + \lambda^*_d \psi) < 0, \quad \frac{\partial \left( \frac{\partial \phi}{\partial \lambda^*_d} \right)}{\partial \dot{s}} = -m \eta \lambda^*_d \psi < 0,
\]

which can be derived by differentiating the relevant partial derivatives given in section 5.7 with respect to \( \dot{s} \).
which, by taking into consideration that
\[
\frac{\partial (\frac{\partial G_2}{\partial \rho})}{\partial \tilde{s}} = \frac{\partial (\frac{\partial \sigma}{\partial \rho})}{\partial \tilde{s}} + \frac{\partial (\frac{\partial \sigma^*}{\partial \lambda})}{\partial \tilde{s}} \frac{\partial \sigma^*}{\partial \rho} + \frac{\partial (\frac{\partial \sigma^*}{\partial \rho})}{\partial \tilde{s}} \frac{\partial \sigma}{\partial \rho} = 0, \quad 35
\]
and
\[
\frac{\partial (\frac{\partial G_2}{\partial \lambda})}{\partial \tilde{s}} = \frac{\partial (\frac{\partial \sigma}{\partial \lambda})}{\partial \tilde{s}} + \frac{\partial \sigma}{\partial \sigma^*} \frac{\partial (\frac{\partial \sigma^*}{\partial \lambda})}{\partial \tilde{s}} < 0, \quad 36
\]
can be simplified into the expression
\[
\frac{d (\frac{\partial \lambda^*_d}{\partial \rho})}{d \tilde{s}} \bigg|_{G_2} = \frac{-0.8}{\left(\partial G_2/\partial \tilde{s}\right)} \left(\frac{\partial G_2}{\partial \rho}\right)^2 \cdot \frac{\partial (\frac{\partial G_2}{\partial \lambda^*_d})}{\partial \tilde{s}} + \left(\frac{\partial (\frac{\partial \lambda^*_d}{\partial \rho})}{\partial \tilde{s}}\right) \bigg|_{G_2} < 0,
\]
whose sign is dependent on the position of \( \rho \), i.e. whether \( \rho \) lies inside or outside the normal range, which is represented by the sign of derivative \( \partial G_2/\partial \rho \). Accordingly, in case of a devaluation, i.e. \( \tilde{s} > 0 \), the demarcation curve becomes flatter over the entire range being depicted in figure 5.8, where the dotted line represents the demarcation curve before the devaluation \( \dot{\rho}_1 = 0 (\tilde{s} = 0) \), and the solid line the demarcation curve after the devaluation has taken place \( \dot{\rho}_2 = 0 (\tilde{s} > 0) \).

The global dynamics in case of a devaluation occurring at the upper turning point are depicted in figure 5.8 which is an extended version of figure 5.7. Since the boom and the overborrowing phase of the twin crisis case coincide with the domestic financial crisis case, figure 5.8 contains both types of global dynamics where the solid lines refer to the twin crisis case and the dotted lines refer to the domestic financial crisis case. In case there is no devaluation at the upper turning point, the boom-bust cycle containing a systemic domestic financial crisis follows time path \( A, F, G, K \) converging in the long-run to the equilibrium business cycle \( A, B, C \) as it was depicted in figure 5.7.

The first stage of the twin crisis case (boom and overborrowing phase) follows the same time path to the upper turning point \( A, F, G \) as the domestic financial crisis case. At the upper turning point \( G \) however, withdrawals of foreign investors exceed the stock of normalized international reserves \( \lambda^*_d + b \) where \( b < 0 \), compelling monetary authorities to devalue the domestic currency, which is indicated by the jump from point \( G \) to \( H \) since the domestic value of foreign debt increases discontinuously by \( \tilde{s} \) per cent. This kind of "foreign debt explosion" emerging from a devaluation of the home currency is equivalent to the Fisherian debt deflation process stemming from deflation of the domestic price level. At the moment of devaluation, there is also a switch from demarcation curve

\[35\text{Note that it holds that } \frac{\partial (\frac{\partial \sigma}{\partial \rho})}{\partial \tilde{s}} = 0, \frac{\partial (\frac{\partial \sigma^*}{\partial \lambda})}{\partial \tilde{s}} = 0, \text{ and } \frac{\partial (\frac{\partial \lambda^*_d}{\partial \rho})}{\partial \tilde{s}} = 0, \text{ which can be derived from equations 5.9 and 5.10.}\]

\[36\text{Note that it holds that } \frac{\partial (\frac{\partial \lambda^*_d}{\partial \rho})}{\partial \tilde{s}} < 0, \text{ and } \frac{\partial (\frac{\partial \lambda^*_d}{\partial \rho})}{\partial \tilde{s}} = \frac{\partial \sigma^*}{\partial \sigma} \frac{\partial (\frac{\partial \sigma}{\partial \lambda})}{\partial \tilde{s}} + \frac{\partial \sigma^*}{\partial \rho} \frac{\partial (\frac{\partial \lambda^*_d}{\partial \rho})}{\partial \tilde{s}} < 0, \text{ which can be derived from equations 5.9 and 5.10.}\]
\( \dot{\rho}_1 = 0 (\dot{s} = 0) \) to \( \dot{\rho}_2 = 0 (\dot{s} > 0) \). The post-devaluation dynamics (bust and recovery phase) are described by time path \( H, I \), converging to a “new” equilibrium business cycle in the long-run which emerges from the change of demarcation curve \( \dot{\rho} = G_2(\lambda^*_d, \rho) = 0 \). However, regarding the characteristics of the new equilibrium business cycle, there is no analytical possibility to determine whether the new limit cycle being relevant for the post-devaluation phase of the twin crisis case becomes greater or smaller.

Comparing the post-devaluation bust and recovery phase with the domestic financial crisis case leads to the observation that, according to figure 5.8, after the occurrence of a currency crisis, the subsequent financial and real sector crisis is much more severe than a financial crisis without a speculative attack owing to a further and sudden devaluation-led squeeze in net worth and cash flow positions. Accordingly, restructuring of unsound balance sheets during the recovery phase lasts much longer than in the domestic financial crisis case since net worth positions are more depressed.

Figure 5.8: Financial Crisis II: Twin Crisis
Regarding empirical examples, there arose two large boom-bust cycles having generated systemic financial crises in the post Bretton-Woods era in emerging market countries. The first one started in the mid 1970s and ended in the international debt crisis in the early 1980s. The recovery period lasted almost one decade due to long lasting negotiations regarding debt relief and debt restructuring. The second cycle began in the early and mid 1990s when emerging markets were again subject to huge capital inflows which led as well to systemic financial crises in Mexico (1994), Asia (1997/1998), Russia/Brazil (1998/1999) and in Argentina (1995 and 2000). The recovery phase of the second cycle has not been completed yet. Both cycles were preceded by large liberalization and stabilization efforts. In several countries, as e.g. in Mexico, there were no equilibrium cycles between the two boom-bust cycles indicating that after the economies had recovered from the first liberalization and stabilization shock in the late 1970s, there were hit by the Washington Consensus liberalization and stabilization shock in the late 1980s which gave rise to a new extensive cycle and systemic financial crises.

5.4.6 A Keynesian Perspective on Global Dynamics

After having studied the global dynamics under the combination of chartist-fundamentalist and long-run rational behaviour, there arises the important question of how global dynamics are going to change if the assumption of long-run rationality is given up. In such a pure chartist-fundamentalist or pure Keynesian world, investors' expectations are driven mainly by general market sentiments during the upswing and the downswing, and by fundamental data at the turning points. Hence, there exists no "rational" mechanism, as well as no "normal" corridor for the state of confidence \( \rho \) guaranteeing a reversal of expectations irrespective of fundamental data in case it can be observed that \( \rho \) has left the normal range.

In terms of the model, a pure Keynesian expectation formation scheme can be represented by a modified non-linear differential equation in the state of confidence \( \rho \), given formally as

\[
\dot{\rho} = G_2(\Lambda_d, \rho) = z(\rho, \sigma^*, \Lambda_u),
\]

for which it holds that \( \partial z / \partial \rho > 0 \) over the entire range for \( \rho \), but which becomes less positive the more \( \rho \) departs from its long-run equilibrium level \( \rho_E = 0 \) whose existence will be proved and outlined below. It still holds that \( \partial z / \partial \sigma^* > 0 \) and \( \partial z / \partial \Lambda_u < 0 \) as in equation 5.13. Equation 5.16 results in an S-shaped demarcation curve \( \dot{\rho} = G_2(\Lambda_d, \rho) = 0 \) having the largest positive slope near the intertemporal equilibrium \( \rho_E = 0 \), and becoming less positive for \( \rho > 0 \) and \( \rho < 0 \). The assumption that \( \partial z / \partial \rho > 0 \) declines with increasing difference \( |\rho - \rho_E| \) represents investors' belief that the state of confidence \( \rho \) can increase or decrease infinitely, but is subject to changes \( \dot{\rho} \) becoming smaller in absolute terms the more \( \rho \) departs from its equilibrium level \( \rho_E = 0 \). Regarding foreign debt dynamics, it is assumed that equation 5.12 still holds.

The dynamic system consisting of equations 5.16 and 5.12 generates two different types of global dynamics hinging upon the strength of the influence of the current state of confidence \( \rho \) on investors' change in profit expectations \( \partial z / \partial \rho \). As in the Keynesian case for industrial countries discussed in section 4.4.6, the assumption of hypersensitive investors near the intertemporal equilibrium level, i.e. \( \partial z / \partial \rho \gg 0 \) near \( \rho_E = 0 \), generates multiple equilibria giving rise a limit set in the form of a saddle loop having being illustrated in
figure 4.8. It has been argued that this form of global dynamics does not explain the stylized facts due to the existence of multiple equilibria.

Hence, to rule out multiple intertemporal equilibria it is necessary to assume that investor behave “normally” near the intertemporal equilibrium $\rho_E = 0$, i.e. it holds that $\partial z / \partial \rho > 0$ near $\rho_E = 0$. The assumption that the intertemporal equilibrium in a pure Keynesian world corresponds to the long-run rational expectations equilibrium $\rho_E = 0$ seems as a contradiction in terms at first sight. However, in a long-run state of $\rho_E \neq 0$, investors are going to revise their expectations leading to a shift in function $\dot{\rho} = z(\lambda^*_d, \sigma, \rho)$ and in demarcation curve $\dot{\rho} = G_2(\lambda^*_d, \rho) = 0$ even in a pure Keynesian world, since expectations have not been fulfilled by the actual development setting up a new dynamic process. Readjustments of expectations and thereby shifts in function $\dot{\rho} = z(\lambda^*_d, \sigma, \rho)$ and in demarcation curve $\dot{\rho} = G_2(\lambda^*_d, \rho) = 0$ are going to continue as long as profit expectations coincide with actual profits, justifying $\rho_E = 0$ as a reasonable assumption even in a Keynesian world.

![Figure 5.9: Financial Crises in a Pure Keynesian World with Normally Reacting Investors](image-url)
The global dynamics under normally reacting investors for the emerging market case are depicted in figure 5.9. The dynamic system gives rise to the emergence of closed orbits by the Poincaré-Bendixon theorem because the local fixed point $E$ is unstable, and rectangle $OPQR$ describes an invariant set $\mathcal{D}$ from which trajectories once having entered cannot escape; the boundary values of $\mathcal{D}$ can be justified economically as in section 5.4.4. As opposed to the case involving long-run rational behaviour, there is no possibility to determine the number of cycles without transforming the dynamical system into e.g. a Liénard equation. In case there evolve multiple closed orbits, the economy is cyclically unstable, as in the industrial country case in section 4.4.6, due to the existence of multiple equilibrium cycles with different amplitudes. As a result, there exist equilibrium cycles near equilibrium $E$ with low amplitudes, as well as equilibrium cycles near the boundaries of compact set $\mathcal{D}$ engendering a financial crisis on each business cycle. Which of these equilibrium cycles is going to be realized is a matter of the initial condition of the system, so that exogenous shocks are able to catapult a cyclically stable economy with low amplitudes to an equilibrium cycle with high amplitudes and financial crises.

Though the case of multiple equilibrium cycles can arise theoretically from system 5.16 and 5.12, it is an unrealistic scenario from an empirical viewpoint since economies tend to be cyclically stable in the long-run, a fact which requires the existence of only one limit cycle being subject to low amplitudes and financial stability. However, even if there exists only one closed orbit as assumed and illustrated by the dotted limit cycle moving through points $A, B$ and $C$ in figure 5.9, there arise important differences to the case involving long-run rational behaviour. Firstly, it is obvious that an equilibrium business cycle in a Keynesian world has a greater amplitude regarding financial and real variables than in a world with long-run rationality. Secondly, at the upper turning point $B$, tensions in financial markets generating bankruptcies among firms and banks are much stronger, causing much deeper recessions or even depressions. Thus, it is not clear whether there exist equilibrium business cycles in the Keynesian case without systemic financial crises. Thirdly, if there arise no financial crises on the equilibrium cycle, economies are cyclically and financially stable in the long-run, so that financial crises can be only caused by exogenous shocks as in the case with long-run rational behaviour. However, in case the economy is hit by an exogenous shock giving rise to a financial crisis, the resulting boom-bust cycle is subject to a much larger amplitude, generates a much deeper financial crisis, and a much longer bust period than under long-run rational behaviour which is illustrated in figure 5.9. The boom-bust cycle giving rise to a full-fledged financial crisis starts with a positive shock to the state of confidence $p$, catapulting the system from point $A$ to point $F$. As there is no long-run rational behaviour, the boom and overborrowing phase last much longer and generate a much higher degree of financial fragility. Whether the economy enters a domestic financial crisis or a twin crisis depends, as in the case involving long-run rational behaviour, on the stock of foreign reserves at the upper turning point $G$. If withdrawals of foreign investors do not exceed the central bank’s stock of foreign reserves, the fixed parity can be maintained, leading to a systemic domestic and possibly international banking crises, and to large-scale bankruptcies among domestic firms. This case is portrayed by the dotted semicircle starting in point $G$ moving through point $K$ and converging in the long-run to the limit cycle.

In case capital outflows exceed the stock of foreign exchange reserves at the upper turning point $G$, the fixed parity cannot be maintained any longer, leading to a twin crisis
which induces several changes of the global dynamics. Firstly, in case $\dot{s} > 0$, demarcation curve $p_1 = 0 (s = 0)$ becomes flatter, being indicated by demarcation curve $p_2 = 0 (\dot{s} > 0)$, whereas demarcation curve $\dot{s}_1 = 0$ is assumed not to change its slope according to the formal results in section 5.4.5. However, as outlined before, there is no possibility to derive any formal results regarding the characteristics of the "new" limit cycle stemming from the change of demarcation curve $\dot{s} = 0$. Secondly, there is a sudden increase in foreign debt in domestic currency terms being represented by the jump from point $G$ to point $H$ in figure 5.9. Thirdly, the bust phase being described by the solid semicircle starting in point $H$ and moving through point $I$ leads to a very deep depression having a much larger contractionary effect on the economy than a domestic financial crisis.

Summing up, a pure chartist-fundamentalist approach requires very restrictive assumptions in order to be consistent with the stylized facts of financial crises. Otherwise, there arise forms of aggregate instability which do not meet empirical regularities. Moreover, it cannot be proved formally whether the ad-hoc assumptions imposed, as e.g. the existence of a unique closed orbit, actually arise from dynamic system 5.16 and 5.12. By way of contrast, the assumption of long-run rational behaviour generates much stronger model results without making use of restrictive assumptions. However, a strict rational expectations approach cannot explain the emergence of endogenous cycles and endogenous financial fragility in the absence of exogenous shocks. Thus, only the combination of chartist-fundamentalist and rational behaviour is able to produce model results which are consistent with the stylized facts.

5.5 A Comparison with Standard Theory of Financial Crises

The advantages of the present model framework over standard theory of financial crises have been already outlined in detail in section 4.5 containing a formal description of standard models of the explanation of financial crises in industrial countries. This section enlarges the discussion of standard theory of financial crises on the one hand, by applying crisis models which were developed for industrial countries to emerging market economies, and on the other hand, by focusing on standard theory which has been especially elaborated for emerging market countries.

The formal description of standard models of financial crises is carried out by the application of the comparative-static results according to table 5.1 though lots of standard approaches are modelled dynamically. However, a dynamic application of the present model to standard theory would not result in deeper basic insights as to the causes of financial crises, and would only complicate the formal analysis. It is obvious that the present model structure cannot reflect exactly the model structures of all standard approaches. Hence, if necessary, the following analysis falls back on other variables or parameters than in the original models to understand the basic logic. Models which have been already discussed in section 4.5 are only going to be outlined by the comparative-static version of the emerging market model without any further explanation of the basic model structure.
5.5.1 Inconsistent Macroeconomic Policy Models

The Absence of Financial Crises in Case of Deflationary Monetary Policy Under Fixed Exchange Rates. The application of Flood and Garber’s (1981b) closed economy bank run model under deflationary monetary policy, having set out in section 4.5.1, to the emerging market country model shows that contractionary, or deflationary monetary policy engenders no financial crisis in an open economy under fixed exchange rates, as a reduction in high-powered money \( h \) leads to a compensating increase in foreign reserves \( b \) to the same amount because of \( \partial b / \partial h = -1 \), improving the stability of the fixed exchange rate system.\(^{37}\) As there is no further impact of \( h \) on other real and financial sector variables in the model, validating the Mundell-Fleming result that monetary policy under fixed exchange rates is ineffective, there arises no possibility of bank runs which are induced by declining asset values of banks.

Currency Crises Triggering Bank Runs Due to Inflationary Monetary Policies Under Fixed Exchange Rates. The application of Flood and Garber’s (1981a) closed economy bank run model under inflationary monetary policy, discussed in section 4.5.1, to the emerging market country model results in no banking crisis if expansionary monetary policies are moderate and do not lead to a breakdown of the the fixed exchange rate system, validating also the Mundell-Fleming result of the ineffectiveness of monetary policy under fixed exchange rates. If there is no currency crisis going to occur, an increase in \( h \) does only induce a decline in foreign exchange reserves \( b \) to the same amount as it holds that \( \partial b / \partial h = -1 \), leaving the money supply and all other real and financial market variables unchanged.

However, in case of overly excessive expansionary monetary policies, the fixed exchange rate system is going to collapse, inducing a twin crisis. Following the model results, a steady rise in \( h \) causes an enduring decline in \( b \), which leads to a speculative attack and to a devaluation of the home currency, i.e. to a rise in \( \hat{s} \), when, according the results of first-generation currency crises models, the flexible shadow exchange rate has increased to the level of the fixed exchange, or equivalently, when the stock of foreign exchange reserves \( b + \lambda_s^* \) falls below a certain minimum threshold value. If the stock of foreign debt \( \lambda^* \) is comparatively high, the devaluation of the home currency is contractionary, leading to a domestic macroeconomic contraction, being associated with a decline in \( u, r, \hat{p}, q \), and an increase in \( j^* \) due to shrinking collateral values and deteriorating liquidity positions. Furthermore, rising failures of firms possibly cause a domestic and international banking crisis. If there are widespread bankruptcies among firms and domestic banks, foreign investors are going to withdraw foreign loans, i.e. \( \lambda^* \) declines, which partly offsets the negative effects of the rise in \( \hat{s} \). However, since investment is constrained by available credit, investment activity and the state of confidence \( \rho \) will decline, leading to a further macroeconomic contraction. A bank run can be a possible outcome even if there is a deposit insurance system in case accumulated losses by banks undermine the credibility of a bail out.

If, by way of contrast, the stock of foreign debt \( \lambda^* \) at the time of the breakdown of the fixed exchange rate system is comparatively low, a devaluation of the home currency leads to a macroeconomic expansion, improving collateral values and liquidity positions of

\(^{37}\)For this result, see section 5.7.
firms and banks. Consequently, a devaluation can strengthen the stability of the financial system if balance sheets are not financially fragile.

**First Generation Currency Crises Models.** The application of Krugman’s (1979) and Flood and Garber’s (1984a) first generation currency crises models, having set out in section 4.5.1, to the emerging market country model leads to the same result as the application of Flood and Garber’s (1981a) closed economy bank run model under inflationary monetary policy to open economy considerations, as in both cases financial crises are caused by overly excessive expansionary monetary policy.

**Twin Crises Emerging From First Generation Currency Crises.** In order to overcome the inability of first generation currency crises models to explain the occurrence of twin crises, latest models of inconsistent macroeconomic policies have started to consider explicitly the influence of the domestic banking sector on the transmission of financial crises. A prominent example is Buch and Heinrich’s (1999) model, which enlarges Flood and Garber’s first generation currency crisis approach (1984a) by the introduction of a domestic banking sector which grants loans to domestic firms in domestic currency, and finances itself mainly by taking foreign loans in foreign currency in international credit markets. The interest rate on foreign loans consists of a risk free international interest rate, plus the exchange rate’s expected rate of change, plus a risk premium, depending negatively on banks’ net worth. Banks’ net worth position is determined by banks’ profits which are negatively dependent on the interest rate on foreign loans. Accordingly, a rise/fall in banks’ profits induces a rise/fall in net worth, leading to a fall/rise in the risk premium, and to a fall/rise in the interest rate on foreign loans, causing a further rise/fall in banks’ profits.

A banking crisis, i.e. a sharp reduction in banks’ net worth induced by a sharp fall in banks’ profits, can be caused, firstly, by an exogenous increase in the international risk free interest rate, secondly, by depreciation expectations of the domestic currency, and thirdly, by a rise in the risk premium. Though the model considers explicitly exogenous foreign interest rate shocks as a cause of financial crises, Buch and Heinrich emphasize the role of overly expansionary monetary policies as the main source of twin crises. Following the logic of first-generation currency crises models, an excessive and persistent increase in high-powered money causes firstly, large capital outflows leading to a depletion of foreign exchange reserves, and secondly, increasing devaluation expectations which induce a rise in the risk premium and in the interest rate on foreign loans. The rise in interest rate costs leads to a reduction in banks’ profits and in banks’ net worth, triggering a banking crisis. The domestic banking crisis leads to massive capital outflows and triggers a currency crisis deteriorating the initial banking crisis.

In terms of the emerging market model, expansionary monetary policy, being represented by an increase in \( h \), leads, as in the extended Krugman (1979) and Flood and Garber (1981a) models having been described above, to shrinking reserves \( b \), causing a banking crisis *after* a contractionary devaluation has taken place. However, according to Buch and Heinrich’s model, the logic is vice versa, i.e. the logic runs from a banking crisis, being triggered by devaluation expectations, to a speculative attack. In terms of the emerging market model, devaluation expectations caused by expansionary monetary policy are represented by a fall in the state of confidence \( p \), leading to a domestic macroe-
economic contraction and to a banking crisis by a fall in $u, r, \hat{p}, q$, and by an increase in $j^*$ and $i$. Apart from the increase in $h$, the fall in $\rho$ leads to additional capital outflows, i.e. to a further reduction in $b$, which, in case the normalized stock of foreign exchange reserves $b + \lambda^*$ falls short of a certain minimum level, leads to a currency crisis (and to a twin crisis), i.e. to a rise in $\hat{s}$, deteriorating the macroeconomic contraction in case the foreign debt-asset ratio $\lambda^*$ has been comparatively high. Capital outflows lead to a decline in $\lambda^*$ which offsets partly the contractionary effects on the economy, but which cannot overcompensate the negative effects of the fall in $\rho$ and the rise in $\hat{s}$.

5.5.2 Self-Fulfilling Expectations Models

Unpredictable Bank Runs Due to Random Withdrawals Without Foreign Borrowing. Diamond and Dybvig's bank run model (1983) studies the effects of random shifts in expectations of depositors in a closed economy, i.e. banks and depositors have no possibility to get into foreign debt. As a result, the application of the Diamond-Dybvig story to the emerging market model requires that the foreign debt-asset ratio $\lambda^*$ takes a zero value. Shifts in expectations are represented, as in section 4.5.2, by changes in the state of confidence parameter $\rho$, where $\rho > 0$ marks the "no-run" equilibrium, and $\rho < 0$ the "bank-run" equilibrium.

In terms of the emerging market country model, the no-run equilibrium, i.e. $\rho > 0$, is characterized by comparatively large values in $u, r, \hat{p}, q$ and $b$, and by comparatively low values in $j^*$ and $i$, indicating a high degree of financial stability and a stable fixed exchange rate regime. By way of contrast, the bank run equilibrium, i.e. $\rho < 0$, is characterized by comparatively low values in $u, r, \hat{p}, q$ and comparatively high values in $j^*$ and $i$, indicating a high degree of financial fragility among domestic banks and firms, as well as depreciation expectations of the home currency leading to large capital outflows and possibly to a breakdown of the fixed exchange rate system, i.e. to a sharp decline in $b$.

Though the open-economy extension of the Diamond-Dybvig model is able to illustrate the occurrence of banking, currency and twin crises, the model provides no clearness with respect to the chronological order of events in case of the bank-run equilibrium, since there arise three possible forms of financial crises. Firstly, if the fall in $\rho$ does not lead to large capital outflows, the fixed exchange rate system will prevail despite a bank run. Secondly, if the fall in $\rho$ leads to a very quick speculative attack, the devaluation of the home currency can stabilize the economy since there is an expansionary devaluation due to $\lambda^* = 0$. Hence, a domestic banking crisis and a subsequent run can be avoided by a macroeconomic expansion, stabilizing liquidity and solvency positions of the banking and the firm sector. Thirdly, the fall in $\rho$ can lead to a twin crisis if the currency crisis following the domestic banking crisis cannot restore financial stability by an expansionary devaluation.

emerging from a domestic creditor panic, having discussed briefly in section 4.5.2, and one originating from a foreign depositor panic.

Regarding the domestic creditor panic case, Chang and Velasco assume explicitly that domestic banks definitely pay back all foreign debt, and that due foreign debt can be rolled-over at the same conditions as before in order to abstract from a foreign creditor panic, and to elaborate the differences between financial crises being triggered by domestic depositors and by foreign creditors. As in the Diamond-Dybvig model, there arise two possible equilibria. The “no run” equilibrium is characterized by only a small fraction of domestic depositors withdrawing their funds from banks, which can meet all payments obligations. The “bank-run” equilibrium is characterized by all depositors withdrawing their funds because each domestic depositor expects all others to do the same. Banks are going to fail in case of a bank run as the face value of deposits is larger than the liquidation value of banks’ long-term assets. As in the Diamond-Dybvig model, Chang and Velasco’s framework does not explain why expectations can shift from the no-run to the run equilibrium. As a result, a domestic creditor panic can simply arise from sudden and inexplicable random events. As there are no runs by foreign depositors by assumption, a domestic creditor panic cannot induce a currency, and thereby a twin crisis.

In terms of the emerging market model, the switch between the no-run and the bank run equilibrium in Chang and Velasco’s model can be explained, as in the Diamond-Dybvig case, by a sudden change in the state of confidence parameter $\rho$, where $\rho > 0$ is associated with the no-run equilibrium, and $\rho < 0$ with the bank run equilibrium. As foreign exchange reserves stem only from foreign loans, implying that normalized reserves amount to $\lambda^* > 0$ where it holds that $b = 0$, a collapse of the fixed exchange system is not possible because, even in case of foreign depositor run, all payment commitments in foreign currency can be met.

In order to study the effects of a foreign creditor panic, Chang and Velasco’s assumption that banks always repay foreign debt even in case of a bank run because of foreign creditors’ willingness to roll-over debt on the same conditions as before, is given up. Accordingly, there arises now the possibility that in case of a domestic depositor panic, banks’ liquidation value does not suffice to meet all foreign payments commitments, making banks susceptible to self-fulfilling bank runs by domestic depositors, which are induced by shifts in expectations of foreign creditors. Chang and Velasco show that a run of domestic depositors is possible if and only if foreign creditors refuse to grant new loans or refuse to roll-over short-term debt, giving rise to a self-fulfilling banking panic. If foreign creditors fear the possibility of a domestic bank run they will refuse to grant new loans or to roll-over short-term debt, which makes banks susceptible to a bank run since banks’ liquidity and the stock of assets to meet depositors withdrawals has declined. If a run then actually occurs, foreign lenders’ pessimistic expectations, as well as their decision not to grant new loans and/or to roll-over existing loans are validated, i.e. expectations are self-fulfilling. If on the other hand, foreign creditors do not believe in the possibility of a domestic bank run, they are not going to refuse to extend new loans and/or to roll-over short-term debt, implying that a bank run is not going to occur, which validates also foreign creditors’ expectations ex post. However, Chang and Velasco’s model does also not explain why expectations can shift, i.e. the long-run equilibrium is determined by random events and independent of economic fundamentals.
According to Chang and Velasco, an important implication of foreign debt effects described above is the fact that the amount of foreign loans has no influence on banks’ fragility, but only the maturity structure, i.e. the more debt contracts are short-term, the higher the probability that foreign investors are not willing to roll-over debt because of the fear of a bank run. However, this implication only results from the assumption that banks do not have to pay interest on foreign loans, which is given up later on when exogenous shocks are studied as potential triggering events of bank runs.

In terms of the emerging market model, a domestic bank run induced by foreign creditors can be also explained by a shift of the state of confidence from \( \rho > 0 \) to \( \rho < 0 \), since domestic and foreign agents have been assumed to be subject to the same expectational climate. Chang and Velasco’s claim that the amount of foreign debt has no influence on the probability of a bank run can also be validated by the current model if interest payments on foreign debt are excluded, i.e. if an increase in \( \lambda^* \), indicating an increase in increase banks’ financial fragility, has no effects on \( r \) and \( q \), and thereby no effects on \( u, \hat{p}, j^*, i \) and \( b \), which implies that the balance sheet structure does not matter, but only the maturity. Consequently, as long as there are no interest payments on foreign debt, and as long as the maturity of debt and investment projects are synchronized there arises no possibility of a banking crisis, i.e. the financial structure does not matter according to the Modigliani-Miller theorem.

Concerning the link between bank runs and currency crises, Chang and Velasco show that monetary authorities can either save banks in case of a bank run or preserve the fixed exchange rate, but cannot do both, where the decision on whether to protect domestic banks or the fixed exchange rate, depends on the exchange rate regime. In case the monetary authority operates under a currency board, it cannot act as a lender of last resort in case of a bank run since liquidity supports to troubled banks, i.e. issuing new high powered money, are only possible if there is an equivalent increase in foreign exchange reserves. Consequently, under a currency board, a domestic bank run leads to disintermediation effects among the banking system but does not lead to a currency collapse since there are sufficient foreign reserves to meet the entire demand for foreign currency. By way of contrast, if the central bank acts as a lender of last resort under a “normal” fixed exchange rate system, a bank run can be prevented by providing sufficient liquidity to banks, but there arises the possibility of a currency crisis since the amount of domestic high powered money falls short of foreign exchange reserves. In case of a speculative attack, a currency crisis can only be avoided if the the central bank can acquire sufficient foreign assets from international lending organizations or foreign governments. One important implication of the model results is the fact that there arises no possibility of a twin crisis, as there is only a choice between a bank run or a currency crisis, being determined by the choice of the fixed exchange rate regime.

In terms of the emerging market model, a currency board regime is characterized by the condition \( h = \lambda^* + b \), whereas according to Chang and Velasco, it holds that \( h = \lambda^* \) at the outset, since it has been assumed that \( b = 0 \) at the beginning. As a result, in case foreign agents withdraw their funds due to a sudden drop in \( \rho \), leading to a domestic banking crisis and to a macroeconomic contraction, the fixed exchange rate can survive, since the entire demand for foreign currency can be met, and since the reduction of \( h \) and \( \lambda^* \) is compensated by an increase in \( b \) leaving the money supply unchanged. In case the central bank acts as lender of last resort under a “normal” fixed exchange rate regime,
the increase in \( h \) due to the liquidity support is compensated by a fall in \( b \) and does not stop further capital outflows stemming from a reduction in \( \lambda^* \) and in \( \rho \), leading to a currency crisis which, in case \( \lambda^* \) is comparatively high at the moment of devaluation, causes a contractionary devaluation.

Apart from the Diamond-Dybvig mechanism of self-fulfilling bank runs, Chang and Velasco study other causes of bank runs within their model framework, like e.g. financial liberalization, moral hazard and overinvestment, exogenous shocks and inconsistent macroeconomic policies. Though these causes of bank runs do not stem originally from self-fulfilling expectations, Chang and Velasco show that negative macroeconomic effects following these kinds of bank runs can be amplified by self-fulfilling expectations. Yet, these model extensions are not going to be discussed here, since they are applications of models which are going to be described in sections 5.5.1, 5.5.3 and 5.5.4.

**Self-Fulfilling Currency Crises.** Similar to Diamond-Dybvig's model bank run model, second-generation currency crises models by Flood and Garber (1984b) and Obstfeld (1986, 1994, 1997), generally abstracting from banking sectors, emphasize the role of self-fulfilling expectations as the trigger of currency crises.\(^38\) In contrast to first generation currency crises models, highlighting the inconsistency between the fixed exchange rate system and the course of macroeconomic policy, second generation models explain currency crises, following the closed-economy models by Barro and Gordon (1983a, 1983b)\(^39\), by governments facing a trade-off between price stability, being supported by a fixed exchange rate system, and other macroeconomic objectives, like e.g. high employment and low interest rates. As long as the benefits of the fixed exchange rate system, i.e. the benefits of price stability, outweigh the costs, like e.g. high domestic interest rates, low employment and a loss of reputation in case of a devaluation, the fixed parity is maintained. Second generation models explicitly assume, in contrast to first generation models, that the costs of a peg do not depend on the level of foreign exchange reserves by assuming that governments can lend reserves without any restrictions from international organizations. By way of contrast, the cost-benefit relation of the fixed exchange rate system depends on private agents' expectations. Accordingly, a sudden shift of expectations towards a devaluation of the home currency can induce governments to abandon the peg, since costs in the form of higher interest rates or lower employment induced by higher inflation expectations and wages outweigh the benefits. Since governments follow the shift in market sentiments, expectations become self-fulfilling. If, on the contrary, market participants expect the peg to be credible, there arise no higher costs, leading actually to a stable exchange rate validating also expectations. Still, second generation models provide no explanation, as the entire bank run literature, for the shift in expectations, i.e. for the switch from a "no-attack-equilibrium" to an "attack equilibrium".

Obstfeld (1994) develops two models highlighting different transmission channels for the occurrence of self-fulfilling currency crises. In his first model, the domestic government maintaining a fixed exchange rate in order to stabilize the domestic price level (PPP is assumed to hold) is indebted in domestic currency at a floating interest rate. Further-

\(^38\) For a detailed discussion of second generation currency crises models, see Radke (2000b) and (2000c). An overview of first and second generation currency crises models can also be found in Flood and Marion (1998).

\(^39\) For open economy extensions of the Barro-Gordon model, see e.g. Spahn (1996, 1997).
more, uncovered interest parity is assumed to hold leading to higher debt costs of the
domestic government if foreign interest rates increase and/or devaluation expectations
arise. The government faces a trade-off between maintaining the peg and benefiting from
price stability, and comparatively high debt costs which could be minimized by aban-
doning the peg in order to pursue an independent low interest rate policy. As long as
the benefits outweigh the costs, the peg will be maintained, where costs depend crucially
on private agents’ expectations regarding the sustainability of government debt. Accord-
ing to Obstfeld, there arise two possible self-fulfilling equilibria depending on the state
of expectations, one leaving the exchange rate unchanged, and the other one leading to
a breakdown of the fixed parity. The “no-attack equilibrium” prevails if private agents
believe in government debt to be sustainable at current interest rates, i.e. if agents do
not expect the government to devalue the domestic currency in order to lower interest
rates, and thereby debt costs. As a result, there arise no devaluation expectations, and
domestic interest rates remain at foreign levels, not forcing the government to devalue.
Private agents’ expectations are self-fulfilling since expecting the exchange rate to remain
unchanged leads to sustainable debt costs, and thereby to a maintenance of the peg. If,
on the contrary, private agents expect the government debt not to be sustainable at cur-
rent interest rates, they expect the government to devalue in order to lower interest rates
by expansionary monetary policy. Emerging devaluation expectations lead to higher do-
mestic interest rates according to UIP, increasing debt costs and forcing the government
to devalue actually if interest rates have risen to a level on which costs of the peg out-
weigh the benefits. Expectations in the “attack equilibrium” are also self-fulfilling, since
expecting the government to devalue creates conditions, here rising interest rates, which
actually force the government to devalue.

Obstfeld’s second model emphasizes the government’s trade-off between maintaining
price stability by a credible fixed exchange rate regime, and a high level of employment, as
the fixed parity does not allow to react on adverse output shocks reducing employment, by
realignments of the fixed exchange rate. Output and employment are assumed to depend
negatively on real wages, where the domestic price level is fixed due to a fixed exchange
rate system (PPP is assumed to hold). Nominal wages are positively dependent on in-
flation expectations which coincide with devaluation expectations of the home currency.
Output and employment are also assumed to be influenced stochastically by positive or
negative shocks. As a discretionary fixed exchange rate system induces, following the
model results by Kydland and Prescott (1977), and Barro and Gordon (1983a, 1983b),
an inflation bias by steady devaluations, the government is assumed to follow a rule of
maintaining a fixed parity, but is allowed to abandon the rule when disturbances to the
economy are too large and too costly. In order to avoid that such “escape clauses” also
induce an inflation bias by steady devaluations, governments have to bear additional fixed
costs, as e.g. in the form of a penalty fee, in case of a realignment. As a result, the fixed
exchange rate prevails as long as costs in the form of deviations from price and output
targets are lower than costs of using the “escape clause” leading to a devaluation of the
home currency. However, costs arising from deviations of prices and output from their
target levels depend heavily on private agents’ expectations, generating multiple outcomes
for a given shock. If private agents believe in stability of the fixed exchange rate in case

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40 “Escape-clause” models were originally developed by Flood and Isard (1989), and Persson and
of a given negative shock, nominal wage demands are moderate and deviations from the output target are only caused by a stochastic shock leaving the fixed parity unchanged. Expectations are self-fulfilling since agents believe in the stability of the fixed exchange rate in case of a given shock, which does not increase the costs of maintaining the fixed parity, and thereby does not lead to a devaluation. If, by way of contrast, private agents expect the government to devalue in case of the occurrence of the same given negative shock, wage demands increase and output is reduced, on the one hand by rising real wages, and on the other hand by the negative shock. As a result, in case the economy is actually hit by a negative shock, the government is forced to devalue since costs have increased due to deteriorating expectations. Expectations are again self-fulfilling since arising devaluation expectations increase the costs of maintaining the peg in case of a shock, leading to a devaluation of the home currency in case the shock actually hits the economy.

In order to describe second generation currency crises models by means of the emerging market crisis model assume firstly, that the stock of normalized foreign exchange reserves \( \lambda^* + b \) is irrelevant for the maintenance of the fixed exchange rate since reserves can be lent from international organizations, and secondly, that the foreign debt-asset ratio \( \lambda^* \) is comparatively small triggering a macroeconomic expansion in case of a devaluation. In order to show how rising interest rates due to devaluation expectations can trigger a currency crisis assume that \( i \) denotes the interest rate on domestic government bonds, and that the government abandons the peg in case \( i \) reaches a certain threshold level. In case there arise no devaluation expectations, it holds that \( d\rho = 0 \) leaving \( i \) unchanged and implying the maintenance of the peg. If, on the other hand, agents expect a devaluation, \( \rho \) declines leading to a rise in \( i \) and, if a certain threshold level is exceeded, to a suspension of the peg.

In order to show how a shift in expectation can trigger a crisis in case of stochastic real sector shocks, assume that the wage share \( v \) depends negatively on \( \rho \), stating that in case of devaluation expectations wage pressure increases, where negative real sector shocks are represented by a rise in the depreciation rate \( \delta \). The government is assumed to maintain the peg as long as cost evolving from capacity utilization, being negatively influenced by increases in \( v \) and \( \delta \), and from the inflation rate deviation from their target levels is smaller than costs which are imposed in case of a devaluation. In case agents do not expect the government to devalue in case of a negative technology shock of size \( d\delta = x \), costs in the form of reduced capacity utilization only emerge from a rise in \( \delta \), leaving the peg unchanged. If, on the contrary, agents expect the government to devalue in case of a negative technology shock of the same size \( d\delta = x \), \( \rho \) declines, leading to a rise in \( v \), and inducing a reduction in \( u \). In case the negative technology shock actually hits the economy, the shock-induced reduction in \( u \) leads to a suspension of the peg.

5.5.3 Asymmetric Information Models

Unpredictable Bank Runs Due to Asymmetric Information and Exogenous Shocks Without Foreign Borrowing. Models by Calomiris, Gorton, Chari and Jagannathan\(^{41}\) have stressed that widespread bank runs can be triggered by exogenous shocks, not by self-fulfilling expectations, since depositors cannot find out, after a neg-

\(^{41}\)See section 4.5.3 for references.
ative shock has hit the banking systems, which banks are still solvent and which banks have gone bankrupt due to information asymmetries, and therefore are going to run all banks. Bank runs remain an unpredictable event since there is no possibility to determine the probability of the negative shock’s occurrence. These closed-economy models abstract from foreign borrowing by banks.

Rendering this approach into the emerging market model requires that the foreign debt-asset ratio takes a value of zero, i.e. $\lambda^* = 0$, in order to exclude foreign borrowing. A widespread bank run occurs if a negative shock leads to liquidity and solvency problems among firms and banks via a deterioration of Tobin’s $q$, which causes a widespread disbelief in the healthiness of the banking system, being indicated by a fall in the state of confidence parameter from $\rho > 0$ to $\rho < 0$. According to the emerging market model, shocks leading a drop in $q$ and $\rho$, and triggering a bank run, can be a tightening up of financial market regulation, i.e. an increase in $\alpha$, negative productivity shocks like an increase in the wage share $v$ and in the depreciation rate $\delta$, or a foreign interest rate shock being represented by a sharp increase in $i^*$. In case a bank run occurs, there is a sharp macroeconomic contraction indicated by comparatively low values in $u, r, \hat{p}, q$ and $b$, and by comparatively high levels of interest rates $j^*$ and $i$, causing possibly a twin crisis if $b = 0$.

The Likelihood of Bank Runs and Twin Crises Due to Exogenous Shocks in Open Economies With Foreign Borrowing. The above-cited closed-economy bank run models by Calomiris, Gorton, Chari and Jagannathan state that bank runs generally occur if the banking system is hit by an adverse shock, but do not specify explicitly the extent, or threshold values of a shock being necessary to trigger a run. That is, these models do not distinguish among small shocks causing no bank runs, and large shocks causing widespread bank runs. Goldfajn and Valdés (1997b) try to overcome this drawback by introducing a known probability distribution of a domestic productivity shock, making it possible to calculate the likelihood of financial crises. Their model is based on an open economy version of Diamond-Dybvig’s bank run model similar to Chang and Velasco’s approach\(^{42}\), in which domestic banks offer short-term deposits only to foreign agents and invest the funds into a long-run domestic risky technology, needing time to mature, and whose return is a random variable, being dependent on random productivity shocks for which a probability distribution is known. Foreign investors can choose to invest their funds either in a secure, short-term international asset or into deposits of the domestic banking system. As in the Diamond-Dybvig model, bank runs have devastating effects on the domestic economy, since early deposit withdrawals by foreign investors make banks liquidate their investments in the long-term technology, leading to bank failures, as the short-run liquidation value of banks’ long-term assets is less than the nominal value of deposits.

In contrast to Diamond-Dybvig’s and Chang and Velasco’s models, bank runs are caused by large adverse random productivity shocks, and cannot arise from self-fulfilling expectations. Hence, foreign investors are going to engage in massive early withdrawals if an adverse productivity shock hits the economy, leading to a fall of the domestic technology’s return to a value which is lower than the return of the international short-term asset. Since the probability distribution of the productivity shock is known, Goldfajn and Valdés’ model is able to determine the probability of a bank run, as well as the thresh-

\(^{42}\)See section 5.5.2 for references.
old value of the productivity shock leading to a lower return of the domestic technology. In case the central bank does not own sufficient reserves to meet all capital outflows, a currency crisis is going to follow the domestic bank run whose probability also can be determined.

However, the logic of twin crises can also run from devaluation expectations to domestic bank runs which are followed by a currency crash. If the central bank is forced to devalue the domestic currency in case of a lack of sufficient foreign exchange reserves, foreign investors' return of holding domestic deposits is going to be reduced, i.e. devaluation expectations depend on the one hand on the extent of the productivity shock inducing investors to withdraw possibly funds early, and on the other hand, on the level of foreign exchange reserves like in first-generation currency crises models, since a higher stock of foreign exchange reserves reduces the probability of a devaluation, thereby reducing the probability of a fall in the return of the domestic technology. As a result, if there is a low stock of foreign reserves, the probability of a bank run and a subsequent currency crisis increases. Among domestic productivity shocks, Goldfajn and Valdés also demonstrate the occurrence of twin crises in case of a foreign interest rate shock, increasing the return of the safe short-term international asset.

Rendering Goldfajn and Valdés' approach into the emerging market model requires that the occurrence of a bank run is defined by Tobin's $q$ falling short of a lower threshold value $q_L$. An exogenous productivity shock leading to such a fall in Tobin’s $q$ can be caused by an increase in the wage share $v$, by a fall in the depreciation rate $\delta$, and by an increase in the foreign interest rate $i^*$. If one assumes probability distributions for different realizations of $v, \delta$ and $i^*$, probabilities for realizations values being lower than $q_L$ triggering a bank run can be calculated. A bank run causes a macroeconomic contraction, being represented by a declining values of $u, r, \tilde{p}$, and by rising values of $j^* \text{ and } i$. Capital outflows are represented by a fall in $\lambda^*$ and $b$, leading to a currency crisis in case $b + \lambda^*$ do not suffice to meet all outflows.

In order to describe the twin crisis logic which runs from devaluation expectations to bank runs, consider that the state of confidence $\rho$, also representing expected changes of the exchange rate, depends positively on realizations of Tobin’s $q$ like in the long-run dynamic analysis, and on normalized foreign exchange reserves $b + \lambda^*$. The lower foreign exchange reserves are, the lower $\rho$ becomes, leading to a fall in Tobin’s $q$, and, if $q$ falls short of $q_L$, to a banking crisis, which is followed by a speculative attack in case $b + \lambda^*$ do not suffice to meet all outflows. This case is also subject to a severe macroeconomic contraction which is deteriorated in case of a contractionary devaluation.

**Moral-Hazard-Driven Financial Crises in Emerging Markets Caused by Exogenous Shocks or Self-Fulfilling Expectations.** The analysis of moral hazard driven financial crisis models without foreign borrowing in section 4.5.3 has shown that the combination of government guarantees to bail out troubled banks, and the existence of an exogenous upper bound of governments' financial support, can generate financial crises by distorting incentives of banks, engaging in much riskier investment projects than it would be optimal under a regime without government guarantees. When it becomes obvious that government rescue packages necessary to bail out troubled banks exceed the limit of governments' financial support, caused either by exogenous shocks or by self-fulfilling
expectations, and the government is forced to suspend its guarantees, bank runs will be the inevitable consequence.

Moral hazard driven financial crises in emerging markets differ from crises in industrial countries, as governments not only guarantee financial claims of domestic investors, but also financial claims of foreign investors in case of lenders', mostly domestic banks', default. As a result, the promise to bail-out domestic and foreign investors implies on the one hand, a guarantee to bail-out the domestic banking system, and on the other hand, a guarantee to maintain a fixed exchange rate level by the use of foreign exchange reserves, which makes domestic borrowers, as well as foreign lenders not to hedge against exchange rate risk, leading to further overinvestment due to overborrowing in foreign currency. Hence, financial support policies in emerging market countries are not only limited by an exogenous bound to support troubled banks by generating extra fiscal deficits, but additionally by the stock of foreign exchange reserves. According to emerging market crises models, triggering events causing the suspension of fixed exchange rate regimes and/or financial support policies for domestic banks, can be either exogenous shocks or self-fulfilling expectations.

Burnside, Eichenbaum and Rebelo (1998) emphasize the self-fulfilling nature of twin crises emerging from government guarantees. In their model, banks take deposits from foreign investors in foreign currency and lend to domestic agents in domestic currency, whereas foreign creditors' claims are protected by government guarantees. The protection of foreign investors' claims by the government causes domestic banks not to hedge against exchange rate risk, leading to overborrowing and excessive capital inflows, since the stock of foreign debt would be much smaller if there was no guarantee to hedge domestic banks against exchange rate risk. Domestic banks are assumed to declare bankruptcy in case of a devaluation and renege on their foreign debt. Consequently, a devaluation transforms contingent government liabilities into actual government liabilities. Furthermore, the government is assumed either to be unwilling, or to be unable to bail out foreign investors in case of a default of domestic banks by a fiscal reform, i.e. by tax finance to maintain a balanced fiscal budget, but engages in seignorage finance. Foreign investors however, do not know in advance that there will be an actual seignorage finance in case of default, but can only expect the government either to carry out a fiscal reform, or to bail out foreign investors by seignorage finance.

These model assumptions generate multiple equilibria giving rise to self-fulfilling financial crises. In case foreign investors believe in the commitment of the domestic government to bail out domestic banks without making use of seignorage finance, but by a fiscal reform (increasing taxes), there arise no devaluation expectations and no capital outflows leaving the exchange rate unchanged. As a result, there are no bankruptcies among banks which would call for government intervention, validating foreign investors' optimistic expectations. If, by way of contrast, foreign investors believe that, in case of default, the domestic government finances banks' foreign debt by seignorage, there arise devaluation expectations, leading to large capital outflows, and after some time, to an actual devaluation of the domestic currency, causing bankruptcy among banks. Since the government is actually not willing or not able to bail out foreign investors by a fiscal reform, bankruptcy among domestic banks leads to seignorage finance thereby validating investors' shift towards pessimistic expectations. According to the model, the shift in expectations is random and not explained, as in other self-fulfilling expectations models.
In contrast to the self-fulfilling nature of moral hazard driven financial crises, there are various authors emphasizing the role of adverse real shocks leading to a suspension of government guarantees, and thereby triggering a twin crisis. According to Velasco (1987) and Corsetti, Pesenti and Roubini (1998), an exogenous decline in output or productivity leads to negative cash flows by firms and banks which can be compensated by borrowing from abroad at a risk-free international interest rate. Foreign borrowers are willing to lend to potentially illiquid domestic banks and firms due to the existence of government guarantees. When foreign borrowing has reached an upper bound, and foreign investors are not longer willing to increase their lending, e.g. due to an exogenously given debt ceiling by international financial markets, then firms and banks become illiquid, inducing a domestic banking crisis, and implying that banks’ liabilities are transformed into government liabilities. Depending on the nature of foreign debt’s repayment, and on the initial stock of foreign exchange reserves, a currency crisis can follow in case foreign exchange reserves do not suffice to meet foreign debt repayments.

According to Dooley’s (1997, 2000) approach, a decline in international interest rates leads to an increase in the stock of the domestic government’s net foreign exchange reserves due to a reduction in foreign government debt. This increase in government reserves is used to set up a domestic deposit insurance system which guarantees banks’ liabilities. These credible government guarantees lead to capital inflows increasing domestic banks’ stock of foreign debt. Banks are assumed not to plan to repay the full amount of their insured liabilities due to government guarantees, enabling them to engage in much riskier investment projects, leading to overborrowing in foreign currency. Foreign investors are willing to increase lending until banks’ total liabilities equal the size of government’s net foreign exchange reserves. Eventually, owing to steady overborrowing by domestic banks, foreign investors are going to run on domestic banks when foreign debt has reached the amount guaranteed by the government. As the government is assumed to cover fully banks liabilities, there are no foreign exchange reserves left to stabilize the fixed exchange rate, leading to a currency and to a twin crisis.

McKinnon and Pill (1996, 1997, 1998, 1999) emphasize the role of positive exogenous shocks, like financial liberalization or other economic reforms, in combination with deposit insurance systems to bail out domestic, as well as foreign creditors of banks, leading to overinvestment and overborrowing in domestic, as well as in foreign currency. In their model, liberalization policies allow for the use of a new investment technology financed by the domestic banking system whose return is subject to a probability distribution. Due to the existence of government guarantees, banks and firms do not rely on the “true” expected value of profits of the new investment technology, but on a distorted expected value which is much higher, since in case of default, losses are covered by the government. As a result, distorted incentives lead to overinvestment and overborrowing, which is additionally accelerated by foreign borrowing by domestic banks, allowing them to grant more loans. Twin crises are triggered by an exogenous “bad” realization of the investment technology, leading to an unexpected large drop in firms’ earnings and causing huge losses among firms and banks which the government is not able, or unwilling to finance. Thus, a domestic banking crisis is going to occur, being followed by a currency crisis in case foreign exchange reserve do not suffice to meet all capital outflows.

In terms of the emerging market financial crisis model, the overinvestment and overborrowing phase can be explained by an increase in the state of confidence $\rho$, caused
by distortions in risk perception by firms and banks due to the existence of government guarantees as already outlined in section 4.5.3. Accordingly, overestimation of profits and underestimation of potential risk leads to a macroeconomic expansion being represented by an increase in $u, r, \bar{p}, q$, and by a decline in $j^*$ and $i$. Due to the favourable economic environment, there are large capital inflows represented by an increase in $b$, and by an increase in the foreign-debt asset ratio $\lambda^*$ which slows down the macroeconomic expansion but is not able to compensate the positive effect of $\rho$.

A self-fulfilling financial crises can emanate from a shift towards pessimistic expectations regarding the maintenance of government guarantees without any fundamental cause. If the government is expected not to be willing, or to be unable to maintain the guarantees at all, or is believed to use seignorage finance to bail-out banks as outlined by Burnside, Eichenbaum and Rebelo (1998), there is a drop in the state of confidence parameter $\rho$, representing on the one hand, the “real” expected profit rate in case guarantees are absent, and on the other hand, devaluation expectations caused by inflation expectations stemming from expected seignorage finance. If the drop in $\rho$ is large enough, the macroeconomic contraction, being represented by a decline in $u, r, \bar{p}, q$, and a rise in $j^*$ and $i$, causes widespread losses among firms and banks whose accumulated value exceeds the upper bound of the government’s financial support policy. If the government simply abandons guarantees, banks and firms go bankrupt, leading to a bank run by foreign investors which is followed by a currency crisis, since foreign exchange reserves do not suffice to meet all capital outflows, leading to a further macroeconomic contraction due to a contractionary devaluation. If, on the other hand, the government bails out foreign investors, but relies partly on seignorage finance in order to prevent a bank run, being represented by a large increase in $h$, this policy has also its natural bound since it leads to a decline of foreign exchange reserves $b$, causing a currency crisis which leads to a contractionary devaluation and bankructcies among banks and firms, inducing eventually a bank run of foreign investors. In both cases, the occurrence of twin crises stemming from an ex ante shift towards pessimistic expectations validates ex post investors’ expectations. If, by way of contrast, agents believe either in the maintenance of government guarantees, or in the absence of seignorage finance in case of default, there is no drop in $\rho$, implying stability of the financial system which validates investors’ optimistic expectations.

A shock-triggered financial crisis is represented by an actual fall in the profit rate $r$, caused e.g. by negative productivity shocks like increases in $v$ and $\delta$, or by international financial market shocks like increases in $\alpha$ or $i^*$, leading to a decline in $q, u, \bar{p}, b$, and to an increase in $j^*$ and $i$. In case the exogenous shock is large enough, and government guarantees cannot be maintained, there are widespread bankruptcies among firms and banks, causing a fall in $\rho$ to its “true” value, and leading to a full-fledged twin crisis by the mechanisms outlined above.

### 5.5.4 Credit Constraint and Balance Sheet Models

**Fourth-Generation Crises Due to Exogenous Shocks.** As described in section 4.5.4, fourth-generation models define a financial crisis as a credit crunch, leading to a drop in investment and output via a reduction in banks’ and/or firms’ collateral values which can be caused either by exogenous shocks or by self-fulfilling expectations. Fourth-generation financial crisis models referring to emerging markets differ from models of
industrial countries by emphasizing that emerging market countries face, in contrast to industrial countries, an international credit constraint in foreign currency, stemming from the “original sin” hypothesis. Hence, a financial crisis in emerging markets is defined as a situation in which the international credit constraint becomes binding, leading to reductions in investment and output.


In terms of the emerging market country model, negative productivity shocks like an increase in $v$ or $\delta$, or international financial market shocks as an increase in $a$ or $i^*$, lead to a reduction in $r, q, u, \hat{p}, b$ and to an increase in $j^*$ and $i$, being amplified by a fall in $\rho$, triggering banking and currency crises. In case the foreign debt-asset ratio is comparatively high, the devaluation of the home currency, i.e. $\delta > 0$, is contractionary.

Fourth-Generation Crises Due to Self-Fulfilling Expectations. Fourth-generation financial crises driven by self-fulfilling expectations have been discussed mainly by theoretical models by Krugman (1999a, 1999b, 2001) and by Aghion, Bacchetta and Banerjee (2000, 2001, 2003). In order to explain the basic logic of these approaches, this paragraph refers to Krugman’s modified Mundell-Fleming open-economy emerging market version of fourth-generation crisis models outlined in Krugman (1999a, 2001), which analyzes the interdependence of exchange rate variations, net worth and output fluctuations when firms’ balance sheets are characterized by a considerable stock of debt denominated in foreign currency, and when investment activities are balance sheet constrained, i.e. when the availability of external investment finance depends positively on firms’ net worth. Accordingly, for favourable levels of the exchange rate, the nominal value foreign debt in domestic currency is comparatively low, leading to a comparatively high level of net worth, stimulating investment demand. By way of contrast, adverse exchange rate levels lead to comparatively low net worth positions which dampen investment demand.

The aggregate effect of exchange rate variations on aggregate demand and output however, depends on the relative strength of the indirect balance sheet effect on investment in comparison with the direct effect on export competitiveness. Krugman assumes that for very low and for very high levels of the exchange rate, the export competitiveness effect dominates. If, for a given level of foreign indebtedness, the exchange rate is very low, firms’ leverage is comparatively low, implying that a devaluation of the home currency does only increase firms’ leverage to a small extent, whereas net exports’ positive reaction is comparatively high. By way of contrast, if, for a given level of foreign debt, the exchange rate level is very high, firms are highly leveraged, implying that investment demand is almost zero, and that a devaluation of the home currency does only lead to a tiny contraction in investment demand, whereas net exports increase significantly. In the medium, and in the relevant range for exchange rate variations however, the balance sheet effect is assumed to dominate the export competitiveness effect, i.e. devaluations of the home currency are assumed to be contractionary. Furthermore, UIP is assumed to
hold, and monetary authorities are modelled as “leaning against the exchange rate” due to the general “fear of floating” argument when foreign debt is high.

The model dynamics generate two stable equilibria, where one equilibrium is associated with a stable macroeconomic environment, and the other one with the occurrence of financial crises. The “no-crisis” equilibrium is characterized by a favourable exchange rate, leading to a comparatively low value of foreign debt in domestic currency, high net worth, high investment demand and high output. On the contrary, the “crisis” equilibrium is subject to a comparatively high level of the exchange rate, a high foreign debt stock in domestic currency, low net worth, low investment demand and low output. Krugman argues that there is no mechanism guaranteeing the prevalence of the “no-crisis” equilibrium, i.e. whether an economy faces a full-fledged financial crisis or not depends solely on the state of expectations. If international investor confidence is strong in domestic business firms, there will be no withdrawal of funds, leaving the exchange rate unchanged, and leading to the “no-crisis” equilibrium which validates international investors’ expectations. If, on the contrary, international investors lose confidence in the firm sector and start to withdraw their funds, the exchange rate appreciates, leading to an increase in foreign debt and to a drop in net worth, investment and output, inducing a systemic financial crisis which validates investors’ pessimistic expectations. Krugman argues that the triggering event catapulting an economy from the “no-crisis” to the “crisis” equilibrium may be a small random incident, or simply a shift of expectations without any cause.

The application of the Krugman model to the emerging market model requires that the foreign debt-asset ratio \( \lambda^* \) takes comparatively high values to allow for contractionary devaluations. Furthermore, since the Krugman model operates under a flexible exchange rate regime, the “no-crisis” equilibrium has to be consistent with the prevalent fixed exchange rate, i.e. it holds that \( s = 0 \), whereas the “crisis” equilibrium has to be subject to a currency crisis, i.e. the central bank runs out of foreign exchange reserves leading to a devaluation of the home currency, i.e. to \( s > 0 \). Generally, the “no-crisis” equilibrium is characterized by a favourable state of confidence, i.e. by \( \rho > 0 \), thereby leading to comparatively high levels of \( u, r, \hat{p}, q \) and \( b \), and to very low values of \( j^* \) and \( i \), validating investors’ optimistic expectations. If, on the contrary, investors expect a downturn of the economy, the state of confidence drops to \( \rho < 0 \), leading to a macroeconomic contraction, and thereby validating investors’ pessimistic expectations. The “crisis” equilibrium is characterized by comparatively low levels of \( u, r, \hat{p}, q \) and \( b \), and by comparatively high levels of \( j^* \) and \( i \) which are going to deteriorate when the domestic currency devalues, i.e. when \( s > 0 \), and a twin crisis is going to occur.

5.5.5 Endogenous Financial Crisis Models

Minsky’s Financial Instability Hypothesis in the Open Economy. This paragraph extends Minsky’s closed economy model to financial crises in open economies, and especially to financial crises in emerging markets being characterized by a large swings in short-term foreign debt. The following analysis only sets outs open economy modifications of the closed economy version having been discussed in section 4.5.5.

The Minskian open economy approach also consists of the five theoretical components as discussed in section 4.5.5, where only the first component, Minsky’s theory of financial stability, has to be enlarged by open economy considerations as set out in sections 2.3.2.3.
and 2.3.2.4 by the introduction of foreign hedge, speculative, and Ponzi finance units. A typical Minsky cycle in emerging market countries begins with liberalization and/or macroeconomic stabilization policies (predominantly exchange rate based stabilization programmes) which are established to boost economic growth, or to stabilize macroeconomic aggregates due to past unsound policies which led to high inflation, low growth and to financial crises. The introduction of liberalization and stabilization policies generally causes a sharp increase in domestic interest rates due to the abolition of interest rate caps, disinflationary monetary policies, and due to a limited supply of credit stemming from underdeveloped domestic financial systems still suffering from past financial repression. As both liberalization policies and exchange rate based stabilization programmes are commonly associated with liberalized capital accounts, the most important source of finance is foreign debt, predominantly stemming from industrialized countries. As foreign creditors want to minimize uncertainties regarding future inflation, future exchange rates, future financial stability, etc., foreign debt-contracts are generally short-term. Moreover, foreign interest rates (in industrial countries) tend to be much lower than domestic ones due to higher exchange rate credibility, lower inflation, lower financial risk, etc. By way of contrast, domestic expected profit rates are generally much higher than foreign ones, as capacity utilization in emerging markets tends to be low and markets are not saturated, implying that a rise in investment and output leads to a quick and large rise in actual profits.

Low foreign interest rates, credible liberalization and stabilization programmes, and a comparatively high expected profit rate in emerging markets induce an endogenous build-up of financial fragility in emerging markets as profits can be realized by expanding investment which is financed by large short-term capital inflows. Accordingly, the introduction of liberalization and stabilization policies in emerging market countries is followed by a cumulative upward process by the interaction of actual profits, expected profits, and investment, which is financed by an increase in short-term debt. The foreign debt-led investment boom causes a substantial increase in financial fragility firstly, by a decline in the ratio of foreign hedge finance units to foreign (super) speculative and Ponzi finance units, and secondly, by an increase in the overall debt-asset ratio as investment expenditures and expected profits commonly grow faster than investment due to chartist-type behaviour of agents.

The boom phase comes to an end by endogenously rising labour and material costs which lead to a fall in the actual profit rate. Declining profits induce large capital outflows and rising short-term foreign interest rates due to endogenously increasing risk premia, leading to present value reversals, and financial posture downgrading. Rising capital outflows and rising foreign interest rates end up in a domestic banking crisis which is deepened by a subsequent currency crisis when foreign exchange reserves do not longer suffice to meet capital outflows. The twin crisis leads to a severe recession or even depression with deflationary spirals. In contrast to industrial countries, lender of last resort interventions by emerging market authorities to prevent a full-fledged systemic twin crisis are not possible. Following the results of Minsky's closed economy model, only an expansionary fiscal policy and increasing government budget deficits can induce a recovery.

In terms of the model, Minsky's open economy approach can be illustrated by the dynamic Keynesian version, being depicted in figure 5.9, and possibly giving rise to recurrent endogenous financial crises due to pure chartist-type behaviour of agents.
Other Approaches. There are similar approaches to financial crises in emerging markets which are associated with excessive boom-bust cycles in goods and financial markets, and large swings in capital flows, as e.g. works of Borio and Lowe (2002), Borio, Furfine and Lowe (2001), which however, as argued in section 4.5.5, provide only an empirical and descriptive analysis, and no theoretical foundation.

5.5.6 An Assessment

The results of the analysis of the differences, common grounds and new elements of the industrial country model in comparison with standard approaches to financial crises, outlined in section 4.5.6, are also valid for the comparison of the emerging market country model with standard models of financial crises and can be completely applied.

5.6 A Comparison with Standard Business Cycle Theory

The discussion of common grounds, differences and new elements of the present approach to financial crises and endogenous fluctuations in industrial countries in comparison with standard theory of business cycles, outlined in section 4.6, can be fully applied to the model results regarding financial crises and business cycles in emerging markets except for the difference that in emerging markets business cycles are mainly driven by capital flows in foreign currency, and not by domestic financial flows in domestic currency.
5.7 Mathematical Supplements

All partial derivatives summarized qualitatively in table 5.1 are given explicitly below. The signs of partial derivatives with respect to the exchange rate’s growth rate \( \dot{s} \) depend on the level of foreign debt; for a comparatively high foreign debt-asset ratio \( \lambda^* \) the signs are marked by \(^1\), and for a relatively low foreign debt-asset ratio by \(^2\). For all partial derivatives, except for derivatives with respect to \( \dot{s} \), it has been assumed that \( \dot{s} = 0 \) because of the fixed exchange rate regime.

Response of Capacity Utilization \( \dot{u} \) to Various Shocks.

\[
\begin{align*}
\frac{\partial \dot{u}}{\partial \lambda} &= \frac{1}{|J|} (-j \eta \lambda^{*s}) < 0 \\
\frac{\partial \dot{u}}{\partial j} &= \frac{1}{|J|} (-m \eta \lambda^{*s}) < 0 \\
\frac{\partial \dot{u}}{\partial \lambda^*} &= \frac{1}{|J|} (-m \eta (1 + \lambda^* + j^* \lambda^{*s})) < 0 \\
\frac{\partial \dot{u}}{\partial \rho} &= \frac{1}{|J|} (-m((-1 + \beta) \eta \lambda^{*s} + g_{i-\rho} \beta(-\lambda^{*s} + (1 + \lambda^*) \lambda^{*s}))) > 0 \\
\frac{\partial \dot{u}}{\partial h} &= 0 \\
\frac{\partial \dot{u}}{\partial m} &= 0 \\
\frac{\partial \dot{u}}{\partial s} &= \frac{1}{|J|} (\eta \lambda^{*s} + m \eta \lambda^{*s} (1 - \lambda^*)) \lambda^{*s} < 0^1, > 0^2 \\
\frac{\partial \dot{u}}{\partial v} &= \frac{1}{|J|} (-m \eta \lambda^{*s}) < 0 \\
\frac{\partial \dot{u}}{\partial \delta} &= \frac{1}{|J|} (-m \eta \lambda^{*s}) < 0 \\
\frac{\partial \dot{u}}{\partial \alpha} &= \frac{1}{|J|} m \eta (1 + \lambda^*) \lambda^{*s} < 0 \\
\frac{\partial \dot{u}}{\partial i^*} &= \frac{1}{|J|} (-m g_{i-\rho}(-\lambda^{*s} + (1 + \lambda^*) \lambda^{*s})) < 0
\end{align*}
\]
Response of the Profit Rate $r$ to Various Shocks.

\[
\frac{\partial r}{\partial \lambda} = \frac{1}{|J|} (-j m(\lambda_j^s - \lambda_q^s)) < 0
\]

\[
\frac{\partial r}{\partial \lambda^*} = \frac{1}{|J|} m((-1 + v)\eta_q - \lambda^* + j^*(-\lambda_j^s + \lambda_q^s)) < 0
\]

\[
\frac{\partial r}{\partial \rho} = \frac{1}{|J|} m((-1 + v)g_{i-p}(\lambda_j^s + \lambda_q^s) + (1 + \beta_\rho)((-1 + v)\eta_q \lambda_j^s - \lambda^* \lambda_q^s)) > 0
\]

\[
\frac{\partial h}{\partial r} = 0
\]

\[
\frac{\partial \delta}{\partial m} = 0
\]

\[
\frac{\partial \delta}{\partial r} = \frac{1}{|J|} m((-1 + v)n x_{s-p} + \lambda^*)(\lambda_j^s - \lambda_q^s)) < 0^t, > 0^t
\]

\[
\frac{\partial \delta}{\partial v} = \frac{1}{|J|} (-m u(\lambda_j^s - \lambda_q^s)) < 0
\]

\[
\frac{\partial \delta}{\partial \lambda^*} = \frac{1}{|J|} (-m(\lambda_j^s - \lambda_q^s)) < 0
\]

\[
\frac{\partial \alpha}{\partial r} = \frac{1}{|J|} m((1 - v)\eta_q + \lambda^*) \lambda_{\alpha}^s < 0
\]

\[
\frac{\partial \lambda^*}{\partial r} = \frac{1}{|J|} m((-1 + v)g_{i-p}(\lambda_j^s + \lambda_q^s)) < 0
\]
Response of the Growth Rate of the Price Level $\dot{\rho}$ to Various Shocks.\textsuperscript{43}

\[
\frac{\partial \dot{\rho}}{\partial \lambda} = \frac{1}{|J|} (-m \eta_q \lambda_j^{ss} \psi_u) < 0
\]

\[
\frac{\partial \dot{\rho}}{\partial \lambda^*} = \frac{1}{|J|} (-m \lambda \eta_q \lambda_j^{ss} \psi_u) < 0
\]

\[
\frac{\partial \dot{\rho}}{\partial \lambda} = \frac{1}{|J|} (-m \eta_q (1 + \lambda^* + j^* \lambda_j^{ss}) \psi_u) < 0
\]

\[
\frac{\partial \dot{\rho}}{\partial \rho} = \frac{1}{|J|} m (1 - \beta_\rho) \eta_q \lambda^* + g_{i-\rho} \beta_\rho (\lambda^* - (1 + \lambda^*) \lambda^{*ss}) \psi_u > 0
\]

\[
\frac{\partial \dot{\rho}}{\partial h} = 0
\]

\[
\frac{\partial \dot{\rho}}{\partial m} = 0
\]

\[
\frac{\partial \dot{\rho}}{\partial s} = \frac{1}{|J|} m (-\eta_q \lambda^* \lambda_j^{ss} + \eta s_{i-\rho} (\lambda_j^{ss} - (1 + \lambda^*) \lambda^{*ss}) \psi_u < 0^1, > 0^4
\]

\[
\frac{\partial \dot{\rho}}{\partial v} = \frac{1}{|J|} (-m \eta_q \lambda_j^{ss} \psi_u) < 0
\]

\[
\frac{\partial \dot{\rho}}{\partial \delta} = \frac{1}{|J|} (-m \eta_q \lambda_j^{ss} \psi_u) < 0
\]

\[
\frac{\partial \dot{\rho}}{\partial \alpha} = \frac{1}{|J|} m \eta_q (1 + \lambda^*) \lambda^{*ss} \psi_u < 0
\]

\[
\frac{\partial \dot{\rho}}{\partial i^*} = \frac{1}{|J|} m g_{i-\rho} (\lambda_j^{ss} - (1 + \lambda^*) \lambda^{*ss}) \psi_u < 0
\]

\textsuperscript{43}As in the financial crisis model for industrial countries, it has been assumed that $\psi_u$ is a positive, but very small number. For details, see section 4.3.1.
Response of Tobin’s $q$ to Various Shocks.

$$\frac{\partial q}{\partial \lambda} = \frac{1}{|J|} \left(-j \, m \, \lambda_j^{*z}\right) < 0$$

$$\frac{\partial q}{\partial j} = \frac{1}{|J|} \left(-m \, \lambda_j^{*z}\right) < 0$$

$$\frac{\partial q}{\partial \lambda^*} = \frac{1}{|J|} \left(-m \, (1 + \lambda^* + j^* \lambda_j^{*z})\right) < 0$$

$$\frac{\partial q}{\partial \rho} = \frac{1}{|J|} \left(-m \, (-1 + (1 + (-1 + v)g_{i-\beta}\beta)\lambda_j^{*z}\right) > 0$$

$$\frac{\partial q}{\partial h} = 0$$

$$\frac{\partial q}{\partial m} = 0$$

$$\frac{\partial q}{\partial \delta} = \frac{1}{|J|} \left(-m \, ((-1 + v)nx_{s-\delta} + \lambda^*)\lambda_j^{*z}\right) < 0^t, > 0^t$$

$$\frac{\partial q}{\partial \lambda^*} = \frac{1}{|J|} \left(-m \, u \, \lambda_j^{*z}\right) < 0$$

$$\frac{\partial q}{\partial \rho} = \frac{1}{|J|} \left(-m \, \lambda_j^{*z}\right) < 0$$

$$\frac{\partial q}{\partial \alpha} = \frac{1}{|J|} \left(m \, (1 + \lambda^*)\lambda_j^*\right) < 0$$

$$\frac{\partial q}{\partial i^*} = \frac{1}{|J|} \left(-m \, (-1 + v)g_{i-\beta} \lambda_j^{*z}\right) < 0$$
Response of the Foreign Loan Rate $j^*$ to Various Shocks.

\[
\begin{align*}
\frac{\partial j^*}{\partial \lambda} &= \frac{1}{|J|} j m \lambda_q^s & > 0 \\
\frac{\partial j^*}{\partial j} &= \frac{1}{|J|} m \lambda_q^s & > 0 \\
\frac{\partial j^*}{\partial \lambda^*} &= \frac{1}{|J|} m (1 + (-1 + v)\eta_q + j^* \lambda_q^s) & > 0 \\
\frac{\partial j^*}{\partial \rho} &= \frac{1}{|J|} m (-1 + (1 + (-1 + v)g_{i-\beta})\beta_\rho)\lambda_q^s & < 0 \\
\frac{\partial j^*}{\partial h} &= 0 \\
\frac{\partial j^*}{\partial m} &= 0 \\
\frac{\partial j^*}{\partial \delta} &= \frac{1}{|J|} m((-1 + v)n x_{\delta-\beta}^* + \lambda^*)\lambda_q^s & > 0^4, < 0^4 \\
\frac{\partial j^*}{\partial v} &= \frac{1}{|J|} m u \lambda_q^s & > 0 \\
\frac{\partial j^*}{\partial \delta} &= \frac{1}{|J|} m \lambda_q^s & > 0 \\
\frac{\partial j^*}{\partial \alpha} &= \frac{1}{|J|} m (-1 - (-1 + v)\eta_q)\lambda_\alpha^s & > 0 \\
\frac{\partial j^*}{\partial i^*} &= \frac{1}{|J|} m (-1 + v)g_{i-\beta} \lambda_q^s & > 0
\end{align*}
\]
Response of the Domestic Interest Rate on Government Bonds $i$ to Various Shocks.

\[
\begin{align*}
\frac{\partial i}{\partial \lambda} &= 0 \\
\frac{\partial i}{\partial j} &= 0 \\
\frac{\partial i}{\partial \lambda^*} &= 0 \\
\frac{\partial i}{\partial \rho} &= \beta_\rho < 0 \\
\frac{\partial h}{\partial i} &= 0 \\
\frac{\partial m}{\partial i} &= 0 \\
\frac{\partial s}{\partial i} &= 0 \\
\frac{\partial v}{\partial i} &= 0 \\
\frac{\partial \delta}{\partial i} &= 0 \\
\frac{\partial \alpha}{\partial i} &= 0 \\
\frac{\partial i^*}{\partial i} &= 1
\end{align*}
\]
Response of Central Bank Reserves $b$ to Various Shocks.\textsuperscript{44}

\[
\frac{\partial b}{\partial \lambda} = \frac{1}{|J|} \left( -j(d_{r+p}(\lambda^*_{j^*} - \lambda^*_{q}) + \eta_q \lambda^*_{j^*}(d_u + d_{\hat{p}})) \right) < 0
\]

\[
\frac{\partial b}{\partial j} = \frac{1}{|J|} \left( -\lambda(d_{r+p}(\lambda^*_{j^*} - \lambda^*_{q}) + \eta_q \lambda^*_{j^*}(d_u + d_{\hat{p}})) \right) < 0
\]

\[
\frac{\partial b}{\partial \lambda^*} = \frac{1}{|J|} \left( -m(1 + (-1 + v)\eta_q)\lambda^*_{j^*} - d_u \eta_q(1 + \lambda^* + j^* \lambda^*_{q}) + m(1 + \lambda^*) \lambda^*_{q} \right. \\
\left. + d_{r+p}((-1 + v)\eta_q - \lambda^* + j^*(-\lambda^*_{j^*} + \lambda^*_{q})) - d_{\hat{p}} \eta_q(1 + \lambda^* + j^* \lambda^*_{q}) \psi_u \right) < 0
\]

\[
\frac{\partial b}{\partial \rho} = \frac{1}{|J|} \left( d_{r+p}((1 + (-1 + v)\beta_p(-g_{i-p} + \eta_q))\lambda^*_{j^*} \\
+((-1 + \beta_p)((1 + (-1 + v)g_{i-p} - \lambda^*))\lambda^*_{q}) \\
+ d_{i-p} \beta_p((1 + (-1 + v)\eta_q)\lambda^*_{j^*} - (1 + \lambda^*) \lambda^*_{q}) \right) \right) > 0
\]

\[
\frac{\partial b}{\partial h} = -1 < 0
\]

\[
\frac{\partial b}{\partial m} = - \frac{b + h + \lambda^*}{m} < 0
\]

\[
\frac{\partial b}{\partial s} = \frac{1}{|J|} \left( d_{r+p}((-1 + v)n_s + \lambda^*)(-\lambda^*_{j^*} + \lambda^*_{q}) \right. \\
\left. + (-\eta_q \lambda^* \lambda^*_{j^*} + n_s \lambda^*_{j^*} - (1 + \lambda^*) \lambda^*_{q})(d_u + d_{\hat{p}} \psi_u) \right) < 0, > 0
\]

\[
\frac{\partial b}{\partial v} = \frac{1}{|J|} \left( -u(d_{r+p}(\lambda^*_{j^*} - \lambda^*_{q}) + \eta_q \lambda^*_{j^*}(d_u + d_{\hat{p}} \psi_u)) \right) < 0
\]

\[
\frac{\partial b}{\partial \delta} = \frac{1}{|J|} \left( -(d_{r+p}(\lambda^*_{j^*} - \lambda^*_{q}) + \eta_q \lambda^*_{j^*}(d_u + d_{\hat{p}} \psi_u)) \right) < 0
\]

\[
\frac{\partial b}{\partial \alpha} = \frac{1}{|J|} \left( \lambda^*_{
abla_{j}}(d_{r+p}((1 - v)\eta_q + \lambda^*) + \eta_q(1 + \lambda^*)(d_u + d_{\hat{p}} \psi_u)) \right) < 0
\]

\[
\frac{\partial b}{\partial \theta^*} = \frac{1}{|J|} \left( d_{i-p}((1 + (-1 + v)\eta_q)\lambda^*_{j^*} - (1 + \lambda^*) \lambda^*_{q}) \right. \\
\left. - g_{i-p}((-1 + v)d_{r+p}(\lambda^*_{j^*} - \lambda^*_{q}) - (\lambda^*_{j^*} - (1 + \lambda^*) \lambda^*_{q})(d_u + d_{\hat{p}} \psi_u)) \right) < 0
\]

\textsuperscript{44}For $\partial b/\partial \lambda$ and $\partial b/\partial j^*$ it has been assumed that $d_{r+p}(\lambda^*_{j^*} - \lambda^*_{q}) + \eta_q \lambda^*_{j^*}(d_u + d_{\hat{p}}) > 0$ which is can be justified, as in the crisis model for industrial countries, by assuming a larger reaction of households' deposit demand as to changes in capacity utilization than as to changes in the expected profit rate $r + \rho$, i.e. it has been assumed that $|d_u| > |d_{r+p}|$ which holds for all partial derivatives for $b$. 

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Chapter 6

A Calibration Model of Financial Crises in Emerging Markets

6.1 The Nature of Calibration Models

6.1.1 Solution Procedures to Dynamic General Function Models, Limitations, and Simulation Methods

The method of solving dynamic portfolio balance macro models of the type given in chapters 4 and 5 is generally carried out in three steps. Firstly, the instantaneous short-run equilibrium is determined without considering dynamic adjustment equations, being followed by conventional comparative static techniques to examine the short-run effects of changes in parameters. Secondly, the long-run steady-state equilibrium is determined by substituting the steady-state values of dynamic adjustment equations into the original model equations, being as well followed by comparative statics in order to study the long-run effects of changes in parameters. Thirdly, if analytically possible, the dynamic stability conditions of the model are going to be analyzed in order to determine whether the system, after having been hit by a shock, is able to converge to a steady-state or not.¹

Though these solution procedures are standard fundamental methods of macroeconomic analysis they are subject to limitations. Firstly, even models with a small number of equations and limited complexity regarding the interdependence of variables, give rise to indeterminacy as to the comparative static effects both in the short-run and in the long-run. Accordingly, general function models lose very fast their ability to provide general results which is often overcome by introducing restrictive assumptions as to the class of functions being used, parameter value ranges, etc. Secondly, even if it is possible to determine the signs of the comparative static effects, the partial derivatives cannot provide any information about the absolute or relative size regarding the changes in endogenous variables caused by changes of parameters. Thirdly, respecting dynamic stability analysis, even with small models it is often impossible to determine stability conditions without making restrictive assumptions, though stability conditions can be derived analytically. Fourthly, even if the dynamics of the system are comparatively simple, as e.g. the dynamics of a linear 2 × 2 system, it is not possible to derive any information regarding the

¹This kind of procedure can be found e.g. in Tobin (1969), Blinder and Solow (1973), Tobin and Buiters (1976, 1980), Turnovsky (1977), Turnovsky and Miller (1984), and Taylor (1991).
time profile of the transitional dynamics or adjustment paths to the steady-state. Fifthly, both the short-run and the long-run equilibrium can be considered as not being of relevant economic interest since on the one hand, the short-run equilibrium is too short with respect to time in order to allow for relevant feedback effects, and on the other hand, the long-run equilibrium is too long regarding time since it takes an infinite time until the system settles on the steady-state. Accordingly, the transitional dynamics, the traverse, or the adjustment path of a system from an initial steady-state to another one, after it has been hit by an exogenous disturbance, is the actual field of interest for economists and policymakers.

In order derive information about the transitional dynamics of an economic system, the original general function model has to be transformed into a model structure in which each equation is specifically determined, e.g. as a linear or non-linear function being “well-behaved” or not, and in which every parameter has to take a specific value. As a result, the transitional dynamics depends heavily on the specific form of functions, and on the choice of parameter values, since assuming only a different functional form of a model equation, or only modifying slightly one parameter value, can change results considerably. Though these simulation techniques can provide important insights into the transitional dynamics of an economic system, a simulation result is only valid for a specific set of functions and parameters. As a result, one important objective of simulation approaches is to formulate simulation models which are valid for a wide range of functional forms and parameters whose validity is generally tested by performing a large number of simulations with different combinations of function and parameter sets. However, validity tests analyzing different combinations of functions and parameters can lead very quickly to a huge potential number of possible combinations even in small models which cannot be all simulated. Furthermore, lots of simulation models cannot be solved analytically, implying a restriction to certain numerical solutions calculated by computer programmes. As a result, the specific form of functions, as well as the range of parameter values have also to be restricted to a “feasible” function and parameter set which limits the general validity of the model. However, simulation techniques can be still useful in pointing out where clear time patterns exists.

The numerical specification of both static and dynamic general equilibrium models regarding the choice of parameters can be carried out either by using stochastic estimation procedures through single-equation or multi-equation methods, or by applying deterministic calibration techniques. Regarding stochastic estimation procedures, maximum likelihood methods are a commonly used technique to estimate parameters of economic models. Though this approach is viewed as most satisfactory from a statistical viewpoint, maximum likelihood procedures are subject to various limitations as to the applicability for general equilibrium models. Firstly, for lots of classes of general equilibrium models depending on the functional forms of the model equations, the likelihood function is not well defined since error terms are not distributed independently. Secondly, the number of parameters which have to be estimated increases very fast with the number of model equations. Accordingly, with a “normal” sample size, the number of parameters to be estimated exceeds very fast the number of available data points, intensifying the degrees of freedom problem. For example, the number of parameters to be estimated in larger models can take values in the thousands. Though these limitations can be partly
overcome by subdividing economic models into subsystems, stochastic estimation procedures seem to be infeasible for simulation procedures.

An alternative simulation approach, which can be used to overcome at least partly the limitations of stochastic estimation procedures, is to “calibrate” an economic model. The term “calibration”, which can be described as “theoretical simulation”, refers to the fact that the numerical specification of the model is adjusted to a base year observation. That is, the model has to be able to reproduce a base year data set as model solution, which is assumed to represent an equilibrium of the economy, by an appropriate choice of the parameter set. If possible, the “key” parameters of the model are generally determined by literature search basing on econometric estimation before calibration can be carried out. However, owing to the widespread use of CES production and utility functions in general equilibrium models, key parameters are mainly elasticities for which either only limited, contradictory, or no information is available in the literature. If there are no key parameter values to be obtained by literature research or empirical estimation, key parameters are simply “chosen” at will in order to generate a base year observation as model solution. In this case, sensitivity analysis is employed to prove at least some robustness of the results by trying alternative parameter values with respect to the robustness of the model findings. Though being better analytically tractable than stochastic estimation procedures, calibration techniques are also subject to various limitations. Firstly, the “selection” of parameters in order to adjust the model solution to the base year observation is arbitrary. Secondly, calibration does not provide any basis for a statistical test because it fits perfectly the data set which has been used for numerical specification. Thirdly, if key parameters are chosen arbitrarily, sensitivity analysis can neither “prove” that the parameters used in the model are “true”, nor that the model results are generally valid.2

6.1.2 Simulation of Financial Crises with Calibration Techniques

The financial crisis models discussed in chapters 4 and 5 are consistent with the solution procedure of dynamic general function models outlined above, firstly, with respect to the determination of the instantaneous equilibrium and the subsequent short-run comparative-static analysis carried out in sections 4.3 and 5.3, and secondly, with respect to the local stability analysis according to sections 4.4.3 and 5.4.3, but do not correspond as to the steady-state analysis. Though several possible steady-state values for the two state variables have been analyzed, there has been no determination of the steady-values of the remaining variables, as well as no long-run comparative static analysis for three reasons. Firstly, since the dynamic system does not converge to a fixed point attractor, but converges to a dynamically stable closed orbit whose time path can only be proven to be existent, there is no possibility to determine analytically the “steady-state” cycle values of the two state variables in the form of explicit solutions. As a result, there is no possibility to substitute the “equilibrium cycle values” of the two state variables into the equation system to derive long-run cyclical steady-state solutions for the remaining endogenous variables. Secondly, though the dynamic system possesses a steady-state value, this intertemporal equilibrium is of limited economic interest since it is locally unstable, i.e. the economic system will never settle at that point. Likewise, the long-run value for 2The pros and cons of calibration techniques vs. stochastic estimation procedures of economic models are discussed e.g. in Mansur and Whalley (1984).
the state of confidence has been assumed to be $\rho_E = 0$, i.e. only the steady-state value of the debt-asset ratio will change, being also irrelevant for the remaining endogenous variables since the steady-state will not be reached. Thirdly, regarding long-run comparative statics, mathematical tools applicable for the analysis of $2 \times 2$ nonlinear systems are not able to provide any information regarding the nature of different limit cycles in case parameters are changed. There exist no possibilities, even graphically, to determine how a cycle changes if a certain parameter is varied, having been discussed in figure 5.8 in chapter 5.4.5, when the dynamic system was hit by a devaluation which changed the nature of the adjustment path and resulted in a "new" limit cycle whose graphical form with respect to the "old" limit cycle could not be determined.

Albeit the solution procedure of the crisis models in chapters 4 and 5 provides deep insights into the dynamics of financial cycles, it underlies some limitations especially with respect to the dynamics of financial crises' episodes. Firstly, in order to obtain unambiguous results in the short-run comparative static analysis, restrictions were imposed. Secondly, the comparative static description of financial crises outlined in sections 4.3.2 and 5.3.2 was only in a position to describe the stylized facts by the use of ad-hoc assumptions regarding the relative strength of counteracting forces during a financial cycle, i.e. the short-run partial derivatives given in sections 4.7 and 5.7 contain no information as to their absolute and relative magnitude. Thirdly, the cyclical dynamic stability of the system could be only proved by assumptions and by imposing restrictions. Fourthly, phase diagram analysis used in sections 4.4.4 and 5.4.4 is not able to provide any insights as to the time profile of the adjustment process to the limit cycle. Fifthly, the short-run, as well as the long-run cyclical equilibrium of the models do not provide any insights into the origin and into the dynamics of financial crises, since crises episodes are transitional dynamic phenomena. According to the crisis models, a financial crisis is a dynamic process occurring due to an exogenous shock between two cyclical steady-states representing "tranquil" times. Thus, financial crises are abnormal or extraordinary events in historical time which are not part of a steady-state, even if the steady-state is subject to cyclical fluctuations involving some financial distress at business cycle peaks as outlined in sections 4.4.5 and 5.4.5. Thereupon, in order to obtain an explicit description of financial crises' dynamics, the general function models given in chapters 4 and 5 have to be numerically specified and simulated. This chapter concentrates on the simulation of a modified emerging market crisis model since the model structure is richer and more complex than the industrial country case. Furthermore, the simulation results of the emerging market case can be simply applied to crisis periods in industrial countries.

Regarding the choice of simulation techniques, the following simulation is based on calibration techniques as stochastic estimation procedures are very difficult to carry out due to the reasons mentioned above, and actually do not exist. However, a calibration of financial crises calls for a modification of general calibration procedures since episodes of financial crises differ considerably from other economic phenomena being simulated. Firstly, the econometric literature provides only limited information regarding key parameters of financial crisis models, since general economic theory works with different model structures which are based on a "normal" functioning of economies, and which generally abstract from balance sheet positions of different sectors, or from "irrational" expectations. Secondly, it is impossible to find a long-run steady-state base year observation data set to which model parameters can be adjusted for a model aiming at providing a
"general" theory of financial crises, being applicable to a wide range of countries, and not only to a specific country at a specific historical time. Furthermore, even if it was possible to determine key parameters for a steady-state solution, there is no guarantee that these parameter values remain constant in times of financial distress, representing extraordinary dynamic disequilibria. As a result, working with parameters being relevant in tranquil times can become impossible, which necessitates finding parameter values being applicable to times of financial distress, which is however also almost impossible since there exists no "steady-state crisis situation" from which parameters can be obtained. Summing up, a calibration of financial crises can only be carried out by a numerical specification of model equations for which parameters have to be varied arbitrarily as long as the calibration model generates a "stylized facts solution" of financial crises. Subsequently, this model solution has to be tested as to its robustness by sensitivity analysis for the key parameters of the model. To the reader, such a procedure may seem to be arbitrary but there are no better options due to the lack of relevant empirical data. However, such a kind of calibration can provide important theoretical insights with respect to transmission mechanisms during crises periods which can be used as a basis for future empirical research and improved calibrations.

The application of this kind of calibration technique to the emerging market crisis model given in chapter 5 can be carried out in several ways. If research interest lies especially on the global and transitional dynamics of the two state variables \( \rho \) and \( \lambda_d^* \), ad-hoc assumptions as to the numerical specification of the \( 2 \times 2 \) nonlinear system given by equations 5.12 and 5.13 can be made, being followed by a computer simulation procedure within a phase diagram analysis.\(^3\) However, such an ad-hoc calibration is of limited interest since parameter values of the two basic differential equations are not derived from the entire model structure. In order to obtain "consistent" parameter values for the \( 2 \times 2 \) nonlinear differential equation system, general functions given by equations 5.1 to 5.7 would have to be formally and parametrically specified in order to substitute the solutions of \( r, \eta(q), q, \rho \) and \( \sigma \) in terms of \( \rho \) and \( \lambda_d^* \) into the two differential equations 5.12 and 5.13.

Nevertheless, such a "consistent" approach can turn out to be infeasible for five reasons. Firstly, reducing the basic equation system, for which specific functional and parametric forms have been assumed, means that the two differential equations 5.12 and 5.13 contain all parameters having been employed in equations 5.1 to 5.7. Owing to existing nonlinearities and a large number of parameters, it is possible that an analytical solution of the "consistent" \( 2 \times 2 \) nonlinear system is not to be found even by computer programmes, requiring to rely on specific parameter values and to solve the model numerically, which limits the general validity of the model results. Secondly, even if the model can be solved analytically, it is difficult to "find" a parameter combination which fits the stylized facts due to the lack of empirical data. Assuming e.g. only two parameters for each equation in system 5.1 to 5.7 amounts to 14 parameters. If each parameter is allowed to take only 10 specific values, being a very low number, there arise \( 10^{14} \) parameter combinations which lead to different dynamic outcomes. As a result, it can turn out to be very difficult to determine the parameter set fitting the stylized facts. Thirdly, owing to the large number of parameters, analytical stability analysis in nonlinear systems becomes almost impossible.

\(^3\)Such ad-hoc calibrations can be found e.g. in Flaschel, Franke and Semmler (1997), pp. 41-43 concentrating on price and quantity adjustments over time.
which requires to rely again on a numerical stability analysis by “searching” for parameter sets which generate a dynamically stable solution. Numerical solutions however, limit the general validity of the calibration model. Fourthly, among the search for a consistent parameter set, the choice of initial conditions of the state variables influences the dynamic properties of the system. As a result, some sets of initial conditions can generate stable dynamics fitting the stylized facts, whereas other sets engender chaotic dynamics. Fifthly, a calibration of emerging market crises has to be able to show the occurrence of twin crises, i.e. the model equations have to determine the time of the speculative attack in order to differentiate between the dynamics before and after the devaluation, which requires to make use of the concept of the shadow exchange rate firstly introduced by Flood and Garber (1984a). Since the exchange rate’s growth rate has been treated as exogenous in the general function model, the calibration model has to be modified with respect to exchange rate and international reserve dynamics in order to solve the model for a flexible and for a fixed exchange rate regime.

Summing up, given the nonlinear dynamic character, the large number of equations and parameters, the need for modification of model equations, as well as the complexity of interdependencies between financial markets and the real sector, a calibration of the emerging market crisis model can be only carried out under very restrictive assumptions. Firstly, the system’s dynamics have to be modified in order to determine the pre- and past-devaluation dynamics, which requires to use another basic differential system whose properties however, are not known. If the new system is supposed to generate nonlinear dynamics and to be analytically soluble, then either the dynamics of \( \rho \) or \( \lambda^* \) have to be abandoned in favour of the introduction of exchange rate and reserve dynamics, since it is not possible to analyze analytically the characteristics of nonlinear systems being higher than of second order. Secondly, given the complex dynamics of the model, a solution can be possibly only obtained by numerical methods, which implies the imposition of very restrictive assumptions as to the set of parameters and initial conditions. As a result, the advantage of having a very sophisticated model structure generating nonlinear dynamics would not offset the disadvantages of limiting the general validity of the model.

This trade-off is partly overcome in the present case by the introduction of a log-linear approximation of the nonlinear crisis model of chapter 5 which can be solved analytically, and which distinguishes between the pre- and post-devaluation period by explicitly considering exchange rate and international reserves dynamics. However, making use of linear dynamics means that the system is not longer able to generate endogenous steady state cycles, as well as cyclical adjustment paths. This implies that for every stage of an excessive business cycle generating financial crises, i.e. for the boom, the overborrowing and for the bust phase, a separate calibration has to be carried out. As a result, the endogenous character of expectations and indebtedness is lost since \( \rho \) and \( \lambda^* \) have to be used as the exogenous “driving forces” of the dynamic system. However, the dynamics of all other variables, as well the dynamics before and after a devaluation can be derived, being not feasible with sophisticated nonlinear model structures as given in chapters 4 and 5. Accordingly, the log-linear calibration model is supposed to be viewed as a complementary model and not as a substitute.

In contrast to the theory of financial crises presented in chapters 4 and 5, almost all standard theories, except for moral hazard models and Minsky’s financial fragility approach, claim that financial crises are caused by negative shocks whose magnitude is
sufficient to generate a high degree of financial fragility and to trigger financial crises. As a result, standard theory does not explain the fact that, in most cases, the build-up of financial fragility is caused by a positive shock to expectations, and that a subsequent financial crisis can be triggered by a very small negative shock whose impact on overall financial fragility can be almost neglected. However, in accordance with standard theory, there arise also situations in reality in which financial crises have their origin in large negative shocks. Yet, these cases occur less frequently in reality than financial crises caused by excessive business cycles. In order to be consistent with the stylized facts, to demonstrate the general validity of the model, and to point out the logic of standard exogenous shock-driven financial crisis models, a separate simulation in addition to the three boom-bust simulations (boom phase, overborrowing phase, bust phase) is carried out for a negative foreign interest rate shock for which the influence of changing profit expectations has been eliminated.

6.2 The Real Side

All variables except for interest rates, risk premia, the profit rate, and the state of confidence, are expressed as natural logs due to the log-linear structure of the model, where natural logs are labelled simply as "logs" in the following. Parameters attached to interest rates, risk premia, the profit rate and the state of confidence in equations defining the natural log of an endogenous variable represent semi-elasticities, whereas parameters attached to the remaining variables represent pure elasticities. Parameters used in equations defining interest rates, the risk premium, and the profit rate represent derivatives.

Consider a small emerging market economy following a "Washington Consensus" style policy and/or an IMF orthodox stabilization programme with open trade, deregulation of domestic industries, domestic financial market liberalization and capital account liberalization. The economy is assumed to peg its exchange rate to an anchor currency like the U.S.-$, the Yen or the Euro. Reasons for a fixed exchange rate regime can reach from inflation stabilization programmes (see e.g. Latin America) to export-led growth strategies (see e.g. Asia). Domestic prices are assumed to be determined by the (natural) log of PPP, reading formally as

\[ \ln P(t) = \ln s(t) + \ln P^*(t), \]  

where \( \ln P(t) \) denotes the log of the domestic price level, \( \ln P^*(t) \) the log of the foreign price level, and \( \ln s(t) \) the log of the exchange rate expressing the price of one unit foreign currency in domestic currency. The foreign price level is assumed to remain constant throughout the analysis.

Output is assumed to be determined by the demand side of the economy. The resulting goods market equilibrium in natural log-form is given formally by

\[ \ln Y(t) = y_0 + y_1 (\ln s(t) + \ln P^*(t) - \ln P(t)) + y_2 (\ln P_K(t) - \ln P(t)) - y_3 (f(t) - \zeta \ln P(t)), \]

\( y_0, y_1, y_2, y_3 > 0, \quad \text{and} \quad \zeta > 0, \)
where $\ln Y(t)$ denotes the log of real output and the right hand side of equation 6.2 the log of real demand for goods consisting of four components. The first demand component $y_0$ represents autonomous demand for domestic goods. The second demand component are net exports being positively dependent on the log of the real exchange rate $\ln s(t) + \ln P^*(t) - \ln P(t)$. Investment demand which is positively dependent on the log of Tobin’s $q$, being defined as $\ln q(t) = \ln P_K(t) - \ln P(t)$ and determined below, constitutes demand component three. Demand component four is government expenditure, being negatively dependent on the nominal long-term interest rate on domestic government bonds $f(t)$, and positively dependent on the log of domestic price level $\ln P(t)$, where $\zeta$ is a positive parameter. It is assumed that government expenditures are reduced when nominal long-term interest rates increase, leading to a rise in the overall nominal debt burden, but expand if there is a rise in the price level which reduces the real value of public debt, and the real value of interest payments; $y_0, y_1, y_2, y_3$ are positive parameters which are going to be specified in the calibration process.

Profits of the business firm sector are represented by the profit rate on capital which is formally given by

$$r(t) = r_0 + r_1 \ln Y(t) - r_2 j(t) - r_3 \delta(t) - r_4 (\ln s(t) + \ln P^*(t)) - (\ln P(t) + \ln K(t)), \quad (6.3)$$

$$r_0, r_1, r_3, r_4 > 0, \quad \text{and} \quad r_2 \leq 0,$$

stating that the profit rate $r(t)$ is determined by firms’ cash flow (earnings less costs) which is deflated by the log of the capital stock valued at replacement costs $\ln P(t) + \ln K(t)$. Earnings are assumed to be positively dependent on the log of real output $\ln Y(t)$. Costs can be subdivided into three components. The first cost component emerges from external debt in the form of interest rate costs on bank loans which are approximated, for reasons of simplicity which are discussed in detail in section 6.3.2, by the loan rate $j(t)$, implying a neglect of the direct influence of the total stock of loans $L(t)$ on interest rate costs $j(t)L(t)$, and thereby on the profit rate $r(t)$. The influence of interest rate costs on the profit rate however, is not unambiguous and varies considerably over the business cycle, i.e. there arise situations in which a decreasing loan rate leads to decreasing total interest rate costs increasing the profit rate, but there are also situations in which a decreasing loan rate increases total interest rate costs leading to decline in the profit rate. In order to take these effects into account, parameter $r_2$ is allowed to take positive as well as negative values in different phases of the business cycle which are discussed in section 6.3.2 and specified in the calibration process. The second cost component stems from depreciation on the capital stock, where $\delta(t)$ denotes the depreciation rate. The costs for imported intermediate goods, whose price in domestic currency in log-form is $\ln s(t) + \ln P^*(t)$, constitute cost component three. For reasons of simplicity, imported intermediate goods and imported final goods are valued by the same price, i.e. by the log of the foreign price level $\ln P^*(t)$; $r_0, r_1, r_3, r_4$ are positive parameters which are going to be specified for the calibration procedure.

\footnote{The non-log version of equation 6.2 reads as $Y(t) = e^{y_0} \left( \frac{s(t)P^*(t)}{P(t)} \right)^{y_1} \left( \frac{P_K(t)}{P(t)} \right)^{y_2} \left( \frac{e^{f(t)}}{P(t)} \right)^{-y_3}$.}
6.3 The Financial Side

6.3.1 A Stylized Financial Structure

Figure 6.1 depicts a simplified and stylized financial structure of small open emerging market economies being characterized, in contrast to chapter 5, by a “developed” domestic financial sector, i.e. the banking sector is fully liberalized and does not suffer any more from past financial repression. Accordingly, the domestic banking sector plays a key role for the allocation of national and international funds into domestic investment opportunities since information asymmetries between foreign savers and domestic investors can be best reduced by banks' intermediation.

Assets and debts are priced at their current market or discounted present values, i.e. there is no distinction between book and market values. In order to distinguish between real stocks, market prices and nominal market values of bonds, equities, and the capital stock, the real stock of equities is denoted as $E$, the real capital stock as $K$, and the real stock of bonds as $B_{xx}$, where the first subscript denotes whether bonds are Short-term or Long-term, and the second one whether they are Domestic or Foreign. As bonds and equities, i.e. real capital, are traded in financial markets, they are valued at their market price $P_{xxx}$, denoting the price in domestic or foreign currency per real unit, where the first subscript describes whether it concerns the price of Bonds, the (demand) price of the capital stock $K$, or the price of Equities; the second and third subscript only refer to bond prices and distinguish whether bond prices relate to Short-term or Long-term bonds, and whether they are Domestic or Foreign. Bond prices are inversely related to their interest rates. Nominal market values of equity and bond holdings are $P_E E$ and $P_{B_{xx}} B_{xx}$. Since foreign short-term bonds $P_{SFB} B_{SF}$ and foreign loans to banks, denoted as $L_F$, are denominated in foreign currency, nominal stocks are multiplied by the exchange rate $s$ expressing the price of one unit foreign currency in domestic currency. In contrast to figure 5.1, the exchange rate does not appear with its pegged value $s$ in balance sheets, since the calibration model solves the equation system both for a fixed and for a flexible exchange rate, whereas the theoretical emerging market crisis model in chapter 5 only considered different pegged exchange rate values.

There are six types of agents in the economy, households, firms, the government, domestic banks, the central bank and foreign investors holding nine sorts of assets. The first sort are deposits $D$, the second sort domestic short-term government bonds $P_{SDB} B_{SD}$ being traded internationally, and being imperfect substitutes for foreign short-term government bonds $sP_{SFB} B_{SF}$ which constitute asset sort three. Though the international financial market for short-term government bonds underlies no restrictions, yields differ due to the existence of a risk premium on domestic short-term bonds reflecting the domestic government’s and the country’s risk of default. Asset type four takes the form of domestic long-term bonds $P_{LDB} B_{LD}$ which are not traded internationally since there are no foreign substitutes. Asset type five is the capital stock $K$ being valued at the demand price of capital $P_K$. Firms’ capital stock is partly financed by the issuance of equities, being asset sort six, whose nominal value amounts to $P_E E$, where the real stock of equities $E$ is assumed to remain constant throughout the analysis. The remaining part of the capital stock is financed by bank loans $L$ constituting asset type seven and being denominated in domestic currency. It is assumed that new investment is financed
Figure 6.1: Stylized Financial Structure in Emerging Markets with a “Developed” Domestic Banking System

by taking new bank loans and by retained earnings, and not by issuing equities, being consistent with the credit view on macroeconomic activity. Asset type eight takes the form of foreign loans denominated in foreign currency \( L^* \) from foreigners to domestic banks whose nominal value in domestic currency amounts to \( sL^* \). Asset type nine is high powered money \( M \) which is held by domestic banks as required reserves (cash and excess reserves are excluded) in the form of deposits with the central bank \( D_{BA} = \tau D = M \), where \( \tau \) denotes the required reserve ratio.

High powered money is generated on the one hand by granting interest bearing loans to banks \( L_{BA} \) constituting the domestic credit component \( H = L_{BA} \), and on the other hand by buying foreign reserves \( Z \). Regarding the domestic credit component \( H \), the present model explicitly considers, in contrast to the financial crisis models in chapters 4 and 5, the existence of a domestic money market in which banks’ demand for the domestic credit component is inversely related to the central banks’ official discount rate \( i_C \). Accordingly,
monetary policy in the present model is carried out by variations in the official discount rate and not by variations in the money supply. Regarding foreign exchange reserves, the model assumes that \( Z \) develops from two main sources. Firstly, \( Z \) comes into being by banks selling their stock of foreign loans \( L^* \) to the central bank at the exchange rate \( s \), which can be used e.g. for reducing \( L_{BA} = H \) with \( D_{BA} \) remaining constant, or for increasing \( D_{BA} \) and thereby \( D \) and \( L \), leaving \( L_{BA} = H \) unchanged. Secondly, in a fixed exchange rate regime \( Z \) develops also from imbalances of current and capital account transactions of other sectors which are offset by variations in international reserves being denoted as \( B \) and expressed in domestic currency terms, i.e. it holds that \( sL^* + B = Z \). Regarding \( B \), it is assumed firstly, that all international monetary transactions stemming from capital account or current account transaction are carried out via the domestic banking sector due to information asymmetries, which sells or buys foreign high powered money to or from the central bank in the foreign exchange market, and secondly, that no other sector than the central bank possesses foreign high powered money.\(^5\) It is important to note that it is possible for situations to arise in which \( B \) takes a negative value (e.g. due to large accumulated current account deficits) implying \( Z < sL^* \), i.e. foreign exchange reserves would not suffice to pay back all foreign loans in case of a sudden and complete withdrawal of foreign investors. Such a situation also implies that foreign loans can be only paid back completely without any further external financing by capital inflows, if the economy is able to generate sufficient current account surpluses in the future.

Despite the fact that domestic financial markets and the capital account are fully liberalized, and portfolio adjustments are assumed to be instantaneous, there exists no perfect capital mobility in the model arising from three assumptions. Firstly, only short-term bonds are assumed to be traded internationally due to the lack of suitable substitutes (domestic long-term bonds) or due to insurmountable information asymmetries (equities). Secondly, short-term bonds are assumed only to be imperfect substitutes owing to the existence of a risk premium. Thirdly, domestic assets are assumed to be only imperfect substitutes, i.e. there is no condition requiring e.g. the equality of equities' and long-term bonds' rate of returns.

Households' nominal net worth \( NW_{HH} \) consists of deposits \( D \), domestic short-term bonds \( P_{BSD}B_{SD} \), domestic long-term bonds \( P_{BLD}B_{LD} \), foreign short-term bonds \( sP_{BSF}B_{SF} \), and equities \( P_E E \).

Firms' capital stock is financed by bank loans \( L \) and by issuing equities \( E \) whose real stock is assumed to be constant. The equity price \( P_E \) is assumed to bring the stock market instantaneously into equilibrium, resulting in a zero net worth of firms.\(^6\) Accordingly, the demand price of capital \( P_K \) is determined via the equity and the domestic loan market, being derived from firms' balance sheet identity as

\[
P_K = \frac{L + P_E E}{K}.
\]

\(^5\)For example, if households want to sell a fraction of short-term foreign bonds, they sell their bonds to banks and receive deposits in domestic currency valued at the prevailing exchange rate. Then, banks sell these bonds in the international market for short-term government bonds receiving foreign reserves which are immediately sold to the central bank increasing either \( D_{BA} \), or reducing \( H \) where \( D_{BA} \) remains unchanged.

\(^6\)For details, see section 4.2.1.
Banks create deposits as a multiple of the monetary base $M$. Demand for high-powered money stems exclusively from the required reserve ratio $\tau$ since cash and excess reserves are excluded. Accordingly, the money multiplier amounts to $m = 1/\tau^7$, i.e. it holds that $M = D_{BA} = \tau D = \frac{1}{m} D$. Required reserves $D_{BA}$ are "financed" on the one hand by borrowing domestic credit $H = L_{BA}$ at the central bank's official discount rate $i_C$, and on the other hand by selling foreign exchange reserves $Z$ to the central bank, where $Z$ stems from the exchange of foreign loans $L^*$ at the exchange rate $s$, and from selling reserves $B$ arising from imbalances of current and capital account transactions. Accordingly, in an environment of financial liberalization and deregulation in which banks are allowed to tap international capital markets, the capacity to create deposits, and thereby loans, is influenced on the one hand by domestic monetary conditions, but also by international monetary conditions which can be illustrated by solving banks' adding-up constraint for the stock of loans $L$, formally given by

$$L = (1 - \tau)D + H + sL_F + NW_{BA} \quad \text{where} \quad \tau D = D_{BA} = H + Z = M.$$ 

As a result, the capacity of creating loans is positively dependent on $D$, $H$, $L_F$ and $NW_{BA}$, and negatively dependent on $\tau$.

The domestic government issues bonds, both short-term $P_{SDB}B_{SD}$ and long-term $P_{LDB}B_{LD}$ to finance its budget deficits. Since the government is assumed not to own any assets, government's net worth $NW_{Gov}$ is negative. The stock of government debt is assumed to remain constant throughout the analysis since the model focuses on financial crises being endogenously driven by market forces, and not by inconsistent macroeconomic policies.

General monetary policy tools are the required reserve ratio $\tau$, and the official discount rate $i_C$ steering the domestic credit component $H$. In the case of a fixed exchange rate regime, the central bank tries to stabilize the exchange rate via interest rate policy and changes in foreign reserves $Z$, whereas in the case of a flexible exchange rate it holds that $Z = 0$ since the central bank does not intervene in the foreign exchange market and follows an independent interest rate policy. The central bank is not assumed to engage in official revaluations of the exchange rate, i.e. in case of a currency crisis there is a transition from a fixed exchange rate regime to a fully flexible exchange rate regime.

Private domestic wealth (excluding government and central bank) is given by

$$W_P = NW_{HH} + NW_{BA} = P_K K + P_{SDB}P_{SD} + P_{LDB}B_{LD} + sP_{SFB}B_{SF} + Z - sL^*,$$

i.e. by the capital stock, by domestic short-term and long-term bonds, by short-term foreign bonds, by foreign exchange reserves less foreign loans.

Overall domestic wealth (including government and central bank) is given by

$$W = NW_{HH} + NW_{BA} + NW_{Gov} = P_K K + sP_{SFB}B_{SF} + Z - sL^*,$$

i.e. by the capital stock, by foreign short-term bonds, by international reserves less foreign loans.

\footnote{For this simplifying assumption, see section 4.2.1.}
6.3.2 Financial Market Equilibria

All financial market equations are derived by approximations of the portfolio structure given in figure 6.1, following the simplified portfolio approach having been introduced in chapters 4 and 5.\(^8\) The equilibrium condition in the market for deposits in log-form reads as

\[
\ln m(t) + \gamma \ln H(t) + (1 - \gamma) \ln Z(t) - \ln P(t) = d_1 \ln Y(t) - d_2 i(t) - d_3 f(t),
\]

\[0 < \gamma < 1, \quad \text{and} \quad d_1, d_2, d_3 > 0.\]  

The left hand side of equation 6.4 represents the log of real supply of deposits by banks and the right hand side the log of households' real demand for deposits. The log of real deposit supply consists of the log of high powered money \(\ln H(t)\) and of foreign reserves \(\ln Z(t)\), where \(\gamma\) denotes a weighting factor\(^9\), \(\ln m(t)\) the log of the money multiplier which is assumed to be constant\(^{10}\), and \(\ln P(t)\) the log of the domestic price level.\(^{11}\) It is assumed that banks do not pay interest on deposits. The log of real deposit demand by households depends positively on the log of real output \(\ln Y(t)\), negatively on the interest rate on domestic short-term bonds \(i(t)\), and negatively on the interest rate on domestic long-term bonds \(f(t)\). For reasons of simplicity, there is no direct negative dependence of deposit demand on the expected profit rate \(r(t) + \rho(t)\), where \(r(t)\) denotes the actual profit rate and \(\rho(t)\) the state of confidence. However, in order to capture the influence of equities on other asset holdings by households, equation 6.9 defining Tobin's \(q\) establishes an inverse relationship between the interest rate on short-term bonds \(i(t)\) and the expected profit rate \(r(t) + \rho(t)\); \(\gamma, d_1, d_2, d_3\) are positive parameters to be specified for the calibration of the model.

Equilibrium in the domestic money market in which domestic banks can borrow high powered money from the central bank at the official discount or prime rate \(i_C(t)\) is described by banks' demand for domestic credit component in log-form \(\ln H(t)\), given formally as

\[
\ln H(t) = h_0 - h_1 i_C(t), \quad h_0, h_1 > 0,
\]

stating firstly, that banks' demand for domestic credit is negatively dependent on the prime rate \(i_C(t)\) which is used as the main monetary policy instrument in the model, and secondly, that the central bank provides each amount of domestic credit demanded by banks at the prevailing discount rate; \(h_0\) and \(h_1\) are positive parameters to be specified in the calibration process.

Foreign loans to domestic banks \(L^*(t)\) denominated in foreign currency are represented by the log of their net loan inflow version \(\ln LF^*(t)\), being defined as the log of the sum of foreign loan inflows less the sum of foreign loan outflows, i.e. it holds that \(\ln LF^*(t) = \ln \dot{L}^*(t)\).\(^{12}\) Net foreign loan inflows to domestic banks are assumed to be determined

\(^8\)For a discussion of the pros and cons of a standardized portfolio approach, see section 4.2.2.
\(^9\)Accordingly, the log of high powered money \(\ln M(t)\) is defined as \(\ln M(t) = \gamma \ln H(t) + (1 - \gamma)Z(t)\).
\(^10\)In log-terms the relation between the money multiplier and the required reserve ratio is given by \(\ln m(t) = - \ln r(t)\).
\(^11\)The non-log version of the deposit market equilibrium reads as \(m H(t)\gamma Z(t)^{1-\gamma}P(t)^{-1} = Y(t)^d_1 e^{-i(t)d_2} e^{-f(t)d_3}\).
\(^12\)Note that \(\ln LF^*(t) = \ln \dot{L}^*(t)\) is an approximation of the log of net loan inflows' growth rate due to
firstly by domestic banks’ collateral, and secondly by the difference between lending costs in domestic and in foreign currency. Regarding the dependence of net capital inflows on banks’ collateral, the model assumes that an increase in collateral leads to higher net capital inflows, where banks’ collateral is approximated by banks’ net worth \( NW_{BA}(t) \), being an indicator both for the liquidity or profit position, and for the solvency position. Respecting the difference in lending costs, domestic banks are assumed to decide upon the amount of foreign borrowing by comparing the cost of borrowing domestic credit \( i_C(t) \) in the domestic money market with the cost of borrowing foreign funds. The cost of borrowing foreign funds, being expressed by the foreign loan rate on foreign funds \( j^*(t) \), consists of three components, formally given by

\[
j^*(t) = i_C^*(t) + rp(t) + E_t[ln s(t)],
\]

where \( i_C^*(t) \) denotes the foreign official discount rate representing refinancing costs of foreign lenders, \( rp(t) \) the risk premium reflecting domestic banks’ risk of default to be determined below, and \( E_t[ln s(t)] \) the exchange rate’s expected rate of change reflecting currency risk, where \( s(t) \) denotes the price of one unit foreign currency in domestic currency, and \( E_t[x] \) the expectations operator expressing the expected value of a variable \( x \) conditional on all information available up to date \( t \). Regarding the formation of exchange rate expectations, the model assumes that agents behave rationally, i.e. it holds that \( E_t[ln s(t)] = ln s(t) \). The assumption of rational expectations contradicts the expectation formation scheme employed in chapters 4 and 5, having claimed that exchange rate expectations depend on the state of confidence, implying that agents are only rational in the long-run. However, imposing short-run rationality as to exchange rate expectations and long-run rationality as to profit rate expectations can be justified by the fact that the exchange rate is a “forward-looking” variable whose value typically incorporates all information as it becomes available, whereas an economy’s profit rate depending on technology, the quality of the capital stock, balance sheet structures, business cycle phases etc., as defined by equations 4.16 and 5.10, is a “backward-looking” or “sluggish” variable whose evolution is tied to the past.\(^{13}\) Furthermore, imposing short-run rationality as to exchange rate expectations is consistent with current financial crisis models in order to derive the time path of the flexible shadow exchange rate, as well as the time of speculative attack. Summing up, net foreign loan inflows to domestic banks in log-terms are formally given as

\[
ln LF^*(t) = l f_1 \ln NW_{BA}(t) + l f_2 (i_C(t) - j^*(t))
= l f_1 \ln NW_{BA}(t) + l f_2 (i_C^*(t) + rp(t) + E_t[ln s(t)]),
\]

(6.6)

\[ l f_1, l f_2 > 0, \quad \text{and} \quad E_t[ln s(t)] = ln s(t), \]

where \( l f_1 \) and \( l f_2 \) are positive parameters to be specified in the calibration procedure. It holds that \( ln LF^*(t) \leq 0 \), where \( ln LF^*(t) > 0 \) is assumed to determine a net inflow, and the fact that a variable’s \( x(t) \) growth rate, being defined in continuous form as \( \dot{x}(t) = \dot{x}(t)/x(t) \), can be approximated in log-terms as \( \dot{x}(t) = ln(x(t)/x(t)) = ln \dot{x}(t) - ln x(t) \approx ln \dot{x}(t) \).

\(^{13}\)The distinction between rational forward-looking and sluggish variables, as well as their influence on the dynamic stability of theoretical models are discussed in appendix D.
In $LF^*(t) < 0$ a net capital outflow. International capital flow reversals can be caused according to equation 6.6 by a drop in the log of banks’ net worth $\ln NW_{BA}(t)$, by an increase in the foreign prime rate $i_0(t)$, by an increase in the risk premium $rp(t)$, or by depreciation expectations of the exchange rate, i.e. by $E_t[\ln s(t)] > 0$.

Banks’ net worth position $NW_{BA}(t)$ depends on banks’ profits which are assumed to hinge predominantly upon the amount of non-performing loans of firms. The amount of non-performing loans itself, depends on the liquidity and on the solvency status of firms which are approximated by firms’ profit rate on capital $r(t)$. Hence, the log of banks’ net worth $\ln NW_{BA}(t)$ is formally given by

$$\ln NW_{BA}(t) = n w_0 + n w_1 r(t), \quad n w_0, n w_1 > 0,$$

(6.7)

stating that a fall in the profit rate worsens firms’ cash flow position to meet their payment obligations on loans, leading to an increase in non-performing loans, and reducing banks’ profits and net worth; $n w_0$ and $n w_1$ are positive parameters to be specified in the calibration process. As a result, a banking crisis can be defined, according to equation 6.7, as a situation in which banks’ net worth falls short of a certain minimum level (e.g. $\ln NW(t) = 0$) set up by regulation authorities.

The risk premium $rp(t)$ in equation 6.6, being an indicator for banks’ default risk, is assumed to depend negatively on banks’ collateral which is approximated by the log of banks’ net worth $\ln NW_{BA}(t)$, formally

$$rp(t) = r p_0 - r p_1 \ln NW_{BA}(t), \quad r p_0, r p_1 > 0,$$

(6.8)

stating that the risk premium increases if banks’ net worth decreases, where $r p_0$ and $r p_1$ are positive parameters to be specified in the calibration process.

Equity market equilibrium is represented by the equilibrium condition in the market for real capital. Assuming that equity demand and supply can be subsumed under real capital demand and supply as in sections 4.2.2 and 5.2.2, equilibrium in the market for real capital in log-form is formally given by

$$\ln K(t) + \ln P_K(t) - \ln P(t) = -k_1 i(t) + k_2 (r(t) + \rho(t)), \quad k_1, k_2 > 0,$$

(6.9)

the left hand side representing the log of the supply of capital in real terms, i.e. the capital stock valued at Tobin’s $q$ whose value in log-terms corresponds to $\ln q = \ln P_K(t) - \ln P(t)$, and the right hand side representing the log of real demand for capital by households; $k_1$ and $k_2$ are positive parameters to be specified in the calibration process. Real demand for capital by households is, according to the portfolio framework depicted in figure 6.1, negatively dependent on the interest rate on short-term bonds $i(t)$, and positively dependent on the expected profit rate $r(t) + \rho(t)$ on real capital, where $r(t)$ represents the current rate of profit, and $\rho(t)$ state of confidence, i.e. the difference between the expected and the actual rate of profit on real capital. Though the domestic loan rate $j(t)$ would be a suitable reference interest rate for the determination of Tobin’s $q$, the model emphasizes the influence of short-term portfolio shifts by households on the demand price of capital being represented by $i(t)$. However, the the domestic loan rate $j(t)$ is implicitly included in equation 6.9 via its influence on firms’ profit rate $r(t)$, being specified in greater detail below.

The international market for short-term government bonds cannot be described by UIP due to the assumption of imperfect capital mobility, i.e. the domestic and the
foreign interest rate differ by a risk premium. Since the model emphasizes the evolution of financial fragility induced by the private sector, and not by the government in the form of inconsistent macroeconomic policy, the risk premium domestic short-term government bonds bear is assumed to be exogenous. Accordingly, equilibrium in the international market for short-term government bonds reads as

\[
i(t) = \hat{i}_c(t) + \alpha + E_t[\ln \hat{s}(t)], \quad \text{and} \quad E_t[\ln \hat{s}(t)] = \ln \hat{s}(t), \quad (6.10)
\]

where \(i(t)\) denotes the domestic interest rate on short-term bonds, \(\hat{i}_c(t)\) the foreign prime rate which is assumed to be a proxy for the foreign interest rate on short-term government bonds, \(\alpha\) the exogenous given risk premia domestic bonds bear, and \(E[\ln \hat{s}(t)]\) the exchange rate's expected rate of change.

The market for domestic loans and its changing demand and supply conditions over the business cycle is, among the state of confidence, one of the most important determinants of the calibration process. As having demonstrated in chapters 4 and 5, each phase of tranquil and financial crisis cycles is characterized by a specific debt-asset ratio/state of confidence constellation. However, as outlined in section 6.1.2, the log-linear calibration model does not engender endogenous nonlinear debt and expectations dynamics due to the need to solve the model for a flexible and for a fixed exchange rate regime. This constraint requires firstly, a linear dynamic system in the log of the exchange rate \(\ln s(t)\) and in the log of foreign reserves \(\ln Z(t)\), and, as a result, secondly, separate linear calibrations of each business cycle phase (boom, overborrowing, and bust) which are characterized by different assumptions as to the state of confidence, loan market reactions with respect to loan rate changes, and as to the influence of interest rate costs on firms' profit rate and on the real sector.

The changing influence of the state of confidence \(\rho(t)\) over the business cycle is captured by assuming a steady and exogenously increasing value of \(\rho(t)\) during the boom and during the overborrowing phase, and an exogenously decreasing value of \(\rho(t)\) during the bust phase. As it will be discussed later, the exogenous character of the state of confidence could have been endogenized by some variables of the calibration model which, however, has been omitted for reasons of mathematical tractability.

Changing loan market reactions and their changing influence on firms' profit rate over the business cycle are taken into consideration by using different assumptions, firstly, as to the loan rate semi-elasticity with respect to the stock of loans, and secondly, as to the derivative of firms' profit rate with respect to the loan rate representing the influence of total debt costs on the profit rate. In order to derive these specific conditions formally, a general loan market equilibrium condition has to be specified in a first step. To keep the model formally tractable, it is assumed firstly, that banks behave as monopolists in the market for loans by setting the interest rate on loans \(j(t)\), and secondly, that firms act as price takers whose demand for loans is negatively dependent on the loan rate. Regarding the loan rate determination, banks' are assumed firstly, to use markup pricing with regard to their refinancing costs, and secondly, to vary the loan rate according to the level of firms' capital stock valued at the stock market which serves as collateral. Formally, the loan rate set by banks is given by

\[
j(t) = j_0 - j_1 (\gamma \ln H(t) + (1 - \gamma) \ln Z(t)) - j_2 \ln P_K(t), \quad j_0, j_1, j_2 > 0 \quad (6.11)
\]

where \(j_0, j_1\) and \(j_2\) are positive parameters to be specified in the calibration process. The \(j_1(\cdot)\) term indicates that the loan rate depends negatively on the log of banks' input factors.
to create deposits and loans, setting up a positive relationship between the loan rate and refinancing costs. If, for example, there is an increase in the domestic prime rate \( i_C(t) \) increasing the cost for domestic credit \( \ln H(t) \), banks reduce \( \ln H(t) \) implying a reduction in deposits and in banks’ capacity to create loans which increases the loan rate. The same effect works through (the log of) foreign exchange reserves \( \ln Z(t) \). If there is a sudden net capital outflow reducing \( \ln Z(t) \), being induced by foreign investors withdrawing loans \( L^*(t) \) from banks, and/or by domestic residents fleeing to quality by reducing domestic asset holdings and buying foreign assets reducing \( B \) in figure 6.1, there is a decline in domestic high powered money, reducing the ability to create deposits and loans which is reflected in a higher loan rate. The \( j_2(\cdot) \) term indicates that the loan rate incorporates a risk premium firms have to pay in order to compensate for the risk of default. This risk premium is dependent on the market valuation of firms’ capital stock serving as collateral. Since the log of the real capital stock \( \ln K(t) \) is assumed constant throughout the analysis, firms’ collateral value can be approximated by the log of the demand price of capital \( \ln P_K(t) \), to be determined below, being both an useful indicator for firms’ liquidity and solvency. Equation 6.11 suggest that the higher the demand price of capital, being caused by a higher market valuation of equities, the lower the loan rate. Consequently, banks amplify the amplitude of business cycles by relaxing credit market conditions in boom phases and by tightening them in downswings according to the financial accelerator effect. The parameter \( j_0 \) can be considered as a theoretical maximum loan rate if high powered money is zero and firms are bankrupt, i.e. the log of the demand price of capital reaches a lower bound \( \ln P_K(t) = 0 \).

In order to determine the influence of total interest rate costs \( j(t)L(t) \) on firms’ profit rate, the equilibrium stock of loans \( L(t) \) has to be specified as a function of the loan rate \( j(t) \). Since banks have been assumed to behave as monopolists in the market for bank loans setting the loan rate according to equation 6.11, the equilibrium stock of loans can be determined by firms’ loan demand which is depicted in figure 6.2 for different stages of the business cycle. However, the insertion of an additional loan demand function by firms would have magnified the complexity of the model by increasing the number of parameters to be specified in the calibration process. Therefore, the influence of the loan rate on the stock of loans, and thereby on total interest rate costs \( j(t)L(t) \), has been specified by the loan rate semi-elasticity with respect to the stock of loans \( \varepsilon_{L,j} = (dL/dj)(1/L) \) determining whether total interest rate costs rise or fall in case \( j(t) \) varies. As a result, the loan rate semi-elasticity \( \varepsilon_{L,j} \) determines the influence of loan rate changes on firms’ profit rate \( r(t) \) which is specified by the derivative of firms’ profit rate with respect to the loan rate, i.e. by \( (dr/dj) \) which is equivalent to parameter \( r_2 \) in the profit rate equation 6.3, i.e. it holds that \( r_2 = dr/dj \).

According to figure 6.2, the boom phase is characterized by a very inelastic loan demand schedule, which can be justified by firms acting conservatively as to the increase in indebtedness since profit expectations are still moderate during that stage, being represented by a positive but small state of confidence value \( \rho_B(t) \). As a result, a reduction in the loan rate from \( j_1 \) to \( j_2 \), being caused by capital inflows and/or by increasing stock prices according to equation 6.11, leads to an increase in the stock of loans being indicated by the move from \( L_1 \) to \( L_2 \), but to a decrease in interest rate payments \( j(t)L(t) \) since \( \varepsilon_{L,j,B} > -1 \), implying that a reduction in the loan rate \( j(t) \) leads to an increase in firms’ profit rate \( r(t) \) which is represented by the derivative condition \( r_{2b} = -dr/dj > 0 \). The
Figure 6.2: Loan Demand, Elasticities and the State of Confidence During Different Stages of the Boom-Bust Cycle
overborrowing phase and the situation at the upper turning point of the business cycle are characterized by a very elastic loan demand since profit expectations have grown rapidly, being represented by a large positive state of confidence value $\rho_O(t)$. Loan rate reductions, as indicated by the fall from $j_2$ to $j_3$ being caused by huge capital inflows, relaxing domestic monetary conditions, and by large increases in stock market valuations, lead to an enormous increase in the stock of loans being represented by the move from $L_2$ to $L_3$. Accordingly, loan rate reductions lead to an increase in total interest costs $j(t)L(t)$ since $\varepsilon_{L,j,O} < -1$, implying that a reduction in the loan rate $j(t)$ leads to a decrease in firms’ profit rate $r(t)$ due to the overborrowing effect, which is represented by the derivative condition $r_{2o} = -dr/dj < 0$. When the asset price bubble bursts, making international investors withdraw foreign loans, and causing domestic investors to flee from domestic assets, leading to huge capital outflows, the bust phase is about to begin being characterized by a sudden change from a very elastic loan demand to a very inelastic loan demand, since profit expectations drop sharply, implying an initial high positive value of the state of confidence $\rho_{BU}(t)$ which is however, decreasing very fast leading to negative values. Comparing the semi-elasticity value $\varepsilon_{L,j}$ and the derivative value $r_2$ of the boom and the bust phase, having both the same sign in each phase, the bust phase’s semi-elasticity is larger, implying also a larger value of $r_2$, since loans cannot be reduced as quickly as expanded in the boom phase due to the fact that a repayment of loans requires either higher cash flows, which is however, not possible during the bust phase, or a liquidation of parts of the capital stock which is often impossible in downswings due to the lack of demand for existing capital goods. As a result, sharp loan rate increases during the bust phase, being indicated in figure 6.2 by a rise from $j_3$ to $j_4$, which arise from large capital outflows, domestic monetary tightening, and from large declines in firms’ market value of collateral due to collapses in equity prices according to equation 6.11, lead only to a small reduction in the stock of loans from $L_3$ to $L_4$ owing to firms’ inability to liquidate parts of the capital stock. As a result, the increase in the loan rate leads to a rise in total interest costs $j(t)L(t)$ since $\varepsilon_{L,j,BU} > -1$, implying that a rise in $j(t)$ leads to a fall in $r(t)$ which is represented by the derivative condition $r_{2BU} = -dr/dj > 0$.

6.4 The Balance of Payments

The current account is represented approximately by the log of the trade balance, formally given as

$$\ln T(t) = tr_1(\ln s(t) + \ln P^*(t) - \ln P(t)) - tr_2 \ln Y(t), \quad tr_1, tr_2 > 0, \quad (6.12)$$

stating that the log of the trade balance denominated in domestic currency $\ln T(t)$ depends positively on the log of the real exchange rate $\ln s(t) + \ln P^*(t) - \ln P(t)$ implying a “normal” reaction, i.e. net exports increase if the real exchange rate increases and vice versa$^{14}$, and negatively on the log of real domestic income $\ln Y(t)$. Though international interest payments can amount to a substantial fraction of the current account, they are neglected for reasons of simplicity.

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$^{14}$A “normal” reaction of the trade balance with respect to real exchange rate movements implies that the Marshall-Lerner and Robinson condition are fulfilled.
The capital account in domestic currency is composed of foreign loans to banks being determined by equation 6.6, and of international short-term government bond transactions. Regarding private capital flows stemming from international bond transactions, the model assumes that net capital inflows are determined positively by the difference between the domestic risk adjusted and the foreign interest rate on short-term government bonds \( i(t) - \alpha - i^*(t) \) which is however, according to equation 6.10, always zero. Accordingly, the log of the capital account in domestic currency is formally given by

\[
\ln CA(t) = \ln s(t) + \ln LF^*(t),
\]

stating that the log of the capital account \( \ln CA(t) \) in domestic currency consist only of capital inflows in the form of the log of foreign loans to banks \( \ln s(t) + \ln LF^*(t) \).

In a regime of fixed exchange rates, the log of the change in international reserves of the central bank \( \ln \hat{Z}(t) \), or the balance of payments in log-form is given by

\[
\ln \hat{Z}(t) = \phi \ln T(t) + (1 - \phi) (\ln s(t) + \ln LF^*(t)), \quad 0 < \phi < 1,
\]

i.e. by the sum of the current and of the capital account in domestic currency, where \( \phi \) is a weighting factor. A regime of flexible exchange rates is characterized by the central bank not intervening in the foreign exchange market and owning no foreign exchange reserves, i.e. under flexible exchange rates it holds that \( \ln \hat{Z}(t) = \ln \hat{Z}(t) = 0 \). Accordingly, the balance of payments in log-form is defined as

\[
\ln T(t) = -\frac{1-\phi}{\phi} (\ln s(t) + \ln LF^*(t)),
\]

stating that e.g. a current account deficit must be offset by a capital account surplus, i.e. by new capital inflows in the form of foreign loans, or leads alternatively to a depreciation of the exchange rate in order to equalize the current account in case private capital flows are zero.

### 6.5 Monetary and Exchange Rate Policy

Standard macroeconomic models generally assume that monetary policy is exercised by money supply policy, i.e. by variations in high-powered money arising from changes in the domestic credit component, and/or from interventions in the foreign exchange market. However, real world monetary policy to control goal variables as inflation, output or the exchange rate, is exercised by (prime) interest rate policy, having a direct influence on the liquidity status of financial intermediaries, and only an indirect influence on endogenous monetary aggregates which cannot be controlled perfectly, and whose influence on output and inflation has become very weak in the last decade due to velocity instability. It must be noted however, that interest rate policy is supplemented by money supply policy especially in periods of financial distress. A common strategy to avoid a collapse of domestic financial systems is to lower prime rates, and to inject large short-term amounts of liquidity into the financial system by increasing base money in order to avoid illiquidity among financial intermediaries. Regarding the prevention of a breakdown of fixed exchange rate regimes

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\[15\text{The non-log version of equation 6.13 reads as } \hat{Z}(t) = T(t)^\phi (s(t)LF^*(t))^{1-\phi}.\]
whose viability depends on the overall level of foreign exchange reserves, central banks' common strategy is to increase domestic prime rates in order to stop capital outflows, and to intervene in the foreign exchange market by selling foreign reserves. If, however, a central bank faces a collapse of the domestic financial system, as well as a breakdown of the fixed exchange rate regime, being typical of twin crises' periods, there is no possibility to support both the domestic financial system and the exchange rate, i.e. one goal has to be abandoned.

Monetary policy in the form of interest rate policy can take various forms, depending on the one hand on central banks’ preferences as to the relative importance of output and inflation targets, and on the other hand on the exchange rate regime. Monetary policy in large industrialized countries with flexible exchange rate regimes, as e.g. in the U.S., is often designed according to Taylor’s rule stating that optimal monetary policy should use the nominal prime rate to stabilize inflation and output on some chosen target levels. Other industrialized countries having committed themselves exclusively and officially to price stability irrespective of output targets, as e.g. the United Kingdom, New Zealand or Canada, follow an inflation targeting strategy by adjusting the nominal prime rate to stabilize inflation on its target level. However, inflation targeting can be also interpreted as a special form of the Taylor rule which does not consider output gaps, but solely inflation gaps. Pure monetary targeting strategies, having been applied by the German Bundesbank until the start of EMU, and by the Swiss National Bank, trying to control money supply via the prime rate, have become very rare due to the breakdown of the relationship between monetary aggregates and the goal variables inflation and output.

An alternative form of monetary policy predominantly used by emerging market and small industrial countries to stabilize inflation without concerning output goals is exchange-rate targeting, either in the form of fixed exchange rate regimes, or in the form of crawling peg arrangements. In exchange-rate targeting regimes, only the key currency country with lowest inflation and most credible monetary policy can exercise an independent monetary policy. Other members of the system have to follow monetary policy of the key currency country, being carried out by adjusting the domestic prime rate to movements in the foreign prime rate, and to movements in foreign exchange reserves whose level determines the stability of the fixed exchange rate system. As a result, in a world of globalized financial markets in which capital account transactions are much larger in volume than current account transactions, exchange rate targeting is mainly achieved by stabilizing movements in capital account transactions via interest rate targeting. A stylized interest rate rule for an exchange rate targeting “follower” country could therefore read as

\[ \Delta i_C(t) = \Delta i_C^{*}(t) - \Delta Z(t), \]

stating that the domestic prime rate \( i_C(t) \) is adjusted positively to changes in the foreign prime rate \( i_C^{*}(t) \), and inversely regarding changes in foreign exchange reserves \( Z(t) \). If, for example, agents expect the exchange rate to depreciate without any change in the foreign prime rate, i.e. \( \Delta i_C(t) = 0 \), for example due to an unsustainable real exchange rate level, arising private capital outflows, causing a reduction in international reserves, i.e. \( \Delta Z(t) < 0 \), make monetary authorities increase the domestic prime rate to stabilize the exchange rate. If, on the other hand, there is an increase in the foreign prime rate, i.e.

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16For details on various forms of monetary policy rules, see Sveriges Riksbank (1999).
17For details on the Taylor rule, see e.g. Taylor (1993).
\(\Delta i_C^*(t) > 0\), the domestic prime rate has to be increased as well, since otherwise, arising capital outflows leading to a reduction in foreign exchange reserves would undermine the stability of the fixed exchange rate system.

In order to be consistent with the stylized facts regarding monetary policy under fixed exchange rate regimes, the present model assumes that exchange rate targeting by interest rate targeting is carried out by the domestic central bank stabilizing the capital account via variations of the domestic prime rate \(i_C(t)\). The capital account, being equivalent to net capital flows in the form of foreign loans to banks, is determined, according to equation 6.6, by domestic banks' net worth and by the risk adjusted interest rate differential between the domestic and the foreign money market rate. Accordingly, an appropriate monetary policy rule is to maintain a risk adjusted interest rate parity between the domestic and the foreign money market rate. This rule however, does not lead to zero net capital flows since it does not consider the effect of banks' net worth on capital flows, fitting the stylized fact that central banks are not able to control capital flows perfectly by prime rate adjustments. Thereupon, monetary policy in the model is assumed to follow the rule

\[
i_C(t) = i_C^*(t) + rp(t) + E_t[\ln s(t)], \quad \text{where} \quad E_t[\ln s(t)] = \ln s(t), \quad (6.14)
\]

i.e. the domestic prime rate \(i_C(t)\) is adjusted to guarantee a risk adjusted interest rate parity between the domestic and the foreign money market rate in order to stabilize foreign exchange reserves.

After having defined monetary policy for a fixed exchange rate regime, the model has to specify as well a monetary policy rule for a flexible exchange rate regime, since the model equations have to be solved both for a fixed and for a flexible system in order to show the effects of a speculative attack on key macroeconomic variables. After the occurrence of a currency crisis there arise various policy alternatives. The feasible spectrum reaches from independent monetary policy up to exchange rate targeting on a devalued post-crisis level. The empirical analysis in chapter 3 has shown that especially emerging market countries operating officially under flexible exchange rate regimes often pursue actually a kind of exchange rate targeting due to the "fear of floating". Accordingly, post-collapse exchange rate regimes are often designed as fixed exchange rate regimes on a devalued post-crisis level, since a further devaluation of the domestic currency could cause on the one hand, high inflation undermining e.g. the achievements of inflation stabilization programmes, and on the other hand, a further deterioration of business firms' and intermediaries' balance sheets in case foreign debt is high. Thereupon, the present model assumes that monetary policy under a flexible exchange rate regime also follows the fixed exchange rate rule given in equation 6.14 to stabilize the exchange rate via prime rate adjustments.

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18 By way of contrast, the financial crisis models in chapters 4 and 5 do not consider the prime rate as the main monetary policy tool and assume that monetary policy is exercised via changes in the domestic credit component and/or in foreign exchange reserves.

19 An alternative interest rate rule, which is obtained by transforming the differential rule \(\Delta i_C(t) = \Delta i_C^*(t) - \Delta Z(t)\) in absolute terms, could have read \(i_C(t) = i_C^*(t) + \beta(Z_E - Z(t))\), where \(Z_E\) stands for a warranted or equilibrium stock of international reserves. However, this kind of interest rate rule would have required to define and to model the determinants of the equilibrium stock of foreign reserves \(Z_E\) for which no general theory exists. In order to avoid such difficulties, monetary policy is assumed to follow equation 6.14.
6.6 Analytical Solution of the Model

The model structure regarding the number of equations, parameters, endogenous, and exogenous variables can be summarized as follows:

- **Model Equations.** The model is defined by equations 6.1 to 6.14, i.e. by 14 equations which are summarized in table 6.1.

- **Endogenous Variables.** The model contains 17 endogenous variables, i.e. \( r(t), i(t), f(t), j(t), i_C(t), r_P(t), \ln P(t), \ln Y(t), \ln H(t), \ln LF^*(t), \ln NW_{BA}(t), \ln P_K(t), \ln T(t), \ln Z(t), \ln \hat{Z}(t), \ln s(t), \ln \hat{s}(t). \)

- **Exogenous Variables.** The model contains 7 exogenous variables, i.e. \( \ln P^*(t), \delta(t), \ln K(t), \ln m(t), \ln \bar{s}, \rho(t), i_C^*(t), \) where \( \rho(t) \) and \( i_C^*(t) \) are used as the “forcing functions” for which exogenous linear time paths are going to be specified.

- **Parameters.** The model contains 31 parameters, i.e. \( y_0, y_1, y_2, y_3, \zeta, r_0, r_1, r_2, r_3, \)
  \( r_4, d_1, d_2, d_3, \gamma, h_0, h_1, l_f, l_f^*, nw_0, nw_1, r_P, r_P^*, k_1, k_2, a, i_0, ii, h, tr_1, tr_2, \phi \) for which specific values are going to be assumed.

Solving the dynamic model for all endogenous variables requires firstly to eliminate the 13 endogenous variables \( r(t), i(t), f(t), j(t), i_C(t), r_P(t), \ln P(t), \ln Y(t), \ln H(t), \ln LF^*(t), \ln NW_{BA}(t), \ln P_K(t), \ln T(t) \) to obtain one basic differential equation in \( \ln Z(t) \) and \( \ln s(t) \) which has to be solved both for a flexible and for a fixed exchange rate system.

In case of a fixed exchange rate system, the basic differential equation reduces to a first-order linear differential equation in \( \ln Z(t) \) since it holds that \( \ln s(t) = \ln \bar{s}, \) and \( \ln \bar{s}(t) = 0. \) In case of a flexible exchange rate system, the basic differential equation reduces to a first-order linear differential equation in \( \ln s(t) \) since the central bank is assumed to hold no foreign exchange reserves under flexible exchange rates, i.e. it holds that \( \ln Z(t) = \ln \hat{Z}(t) = 0. \)

The differential equation in \( \ln s(t) \), as well as the differential equation in \( \ln Z(t) \) are both functions of all parameters and all exogenous variables, where exogenous variables can be assumed as remaining constant or as being an exogenous function of time. As a result, both differential equations reduce to a linear first-order differential equation in the form of

\[
\dot{x}(t) - \theta x(t) = \kappa a(t),
\]

where \( \theta \) and \( \kappa \) are constants containing all parameters of the model, and \( a(t) \) is the forcing function, being a function of time \( t \) in case one or more exogenous variables are assumed to be exogenous functions of time, but which reduces to a constant \( a(t) = \bar{a} \) in case all exogenous variables are assumed to remain constant. Since the exchange rate is a pure forward looking variable being subject to rational expectations, the differential equation in \( \ln s(t) \) is unstable, i.e. it holds that \( \theta > 0. \) As a result, in order to guarantee dynamic stability and to rule out bubbles, the general solution has to exclude the homogenous part, and the particular integral has to be solved forward looking being a function of exogenous variables \( a(t). \)

Furthermore, in case of shocks, the exchange rate is allowed to "jump" on

\[^{20}\text{This solution method can be found almost in every model of currency crises, having been firstly introduced by Flood and Garber (1984a).}\]
its new long-run equilibrium path in order to rule divergent dynamic behaviour. By way of contrast, foreign exchange reserves are a backward looking variable whose evolution is tied to the past, leading to a stable differential equation which is characterized by $\dot{v} < 0$. Thus, the particular integral which is a function of exogenous variables $a(t)$ has to be solved backward looking, and the general solution including the solution of the homogenous equation is convergent.\footnote{For details regarding the solution of unstable and stable differential equations, the distinction among forward and backward looking variables, and solutions to general rational expectations models, see appendix D.} However, in order to avoid difficulties regarding the selection of the initial condition for foreign exchange reserves, i.e. $\ln Z(0)$, it is assumed for every simulation that foreign exchange reserves' initial value equals its long-run steady state value, i.e. the general solution of foreign exchange reserves is generally given by the particular integral.\footnote{The assumption that the initial values of endogenous variables coincide with their steady-state solution is a common procedure of simulation models which can be found e.g. in Montiel, Agénor and Ul Haque (1993).} After having solved the basic differential equation for both the fixed and the flexible exchange rate system, the time paths of the remaining endogenous variables are obtained by backward substitution of the solutions for $\ln Z(t)$ and $\ln s(t)$.

6.7 Simulation Classifications and Assumptions

The calibration model is going to be simulated in different ways regarding the kind of "shocks" causing financial fragility in order to describe financial crises both as a positive shock-induced cyclical phenomenon, and as the result of a large adverse and exogenous shock without causing a cyclical dynamic behaviour. The simulation procedure consists of four different model simulations portraying the behaviour of all 14 endogenous variables and combinations of these variables. The first three model simulations, outlined in section 6.7.1, refer to the explanation of financial crises as the result of a positive exogenous shock to expectations generating an endogenous boom-bust cycle according to the theories outlined in chapters 4 and 5. The fourth model simulation, outlined in section 6.7.2, portrays the occurrence of financial crises caused by a large negative foreign interest rate shock.

6.7.1 Financial Crises as a Cyclical Phenomenon

Since there is no possibility to portray an endogenous cycle by the use of linear dynamic systems for the reasons outlined in section 6.1.2, each phase of the business cycle, i.e. the boom phase, the overborrowing phase and upper turning point, and the bust phase, is simulated separately. According to the dynamic analysis in chapters 4.4 and 5.4, the “driving” forces of an endogenous financial crisis cycle are the state of confidence $\rho(t)$ and the debt-asset ratio which is represented by parameter $r_2$ describing the influence of total debt costs on firms' profit rate $r(t)$. Since both the exogenous variable $\rho(t)$, and parameter $r_2$ take different values during different stages of the business cycle, the three business cycle phases being simulated can be classified according to specific constellations of $\rho(t)$ and $r_2$ as follows:
Table 6.1: Summary Equations of the Calibration Model

<table>
<thead>
<tr>
<th>Equation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 ( \ln P(t) = \ln s(t) + \ln P^*(t) )</td>
<td>Domestic Price Level (PPP)</td>
</tr>
<tr>
<td>6.2 ( \ln Y(t) = y_0 + y_1 (\ln s(t) + \ln P^*(t) - \ln P(t)) + y_2 (\ln P_K(t) - \ln P(t)) - y_3 (f(t) - \zeta \ln P(t)) )</td>
<td>Goods Market Equilibrium</td>
</tr>
<tr>
<td>6.3 ( r(t) = r_0 + r_1 \ln Y(t) - r_2 j(t) - r_3 \delta(t) - r_4 (\ln s(t) + \ln P^*(t)) - (\ln P(t) + \ln K(t)) )</td>
<td>Profit Rate</td>
</tr>
<tr>
<td>6.4 ( \ln m(t) + \gamma \ln H(t) + (1 - \gamma) \ln Z(t) - \ln P(t) = d_1 \ln Y(t) - d_2 i(t) - d_3 f(t) )</td>
<td>Deposit Market Equilibrium</td>
</tr>
<tr>
<td>6.5 ( \ln H(t) = h_0 - h_1 i_C(t) )</td>
<td>Money Market Equilibrium</td>
</tr>
<tr>
<td>6.6 ( \ln L F^<em>(t) = l f_1 \ln N W_{BA}(t) + l f_2 (i_C(t) - (i_C^</em>(t) + r p(t) + E_i[\ln \dot{s}(t)]) )</td>
<td>Net Foreign Loan Inflow</td>
</tr>
<tr>
<td>6.7 ( \ln N W_{BA}(t) = n w_0 + n w_1 r(t) )</td>
<td>Banks’ Net Worth</td>
</tr>
<tr>
<td>6.8 ( r p(t) = r p_0 - r p_1 \ln N W_{BA}(t) )</td>
<td>Risk Premium</td>
</tr>
<tr>
<td>6.9 ( \ln K(t) + \ln P_K(t) - \ln P(t) = - k_1 i(t) + k_2 (r(t) + \rho(t)) )</td>
<td>Stock Market Equilibrium</td>
</tr>
<tr>
<td>6.10 ( i(t) = i_C^*(t) + \alpha + E_i[\ln \dot{s}(t)] )</td>
<td>Bond Market Equilibrium</td>
</tr>
<tr>
<td>6.11 ( j(t) = j_0 - j_1 (\gamma \ln H(t) + (1 - \gamma) \ln Z(t)) - j_2 \ln P_K(t) )</td>
<td>Domestic Loan Rate</td>
</tr>
<tr>
<td>6.12 ( \ln T(t) = t r_1 (\ln s(t) + \ln P^*(t) - \ln P(t)) - t r_2 \ln Y(t) )</td>
<td>Current Account</td>
</tr>
<tr>
<td>6.13 ( \ln Z(t) = \phi \ln T(t) + (1 - \phi) (\ln s(t) + \ln L F^*(t)) )</td>
<td>Balance of Payments</td>
</tr>
<tr>
<td>6.14 ( i_C(t) = i_C^*(t) + r p(t) + E_i[\ln \dot{s}(t)] )</td>
<td>Monetary Policy Rule</td>
</tr>
</tbody>
</table>

It holds that

1. \( E_i[\ln \dot{s}(t)] = \ln \dot{s}(t) \),
2. \( \ln s(t) = \ln \bar{s} \) and \( \ln \dot{s}(t) = 0 \) for a fixed exchange rate system,
3. \( \ln Z(t) = \ln \dot{Z}(t) = 0 \) for a flexible exchange rate system.
• **The Boom Phase.** Increasing profit expectations are represented by a linearly increasing state of confidence \( \rho(t) \) with respect to time \( t \), given formally as

\[
\rho_B(t) = \rho_B(0) + \psi_B t, \quad \psi_B > 0, \tag{6.15}
\]

where \( \rho_B(0) \) denotes the initial value of \( \rho \) at the beginning of the boom phase at time \( t = 0 \), and \( \psi_B \) the strength of the increase in the state of confidence. The influence of a rising debt stock on total interest rate costs is assumed to be negative owing to figure 6.2, i.e. rising debt leads to an increase in the profit rate according to a loan rate semi-elasticity value with respect to the stock of loans of \( \varepsilon_{L,j,B} > -1 \), being reflected by a positive derivative of firms’ profit rate with respect to the loan rate

\[
r_{2B} > 0. \tag{6.16}
\]

Given the forcing function 6.15 for the boom phase, both the time path of foreign exchange reserves \( \ln Z(t) \), and the time path of the exchange rate \( \ln s(t) \), are linear functions of time \( t \), leading to linear time paths of all endogenous variables.

• **The Overborrowing Phase and the Upper Turning Point.** This stage of the business cycle is characterized by a steady increase in the state of confidence due to the dominance of the "chartist" effect on expectations, being described by the same type of linear function 6.15, formally given as

\[
\rho_O(t) = \rho_O(0) + \psi_O t, \quad \psi_O = \psi_B > 0, \quad \rho_O(0) > \rho_B(0), \tag{6.17}
\]

where \( \rho_O(0) \) denotes the initial value of \( \rho \) at the beginning of the overborrowing phase at time \( t = 0 \), being greater than \( \rho_B(0) \), since \( \rho(t) \) has grown during the boom phase; \( \psi_O \) denotes the strength of the increase in the state of confidence which is assumed to be equal to the value in the boom phase. In order to model the “irrational exuberance” effect of rising profit expectations, and a simultaneously declining actual profit rate due to an overproportional increase in total debt costs, the semi-loan rate elasticity with respect to the stock of loans is assumed to take a value of \( \varepsilon_{L,j,O} < -1 \) according to figure 6.2, being reflected in a negative derivative of firms’ profit rate with respect to the loan rate, i.e. it holds that

\[
r_{2O} < 0, \tag{6.18}
\]

stating that an increase in the loan rate leads to a reduction in the actual profit rate. According to the linear forcing function 6.17, all endogenous variables are linear functions of time \( t \).

• **The Bust Phase.** This phase is characterized by a sharp declining state of confidence, being described by an analogous linear function which is however a decreasing function of time \( t \), formally given by

\[
\rho_{BU}(t) = \rho_{BU}(0) + \psi_{BU} t, \quad \psi_{BU} < 0, \tag{6.19}
\]

\[
|\psi_O| = |\psi_B| < |\psi_{BU}|, \quad \rho_{BU}(0) > \rho_O(0) > \rho_B(0),
\]

\(^{23}\)For reasons of simplicity, the time index \( t \) has been set to zero for the beginning of each business cycle phase.
where $\psi_{BU}$, being negative, denotes the strength of the decline in the state of confidence which is stronger than the positive effect in the boom and in the overborrowing phase; $\rho_{BU}(0)$ denotes the initial value of $\rho$ at the beginning of the bust phase at time $t = 0$, being greater than $\rho_B(0)$ which is obviously greater than $\rho_B(0)$. The influence of a declining debt stock on total debt costs and on firms’ profit rate is assumed to be inverse due to a loan rate semi-elasticity value with respect to the stock of loans of $\varepsilon_{L,j_{BU}} > -1$ according to figure 6.2, i.e. though the stock of loans is decreasing, total debt costs increase due to an overproportional rise in the loan rate, leading to a decline in the profit rate which is represented by a positive derivative of the profit rate with respect to the loan rate, i.e. by

$$r_{2BU} > 0.$$  \hfill (6.20)

Comparing the elasticity values $\varepsilon_{L,j}$ and derivative values $r_2$ in the boom and in the bust phase, having all the same sign, it holds that

$$\varepsilon_{L,j_{BU}} > \varepsilon_{L,j_B} \quad \text{and} \quad r_{2BU} > r_{2B} \quad \text{since} \quad \text{loan demand in the bust phase is less elastic than in the boom phase according to figure 6.2.}$$

The simplifying assumption of an exogenously increasing or decreasing state of confidence in the model simulations, for reasons discussed in section 6.1.2, is very restrictive since the endogenous character of financial crises according to chapters 4 and 5 is lost. However, as the simulation results are going to show, the state of confidence $\rho(t)$ could have been endogenized theoretically by the difference between the actual profit rate and the real loan rate, i.e. by $r(t) = (j(t) - p(t))$, where $p(t) = d(\ln P(t))/dt = \dot{P}(t)/P(t)$ denotes the price level’s growth rate. The difference $r(t) - (j(t) - p(t))$ can be interpreted as a risk premium firms have to pay to investors for holding capital assets, where the real loan rate serves as reference interest rate. This risk premium is similar to the risk premia $\sigma$ and $\sigma^*$ having been used in chapters 4 and 5 in equations 4.16 and 5.10 as a determinant of the state of confidence. As a result, the change of the state of confidence $\dot{\rho}(t)$ could have been determined by economic fundamentals, but not by “chartist” behaviour, given formally by

$$\dot{\rho}(t) = r(t) - (l(t) - p(t)),$$  \hfill (6.22)

which however has been omitted for reasons of simplicity with respect to the dynamic structure of the model.

### 6.7.2 Financial Crises as an Adverse Exogenous Shock Phenomenon

The fourth model simulation considers the effect of a permanent negative foreign interest rate shock by assuming a steady and linear increase in the foreign prime rate with respect to time $t$, being formally given as

$$i^*_C(t) = i^*_C(0) + \chi t, \quad \chi > 0,$$  \hfill (6.23)

where $i^*_C(0)$ denotes the initial value of the foreign prime rate at time $t = 0$, and $\chi$ the strength of the foreign prime rate effect being positive. This simulation explicitly excludes...
the influence of the state of confidence on the macroeconomy, being denoted as $\rho_F(t)$ in
the interest rate shock simulation, by the assumption

$$\rho_F(t) = 0$$

(6.24)

throughout the analysis. In order to be consistent and comparable with the other simu-
lations, the loan rate semi-elasticity $\varepsilon_{L,j,F}$ value and the derivative value $r_{2F}$ are assumed

$$\varepsilon_{L,j,F} = \varepsilon_{L,j,BU} > -1 & r_{2F} = r_{2BU} > 0,$$

(6.25)

i.e. a rising loan rate leads to a rise in total debt costs by an underproportional reduction

of the stock of loans, and, as a result, to decline in the profit rate $r(t)$. The assumption of

an inelastic loan demand function in periods of rising domestic interest rates in order to

support a fixed exchange rate regime fits the stylized facts, since domestic interest rates

have to follow foreign interest rates instantaneously, whereas long-term loan finance of

investment cannot be reduced instantaneously, and adjusts only gradually.

6.8 Sensitivity Analysis and Method of Graphical Rep-
presentation

In order to guarantee consistency and general validity of the parameter sets, most pa-
rameter values, except for the “driving forces” $\rho$, $r_2$, $t^*_C$, and some few other parameters,
are assumed to remain constant throughout all model simulations. The parameter values
chosen in the simulation process do not apply to any real-world economy. In lieu, they are
assumed to reflect conditions which are applicable to a large variety of possible systems,
which calls for performing a sensitivity analysis with respect to “key” parameters of the
model in order to test their robustness regarding the observed dynamic patterns of the
simulation results. The “key” parameters which are going to be tested in each of the four
simulations are

$$h_1, r_{p1}, nw_1, lf_1, j_2, k_2, r_1, r_2, y_2, y_3,$$

which have been selected according to their relative importance in comparison with the
remaining parameters regarding the transmission of shocks into the real, and into the
financial system of the economy. It must be stressed that sensitivity analysis cannot
“prove” that the parameters used are “true”, nor that the observed dynamic patterns are
generally valid.

As the charts of the simulation procedure are going to portray, there arise situations in
which some endogenous variables, as e.g. nominal and real interest rates, take unrealistic
absolute numerical values, stemming on the one hand from the choice of unrealistic, but
mathematically tractable values of exogenous variables and parameters, and on the other
hand from the semi-logarithmic nature of the model distorting the general scale and the
ratios of non-log and log variables. For example, regarding the simulation of financial
crises as a cyclical phenomenon, during the boom and the overborrowing phase, being
characterized by a declining risk premium and by a depreciating exchange rate, both
the nominal prime interest rate and the nominal short-term interest rate on government
bonds become negative according to equations 6.10 and 6.14, emanating from the fact that
foreign prime interest rate has been assumed to be zero. Accordingly, unrealistic numerical values must not be interpreted as an indicator for the invalidity of calibration model, but result from a mathematically tractable choice of parameter and exogenous variable values.

Regarding the avoidance of unrealistic numerical values in calibration models, there are two generally adopted strategies, having however, both not been applied to the present model in order not to distort the general solution by adjusting the model results to reasonable numerical values. The first strategy is to plot the time paths of the endogenous variables only qualitatively without defining a parameter set and accordingly, without declaring numerical values on the axes of the plot. The second strategy is to calculate in a first step for a given parameter set a baseline solution of the model without any forcing functions representing the steady-state solution of the model. In a second step, a shock is introduced by an exogenously determined time path of an exogenous variable, and the model is going to be simulated numerically for the shock scenario without changing the initial parameter set. Finally, in a third step, the numerical differences between the steady-state and the shock scenario solution are calculated and portrayed in charts, often in the form of percentage deviations from the steady-state baseline result, eliminating the absolute numerical values of all endogenous variables and providing only information about the “direction” of the shock’s influence on endogenous variables. Accordingly, calibration models do not intend to generate relevant real-world numerical values like econometric simulation models based on estimation, but to provide information about the “direction” endogenous variables are going to follow in case the system is hit by a shock. Applying this kind of procedure to the present model means that the most important information provided by the simulations is the question of whether a variable is increasing or decreasing in the face of a shock, and not which numerical value an endogenous variable is going to take at a specific moment in time.

Regarding the graphical distinction in the charts between the fixed and the flexible exchange rate solution of the model, the fixed exchange rate solution is generally plotted by solid lines, and the flexible exchange rate solution by dotted lines. In case of the occurrence of a currency crisis, the pre-crisis phase plot is restricted to the fixed exchange rate solution, and the post-crisis phase plot is restricted to the flexible exchange rate solution. The time of a speculative attack is graphically determined by the intersection of the fixed exchange rate path and of the flexible or shadow exchange rate path in case the pre-crisis state is characterized by the shadow exchange rate being smaller than the fixed rate, making it unprofitable to attack the currency. In case of a speculative attack, the log of the stock of foreign reserves $\ln Z(t)$ is reduced discontinuously to zero.

24 This procedure can be found for example in Willman (1988), and in Calvo and Végh (1993).
25 In terms of the present model, the steady-state solution could have been calculated by assuming the state of confidence to be zero which would have resulted in constant steady-state values for $\ln s(t)$ and $\ln Z(t)$ and, as a result, in constant steady-state values for all other endogenous variables.
26 For this procedure, see e.g. Montiel, Agenor and Ul Haque (1993), chapter 5.
27 For this procedure, see e.g. Willman (1988), Flood and Garber (1984a), and Agénor, Bhandari and Flood (1992).
6.9 Simulation of Financial Crises as a Cyclical Phenomenon

6.9.1 The Boom Phase

Following the simulation classification given in section 6.7, the first three model simulations refer to the emergence of financial crises as a part of an excessive business cycle which is going to be subdivided into the boom, the overborrowing and into the bust phase. The relevant parameter and exogenous variable set, as well as the specific form of the forcing function for the boom phase simulation are summarized in table 6.2. The time paths of all 14 endogenous variables as well as the time paths of additional 9 endogenous variables being combinations of the 14 basic endogenous variables are depicted in 23 panels in figures 6.3(a), 6.3(b), and 6.3(c). Though there exist various interdependencies among the endogenous variables of the model, the following qualitative description of the plots only highlights the most important causal relationships. Since there is no currency crisis during the boom phase, i.e. the shadow exchange rate value (dotted line in the uppermost right panel of figure 6.3(a)) is always smaller than the fixed exchange rate value (solid line) and even decreasing over time, all plots show the behaviour both for a flexible (dotted plots), and for a fixed exchange rate system (solid plots). The qualitative description starts with the fixed exchange rate case and discusses adjacently the differences to a flexible exchange rate system in order to highlight the effect of the choice of the exchange rate system regarding the generation of financial fragility during the boom phase.

The Boom Phase Under a Fixed Exchange Rate Regime. The boom phase is driven by an exogenously increasing state of confidence $\rho$ according to equation 6.15 (forcing function), and by a positive $r_{2g}$ value according to condition 6.16. The increase in the state of confidence can be justified (and could have been endogenized) by an increasing positive difference between the profit and the real lending rate $r - (j - p)$ (figure 6.3(a)), serving as a fundamental indicator for actual profitability. A rising state of confidence causes, according to equation 6.9, a rise in the log of the demand price of capital $\ln P_K$ (figure 6.3(a)) and a rise in the log of Tobin's $q$, $\ln q$ (figure 6.3(a)), at a constant log of the domestic price level $\ln P$ (figure 6.3(a)) causing zero domestic inflation $p$ (figure 6.3(a)). As a result, nominal and real interest rates (figure 6.3(b)) coincide under fixed exchange rates. The constant log of the domestic price level is caused, according to equation 6.1, by a constant log of the foreign price level $\ln P^*$ and by a fixed exchange rate value $\ln \bar{s}$. The rise in the log of Tobin's $q$ stimulates investment demand and thereby the log of output $\ln Y$ (figure 6.3(c)) according to equation 6.2, causing an increase in the actual profit rate $r$ (figure 6.3(a)) according to equation 6.3, leading to a further rise in $\ln P_K$, $\ln q$, $\ln Y$ and again in $r$. Accordingly, rising profit expectations and rising actual profits cause a cumulative expansion process in the real sector being subject to rising output, profits and share prices.

The dynamics on international financial markets amplify and accelerate the expansion process by a relaxation of external financing conditions, allowing banks to increase the stock of foreign loans being used to finance domestic firms' increasing external financing needs due to the expansion in the real sector. Banks' rise in foreign debt finance is caused
Table 6.2: Parameters, Exogenous Variables, and Forcing Function During the Boom Phase

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y_0 = 0$</td>
<td></td>
</tr>
<tr>
<td>$y_1 = 0.35$</td>
<td></td>
</tr>
<tr>
<td>$y_2 = 0.8$</td>
<td></td>
</tr>
<tr>
<td>$y_3 = 0.8$</td>
<td></td>
</tr>
<tr>
<td>$\zeta = 0.01$</td>
<td></td>
</tr>
<tr>
<td>$r_0 = 2$</td>
<td></td>
</tr>
<tr>
<td>$r_1 = 0.0001$</td>
<td></td>
</tr>
<tr>
<td>$r_{2B} = 0.75$</td>
<td></td>
</tr>
<tr>
<td>$r_3 = 0$</td>
<td></td>
</tr>
<tr>
<td>$r_4 = 0$</td>
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</tr>
<tr>
<td>$\gamma = 0.5$</td>
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</tr>
<tr>
<td>$d_1 = 0.03$</td>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
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</tr>
<tr>
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</tr>
<tr>
<td>$lf_1 = 0.3$</td>
<td></td>
</tr>
<tr>
<td>$lf_2 = 0$</td>
<td></td>
</tr>
<tr>
<td>$nw_0 = 300$</td>
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<td>$nw_1 = 8$</td>
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<td>$rp_1 = 0.005$</td>
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<td>$k_2 = 8$</td>
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<td>$tr_2 = 0.9$</td>
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<tr>
<td>$\phi = 0.3$</td>
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<thead>
<tr>
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<th>Value</th>
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<td>$\ln P^*(t) = 0$</td>
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</tr>
<tr>
<td>$\delta(t) = 0$</td>
<td></td>
</tr>
<tr>
<td>$\ln K(t) = 0$</td>
<td></td>
</tr>
<tr>
<td>$\ln m(t) = 2$</td>
<td></td>
</tr>
<tr>
<td>$\ln s = 20$</td>
<td></td>
</tr>
<tr>
<td>$\iota_C(t) = 0$</td>
<td></td>
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<table>
<thead>
<tr>
<th>Forcing Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_B(t) = \rho_B(0) + \psi_B t$</td>
<td></td>
</tr>
<tr>
<td>$\rho_B(0) = 0$</td>
<td></td>
</tr>
<tr>
<td>$\psi_B = 3.5$</td>
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</table>

by an increase in firms' profit rate $r$ which reduces the amount of nonperforming loans, leading to increasing bank profits and to an augmenting log of banks' net worth $\ln NW_{BA}$ (figure 6.3(c)) according to equation 6.7. This increase in banks' net worth lowers on the one hand the interest rate on foreign loans by a reduction of the risk premium $rp$ (figure 6.3(c)) according to equation 6.8, and increases on the other hand foreign loan inflows $\ln LF^*$ (figure 6.3(c)) according to equation 6.6 due to an improved collateral position of domestic banks.

Increasing capital inflows make monetary authorities decrease the nominal domestic prime rate $i_C$ (figure 6.3(b)), being equal to the real domestic prime rate $i_C - p$, according to equation 6.14 in order to stabilize the fixed exchange rate by reducing foreign loan inflows. However, since capital inflows cannot be controlled perfectly by monetary authorities according to equations 6.6 and 6.14, lowering the domestic prime rate is only able to weaken, but not to stop capital inflows $\ln LF^*$ since the influence of banks' net worth $\ln NW_{BA}$ dominates international capital movements. There arise no international capital flows from short-term bond transactions since the capital flow determining difference between the domestic nominal short-term interest rate on bonds $i$, being equal to the real short-term interest rate $i - p$, and the constant foreign prime rate $i^{c*}$, adjusted by the constant risk factor $\alpha$, is always zero according to equation 6.10. Thus, the domestic nominal and real domestic short-term bond rate, $i$ and $i - p$ (figure 6.3(b)), remain constant at an $\alpha$ per cent higher level than the foreign prime rate.

The balance of payments and the level of the log of international reserves $\ln Z$ is dominated by the capital account surplus leading to an increasing stock of foreign reserves $\ln Z$ (figure 6.3(a)) according to equation 6.13, though the log of the current account $\ln T$ is deteriorating inducing a current account deficit. The deteriorating current account position $\ln T$ (figure 6.3(c)) is caused, according to equation 6.12, by an increase in the
log of domestic output $\ln Y$ stimulating import demand, whereas there is no influence of the real exchange rate on the trade balance due to the validity of PPP.

Increasing foreign exchange reserves $\ln Z$ and a decreasing domestic prime interest rate $i_C$, causing a rise in the log of the domestic credit component $\ln H$ (figure 6.3(c)) due to a reduction of banks' lending costs according to equation 6.5, lead to an increase in the amount of high powered money $\ln M = \gamma \ln H + (1 - \gamma) \ln Z$ (figure 6.3(c)) and thereby to an increase in the supply of deposit according to equation 6.4. Though there is an increase in deposit supply, the nominal interest rate on domestic long-term bonds $f$, being equal to the real domestic long-term bond rate $f - p$, rises (figure 6.3(c)) due to an increase in deposits demand caused by a rise in the log of output $\ln Y$, being larger than the increase in deposit supply, inducing agents to sell long-term bonds owing to liquidity needs which lowers market prices on long-term bonds according to equation 6.4. The rise in the nominal interest rate on long-term government bonds $f$ reduces government expenditure due to increasing government debt costs, and weakens partly the expansion of the log of output $\ln Y$ according to equation 6.2.

A rising stock of deposits induced by declining refinancing costs enables domestic banks to expand loans to domestic firms by lowering the loan interest rate $j$, being equal to real loan rate $j - p$, (figure 6.3(b)) according to equation 6.11. The expansion of domestic loans is additionally reinforced by improving collateral values of firms by a rising demand price of capital $\ln P_K$, leading to a further decline in the loan rate according to equation 6.11. As there is a total decline in total interest rate costs due to the decline in the loan rate being larger than the increase in the stock of loans, a falling loan rate $j$ leads to an increase in firms' profit rate $r$ according to equation 6.3, leading to cumulative repetitions of the expansion process described above.

The Boom Phase Under a Flexible Exchange Rate Regime. Though the simulation of financial crises as a cyclical phenomenon assumes a fixed exchange rate system to prevail until the occurrence of a speculative attack, it is important to study the effects of the exchange rate system on the build-up of financial fragility during the boom phase by comparing the dynamic patterns under fixed and flexible exchange rates. The dotted lines in figures 6.3(a), 6.3(b), and 6.3(c) illustrate that the boom phase under flexible exchange rates is characterized by less expansionary effects than under fixed exchange rates, being caused by the absence of central bank intervention in the foreign exchange market, weakening high-powered money expansion. Instead of leading to a rise in the log of the stock of foreign exchange reserves $\ln Z$, increasing capital inflows $\ln LF^*$, which are induced by the same expansionary mechanism as under fixed exchange rates $^{28}$, lead to an appreciation of the domestic currency, i.e. to a decline in $\ln s$ causing domestic deflation via PPP, as the rise in capital inflows is larger in absolute terms than the rise in the current account deficit $\ln T$ in domestic currency, which is induced by the expansion of import demand. Accordingly, due to the absence of the expansionary effect of increasing foreign exchange reserves $\ln Z$ on high-powered money $\ln M$, the reduction in the nominal $j$ and in the real loan rate $j - p$ is less than under fixed exchange rates, leading to a smaller increase in firms' profit rate $r$, weakening the increase in the log of the demand price of capital $\ln P_K$, in the log of Tobin's $q$, $\ln q$, and in the log of output $\ln Y$. A smaller

$^{28}$The expansion process is induced by a rise in $\rho$, leading to increasing values in $\ln P_K$, $\ln q$, $\ln Y$ and in $r$, inducing an increase in $\ln NW_{BA}$, and causing $\ln LF^*$ to rise.
increase in firms’ profits leads to a less pronounced increase in banks’ net worth \( \ln NW_{BA} \), to lower capital inflows \( \ln LF^* \), and to a smaller reduction in the risk premium \( rp \), which requires a smaller reduction in the domestic prime rate \( i_C \) having a dampening effect on the increase in the log of the domestic credit component \( \ln H \). Rising output \( \ln Y \) and a less increasing deposit supply requires a larger increase in the long-term bond rate \( f \) than under a fixed exchange rate system. The nominal short-term bond rate \( i \) is lower than under fixed rates owing to exchange rate depreciation, whereas the real short-term bond rate \( i - p \) is identical with the fixed exchange rate case since the deflation and the depreciation rate coincide. Summing up, a flexible exchange rate system creates a less pronounced increase in indebtedness of banks and firms under an identical time path of profit expectations, thereby creating a lesser degree of financial fragility than under fixed exchange rates.

**Sensitivity Analysis.** The dynamic solution depicted in figures 6.3(a), 6.3(b), and 6.3(c) is stable for a ±10% variation of all key parameters \( h_1, rp_1, nw_1, lf_1, j_2, k_2, r_1, r_2, y_2, \) and \( y_3 \), i.e. the dynamic patterns of all variables do not change. The solution is also stable for a +20% variation of all key parameters and, except for parameters \( nw_1, lf_1, l_2, r_2 \), in case of a -20% variation. A -20% variation of parameters \( nw_1, lf_1, l_2, \) and \( r_2 \) generates a boom which ends up in a currency crisis, but not in a banking crisis, due to a very fast increasing current account deficit leading to a depletion of foreign exchange reserves \( \ln Z \), and to a speculative attack.

### 6.9.2 The Overborrowing Phase and the Upper Turning Point

The set of parameters, exogenous variables, as well as the specific form of the forcing function for the overborrowing process simulation are summarized in table 6.3. In comparison with the boom phase parameter set given in table 6.2, only the initial value of the state of confidence \( p_0(0) \), being larger than the initial value of the boom phase \( p_B(0) \) according to equation 6.17, and parameter \( r_2 \), having now a negative sign according to condition 6.18, have different values; all other parameters have the same values as in table 6.2.

The overborrowing process is driven, as the boom phase, by an exogenous increase in the state of confidence \( \rho \) according to equation 6.17, which could be justified by an increasing difference between the profit and the real lending rate \( r - (j - p) \) (figure 6.4(a)), though the actual profit rate \( r \) is decreasing, or even becoming negative (figure 6.4(a)). Accordingly, the rise in difference \( r - (j - p) \), i.e. the reduction of the negative value of \( r - (j - p) \) according to figure 6.4(a), results from the real lending rate \( j - p \) (figure 6.4(b)) declining more than the profit rate \( r \). Such a situation in which the actual profit rate declines or even becomes negative, but profit expectations rise and induce a further increase in indebtedness by a further relaxation of financial market conditions, is a typical state of “irrational exuberance”. In a state of irrational exuberance, agents’ expectations are mainly driven by chartist behaviour, expecting the past trend to be continued in the future without any reasonable consideration of fundamental data which indicate a downward revision of expectations. In the present case, the rising state of confidence \( \rho \) can be explained by chartist behaviour either without any consideration of fundamental data, or partly according to a misinterpretation of a decline of the negative difference \( r - (j - p) \) as an indicator of rising future profitability though actual profitability declines.
By figures 6.4(a), 6.4(b), and 6.4(c), the simulation of the overborrowing process is subject to a currency crisis taking place at time $t = 15.04$ when the flexible shadow exchange rate $\ln s$ (uppermost right panel in figure 6.4(a)) hits the fixed exchange rate $\ln \bar{s}$, inducing agents to sell domestic currency in huge volumes, and leading to a complete depletion of foreign exchange reserves $\ln Z$ (uppermost left panel in figure 6.4(a)) and to an abolition of the exchange rate peg. Yet, empirical evidence, as well theory of financial crises according to chapters 4 and 5 argue that the overborrowing phase of an excessive business cycle generally is not subject to a currency crisis, occurring only when profit expectations collapse, or already have collapsed. Furthermore, the post-currency crisis period is characterized, according to figures 6.4(a), 6.4(b), and 6.4(c), by unrealistic behaviour of some macrovariables, as e.g. by increasing share prices $\ln P_K$ and $\ln q$ (figure 6.4(a)) and declining nominal and real lending rates $j$ and $j - p$, though the actual profit rate $r$ (figure 6.4(a)) declines, though the log of banks' net worth $\ln NW_{BA}$ (figure 6.4(c)) is subject to a further decline and becomes even negative indicating a severe banking crisis, and though there are increasing foreign capital outflows $\ln LF^*$ (figure 6.4(c)) inducing a sharp increase in the domestic prime rate $i_C$ (figure 6.4(b)). These results mainly stem from the assumption of a further exogenous increase in the state of confidence $\rho$ after the occurrence of a speculative attack, being an unrealistic scenario, even according to the model since the difference $r - (j - p)$ (figure 6.4(a)) is declining, indicating a downward revision of profit expectations. However, these unrealistic post-currency crisis simulation results must not be misinterpreted as an indicator for the invalidity of the calibration model since firstly, the pre-currency crisis results match with the stylized facts described below, secondly, the simulation highlights the fact that a situation of irrational exuberance leads to a financial collapse (twin crisis) even if expectations have not yet collapsed, and thirdly, the simulation indicates that expectations are going to be reversed according to the difference between the profit and the real lending rate $r - (j - p)$ (figure 6.4(a)).

Summing up, though the simulation of the overborrowing process generates a currency crisis, it is reasonable to analyze only the pre-currency crisis phase, since the build-up of financial fragility, being completely ignored by investors, takes place predominantly in the overborrowing phase being characterized by the absence of any financial distress in the economy. The collapse of a fixed exchange rate regime follows in most cases a domestic financial crisis (banking crisis and widespread bankruptcies among firms), being analyzed in the bust phase simulation, which has been caused by a crash in expectations when agents have realized that expectations cannot be fulfilled by actual developments.

In the pre-currency crisis phase of the overborrowing process when the economy approaches the upper turning point of the business cycle, the rise in the state of confidence $\rho$ causes, according to equation 6.9, a rise in the log of the demand price of capital $\ln P_K$ (figure 6.4(a)), and a rise in the log of Tobin's $q$, $\ln q$ (figure 6.4(a)), where the log of the domestic price level $\ln P$ (figure 6.4(a)) remains constant according to PPP, resulting in zero inflation $\rho$ (figure 6.4(a)) according to equation 6.1, causing a correspondence of nominal and real interest rates in the overborrowing phase. However, by equation 6.9, the rise in the log of the demand price of capital $\ln P_K$ and in the log of Tobin's $q$, $\ln q$, requires that the increase in the state of confidence $\rho$ is stronger than the fall in the profit rate $r$ (figure 6.4(a)), having been explained above by a chartist type dominated expectation formation scheme. The rise in the log of Tobin's $q$, $\ln q$, stimulates investment demand and has an expansionary influence on the log of output $\ln Y$ though the log of output $\ln Y$
Table 6.3: Parameters, Exogenous Variables, and Forcing Function During the Overborrowing Phase and at the Upper Turning Point

<table>
<thead>
<tr>
<th>Parameters</th>
<th>( y_0 = 0 )</th>
<th>( y_1 = 0.35 )</th>
<th>( y_2 = 0.8 )</th>
<th>( y_3 = 0.8 )</th>
<th>( \zeta = 0.01 )</th>
<th>( r_0 = 2 )</th>
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<td>( r_1 = 0.0001 )</td>
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<td>( r_3 = 0 )</td>
<td>( r_4 = 0 )</td>
<td>( \gamma = 0.5 )</td>
<td>( d_1 = 0.03 )</td>
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<tr>
<td>( d_2 = 0.05 )</td>
<td>( d_3 = 0.02 )</td>
<td>( h_0 = 40 )</td>
<td>( h_1 = 4 )</td>
<td>( l_f_1 = 0.3 )</td>
<td>( l_f_2 = 0 )</td>
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<td>( r p_1 = 0.005 )</td>
<td>( k_1 = 2 )</td>
<td>( k_2 = 8 )</td>
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</tr>
<tr>
<td>( \alpha = 0.01 )</td>
<td>( j_0 = 2 )</td>
<td>( j_1 = 1.4 )</td>
<td>( j_2 = 0.105 )</td>
<td>( t r_1 = 0.1 )</td>
<td>( t r_2 = 0.9 )</td>
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<tr>
<td>( \phi = 0.3 )</td>
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<th>Exogenous Variables</th>
<th>( \ln P^*(t) = 0 )</th>
<th>( \delta(t) = 0 )</th>
<th>( \ln K(t) = 0 )</th>
<th>( \ln m(t) = 2 )</th>
<th>( \ln s = 20 )</th>
<th>( \delta_C(t) = 0 )</th>
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<table>
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<tr>
<th>Forcing Function</th>
<th>( \rho(t) = \rho(0) + \psi t )</th>
<th>( \rho(0) = 5 )</th>
<th>( \psi = 3.5 )</th>
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(figure 6.4(a)) is actually declining according to equation 6.2, due to a large reduction in government expenditure which is caused by a sharp increase in the long-term interest rate on government bonds \( f \) according to equation 6.4, being explained below. Thus, the profit rate \( r \) declines not only owing to the overborrowing effect represented by a negative \( r_{2o} \) value according to equation 6.3, but also by declining output reducing sales revenues. Accordingly, though the status of the real sector is characterized by declining profits and sales, share prices continue to rise owing to an unbounded increase in profit expectations, being characteristic of a state of irrational exuberance.

The reversal of the expansion process in the real sector is reflected in increasing financial tensions among banks due to a rising number of nonperforming loans which are mainly caused by illiquidity in the firm sector, i.e. by a declining profit rate \( r \), but not by insolvency since collateral values of firms, i.e. the log of the demand price of capital \( \ln P_K \), are subject to further increases. This contradictory picture of firms' financial status, i.e. rising illiquidity on the one hand, but rising solvency on the other hand, causes banks in most cases roll-over loans, or even to expand credit lines for potentially illiquid firms since their rising collateral values reduce losses by banks in case of firms' default. As a result, though banks face increasing liquidity failures among firms lowering banks' profits and the log of their net worth \( \ln NW_{BA} \) (figure 6.4(c)) according to equation 6.7, banks are willing to increase credit lines, being reflected in a declining nominal \( j \) and real interest rate \( j - p \) on loans (figure 6.4(b)) due to the dominance of the rising collateral value effect according to equation 6.11, which overcompensates the negative influence of a declining log of high powered money \( \ln M \) (figure 6.4(c)). However, this relaxation of loan market conditions leads to an increase in firms' total debt costs since the percentage increase in the stock of loans is larger than the decline of the loan rate, lowering additionally firms' profit rate \( r \) (figure 6.4(a)) owing to the overborrowing effect according to equation 6.3.
Foreign investors start to withdraw their funds, leading to rising capital outflows $\ln LF^*$ due to a deteriorating collateral position of banks $\ln NW_{BA}$ according to equation 6.6, leading to an increase in interest rate costs on foreign loans by a rise in the risk premium $rp$ according to equation 6.8. Rising capital outflows $\ln LF^*$, and a rising risk premium $rp$ cause monetary authorities to increase the nominal prime rate $i_C$, leading also to an increase in the real prime rate $i_C - p$ (figure 6.4(a)), in order to stabilize capital outflows according to equation 6.14. Yet, since capital outflows cannot be controlled perfectly due to the dominance of banks’ collateral effect according to equations 6.6 and 6.14, a rising capital account deficit leads to a depletion of the log of foreign exchange reserves $\ln Z$, though the log of the current account $\ln T$ is improving and even changing into a current account surplus due to a declining import demand, being caused by a shrinking log of output $\ln Y$. There arise no international capital flows from short-term bond transactions since the domestic nominal short-term bond rate $i$, being equal to the real short-term bond rate $i - p$ (figure 6.4(b)), remains constant at an $\alpha$ per cent higher level than the foreign prime rate $i^*_0$, leading to a zero value of the capital flow determining interest rate differential $i - (i^*_0 + \alpha)$ according to equation 6.10.

An increasing nominal domestic prime rate $i_C$, causing a decline in the log of the domestic credit component $\ln H$ (figure 6.4(c)) by an increase in banks’ lending costs according to equation 6.5, and a shrinking log of foreign exchange reserves $\ln Z$, lead to a declining log of high powered money $\ln M$ (figure 6.4(c)), reducing deposit supply according to equation 6.4. Though deposit demand is reduced by a shrinking log of output $\ln Y$ according to equation 6.4, agents are forced to sell domestic long-term bonds due to an excess demand for deposits which is caused by the deposit supply being reduced to a larger extent than deposit demand via a reduction of $\ln Y$. As a result, the nominal and the real interest rate on long-term government bonds $f$ and $f - p$ (figure 6.4(b)) rise by equation 6.4, leading to a reduction in government expenditure which is larger than the rise in investment demand due to an increase in $\ln q$, causing the log of output $\ln Y$ to shrink.

Summing up, the overborrowing phase and the upper turning point are characterized by a chartist expectation formation scheme, leading to increasing share prices and to an expansion of loans to domestic firms though fundamentals, as the profit rate, output, banks’ net worth, as well as rising capital outflows indicate an unavoidable downturn of the economy being associated with severe financial distress.

**Sensitivity Analysis.** The solution is stable within a $\pm 10\%$ variation range of all key parameters $h_1, \ r_{p1}, \ nw_1, \ lf_1, \ j_2, \ k_2, \ r_1, \ r_2, \ y_2, \text{ and } y_3$. Except for a $-20\%$ decrease in parameter $r_{20}$, the solution is even stable in a $\pm 20\%$ range. A $-20\%$ decrease in $r_{20}$, being equivalent to a stronger overborrowing effect, only causes the difference between the profit and the real lending rate $r - (j - p)$ to decline in the pre-currency crisis period leaving all other dynamic patterns unchanged. This result indicates that, in case the formation of profit expectations follows the fundamental $r - (j - p)$ in periods of weak chartist influence, a rising overborrowing effect causes expectations to switch from optimism to pessimism, determining the upper turning point and the beginning of the bust phase.
6.9.3 The Bust Phase

The overborrowing process comes to a halt at the upper turning point of the business cycle when investors conceive suddenly that profit expectations cannot be realized any more because of unsustainable high external debt among firms and banks, leading to a steady deterioration of the liquidity status, and eventually of the solvency status. In most cases, the downward revision of profit expectations is caused by a small shock, as e.g. the failure of an important business firm or bank, having the effect of a “wake up call” on investors. Since investors do not follow fundamental data when forming profit expectations in the overborrowing phase, the triggering event for collapsing expectations is generally interpreted as an exogenous shock, being however an *endogenous* phenomenon since steady increasing debt costs and declining revenues finally must lead to illiquidity and insolvency. Accordingly, the triggering event causing a downward revision of expectations is only a mechanism to reveal widespread financial fragility which has been ignored so far. In an environment with low financial fragility, the same triggering event would not have caused a widespread collapse of expectations, since the development of actual profits would have validated the existing financial structure, and would have indicated no overindebtedness and widespread potential illiquidity and insolvency. According to the sensitivity analysis of the overborrowing phase, increasing indebtedness in the model, causing a steady fall in the profit rate $r$ and in the log of banks’ net worth $\ln NW_{BA}$, engenders finally a downward revision of expectations in case the overborrowing process is reinforced when the economy reaches the upper turning point of the business cycle, being a realistic scenario in a nonlinear real-world dynamic environment as shown in chapters 4 and 5.29

When the growth in profit expectations comes to a halt, the bust phase is about to begin whose simulation follows the set of parameters, exogenous variables, as well as the forcing function summarized in table 6.4. The bust phase is driven by a sharply declining state of confidence $\rho$ whose initial value $\rho_{BU}(0)$ is the maximum the state of confidence can reach, and whose negative growth rate is larger in absolute terms than the positive growth rate of $\rho$ during the boom and the bust phase according to equation 6.19. Furthermore, the bust phase is characterized by a loan rate semi-elasticity value with respect to the stock of loans of $\varepsilon_{L,JBu} > -1$, being reflected in a positive parameter $\rho_{2Bu}$ whose value is greater than in the boom phase $\rho_{2B}$, reflecting a much less elastic loan demand in the bust phase according to condition 6.21.

The dynamic patterns of the endogenous model variables depicted in figures 6.5(a), 6.5(b), and 6.5(c) differ, by comparison with the boom and the overborrowing simulation, with respect to the occurrence of a speculative attack, and with respect to “jumps” of almost all variables at the moment of speculative attack, whereas the pre-currency crisis period is almost a mirror image of the boom phase simulation. The pre-currency crisis period from time $t = 0$ until the moment of speculative attack at time $t = 20.47$ is characterized by a fixed exchange rate at level $\ln s = 20$ (solid line in uppermost right panel in figure 6.5(a) for $0 < t \leq 20.47$), while the post-currency crisis period is subject to a flexible exchange rate regime starting at $\ln s = 20$ at time $t = 20.47$ and following the flexible exchange rate path for $t > 20.47$ (dotted line in uppermost right panel in

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29 Sensitivity analysis of the overborrowing process has shown that a steady fall in $r_{2O}$, i.e. a strengthening of overindebtedness, leads to a declining negative value of the difference between the profit and the real lending rate $r - (\bar{j} - p)$, causing a sharp reduction in the state of confidence $\rho$ in case expectations are influenced by the fundamental $r - (\bar{j} - p)$. 

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via free access
Table 6.4: Parameters, Exogenous Variables, and Forcing Function During the Bust Phase

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<th>Forcing Function</th>
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</tr>
<tr>
<td>$P^*(t) = 0$</td>
<td>$\delta(t) = 0$</td>
<td></td>
</tr>
<tr>
<td>$ln K(t) = 0$</td>
<td>$ln m(t) = 2$</td>
<td></td>
</tr>
<tr>
<td>$i_C(t) = 0$</td>
<td>$\rho_{BU}(t) = \rho_{BU}(0) + \psi_{BU} t$</td>
<td></td>
</tr>
<tr>
<td>$\ln P(t) = 0$</td>
<td>$\ln s = 20$</td>
<td></td>
</tr>
</tbody>
</table>

The time paths of the remaining variables under the fixed exchange rate regime until time $t = 20.47$ are represented by solid lines, whereas their post-currency crisis paths are represented by dotted lines. The “jumps” of almost all endogenous variables at the moment of speculative attack at time $t = 20.47$, except for the log of the exchange rate $\ln s$ and the log of the domestic price level $\ln P$ as to equation 6.1, are originally caused by a sudden and discontinuous decline in the log of foreign exchange reserves $\ln Z$ from $\ln Z > 0$ to $\ln Z = 0$ (uppermost left panel in figure 6.5(a)) leading to a downward jump in the log of high powered money $\ln M = \gamma \ln H + (1 - \gamma) \ln Z$ (figure 6.5(c)) causing the remaining variables to change discontinuously. The following qualitative description of the bust phase depicted in figures 6.5(a), 6.5(b), and 6.5(c) discusses at first the pre-currency crisis situation, and afterwards the speculative attack’s effects and the post-currency crisis phase.

The Pre-Currency Crisis Phase. The reduction in the state of confidence $\rho$ by equation 6.19, which can be justified by a declining difference between the profit and the real lending rate $r - (j - p)$ (figure 6.5(a)), leads to a decline in log of the demand price of capital $\ln P_K$ (figure 6.5(c)) by equation 6.9, and to a decline in the log of Tobin’s $q$, $\ln q$ (figure 6.5(a)), at a constant log of the price level $\ln P$ (figure 6.5(a)), resulting in zero inflation $p$ (figure 6.5(a)) by equation 6.1. Hence, in the pre-currency crisis phase, nominal and real interest rate are identical. The fall in the log of Tobin’s $q$, $\ln q$, causes a reduction of investment demand leading to a fall in the log of output $\ln Y$ (figure 6.5(c)).
by equation 6.2. This reduction in sales engenders ceteris paribus a reduction in firms’ profit rate $r$ (figure 6.5(a)) by equation 6.3, causing a further decline in the log of the demand price of capital $\ln P_K$ according to equation 6.9, in the log of Tobin’s $q$, $\ln q$, in the log of output $\ln Y$, and thereby again in the profit rate $r$. Thus, the fall in the state of confidence $\rho$ leads to a contractionary cumulative process being subject to declining share prices, declining output, declining profits and deteriorating liquidity positions of firms.

Rising liquidity problems among firms, indicated by a fall in the profit rate $r$, cause a banking crisis by an increasing amount of nonperforming loans, leading to a reduction in banks’ profits and in the log of banks’ net worth $\ln NW_{BA}$ (figure 6.5(c)) by equation 6.7. Rising solvency problems among banks lead on the one hand, to an increase in interest rate costs on foreign loans by an increase in the risk premium $rp$ (figure 6.5(c)) as to equation 6.8, and on the other hand to a rising growth of capital outflows $\ln LF^*$ (figure 6.5(c)) according to equation 6.6. There are no international capital flows from short-term bond transactions since the domestic nominal short-term interest rate on bonds $i$ (figure 6.5(b)), being equal to the real short-term bond rate $i - p$ (figure 6.5(b)), always adjusts instantaneously to guarantee the risk adjusted interest parity condition 6.10 by having a constant $\alpha$ percent higher value than the foreign prime rate $i_C^*$. Rising foreign loan outflows make monetary authorities increase the domestic prime rate $i_C$ (figure 6.5(b)), being equal to the real domestic prime rate $i_C - p$ (figure 6.5(b)), as to equation 6.14 in order to stabilize the capital account. Since international capital flows cannot be steered perfectly by monetary authorities owing to the dominance of banks’ collateral effect as to equations 6.6 and 6.14, a rising capital account deficit causes the central bank to intervene in the foreign exchange market by selling foreign reserves $\ln Z$ (figure 6.5(a)) according to equation 6.13, though the current account deficit $\ln T$ (figure 6.5(c)) improves and reverses into a current account surplus due to the fall in the log of output $\ln Y$ by equation 6.12, which however, does not suffice to offset rising capital outflows.

Declining foreign exchange reserves $\ln Z$, and a rising domestic prime rate $i_C$ leading to a reduction of the log of the domestic credit component $\ln H$ (figure 6.5(c)), cause a reduction in high powered money $\ln M$ (figure 6.5(c)). This reduction in high powered money reduces banks’ deposit supply as their input factor to create loans, leading to a rise in the nominal loan rate $j$ (figure 6.5(b)), being equal to the real loan rate $j - p$ (figure 6.5(b)) by equation 6.11. However, the increase in the nominal loan rate $j$ is also driven by declining collateral values of firms represented by a fall in the log of the demand price of capital $\ln P_K$ as to equation 6.11. As a result, tightening financial market conditions, as well as declining collateral values among firms lead to a further cumulative reduction in firms’ profit rate $r$ according to equation 6.3, since the rise in the loan rate is larger than the percentage reduction in the stock of loans according to condition 6.21.

The reduction in the log of high powered money $\ln M$, and accordingly in deposit supply, leads to an increase in the domestic nominal long-term interest rate on government bonds $f$ (figure 6.5(b)) by equation 6.4, since the decline in deposit supply is larger than the decline in deposit demand, being caused by the fall in the log of output $\ln Y$, leading to an excess supply of long-term bonds. This increase in the domestic nominal long-term bond rate $f$, being equal to the real long-term bond rate $f - p$ (figure 6.5(b)), causes a reduction in government expenditures, and thereby a further cumulative reduction in the log of output $\ln Y$ by equation 6.2.
Speculative Attack and Post-Currency Crisis Phase. An actual and expected rise in the flexible shadow exchange rate $\ln s$ (figure 6.5(b)), caused by the capital account deficit being larger in absolute terms than the current account surplus according to equation 6.13, makes foreign exchange market participants attack the domestic currency by buying the entire stock of foreign exchange reserves $\ln Z$ at time $t = 20.47$ when it holds that $\ln s = \ln \dot{s}$. Attacking the domestic currency is profitable from an investor’s viewpoint as the acquired stock of foreign reserves $\ln Z$ can be sold later at a much higher exchange rate value $\ln s$. This discontinuous reduction in the log of foreign exchange reserves $\ln Z$ (figure 6.5(b)) leads to a downward jump in the log of high powered $\ln M$ (figure 6.5(c)) which induces a discontinuous rise in the nominal long-term interest rate on bonds $f$ (figure 6.5(b)), causing a discontinuous reduction in government expenditures and in the log of output $\ln y$ by equation 6.2. This downward jump in the log of output $\ln Y$ causes a discontinuous reduction in sales, and therefore in firms’ profit rate $r$ (figure 6.5(a)) by equation 6.3. Suddenly rising liquidity problems among firms induce a stock market “crash”, being represented by downward jumps in the log of the demand price of capital $\ln P_K$ (figure 6.5(a)) by equation 6.9, and in the log of Tobin’s $q$, $\ln q$ (figure 6.5(a)), which is however dampened by an increase in the log of the price level $\ln P$ (figure 6.5(a)) by equation 6.1, causing inflation $\ln p$ (figure 6.5(a)) to jump from zero to a positive value. Consequently, all increases in nominal interest rates are dampened by increasing inflation. The drop in the log of Tobin’s $q$, $\ln q$, causes a further deterioration of the cumulative contractionary process by a sudden decline in investment demand, a further discontinuous drop in the log of output $\ln Y$, in the log of the demand price of capital $\ln P_K$, and in firms’ profit rate $r$.

The decline in firms’ profit rate $r$ leads to a rise in the amount of nonperforming loans, being reflected in a downward jump in the log of banks’ net worth $\ln NW_{BA}$ (figure 6.5(c)) as to equation 6.7, intensifying the banking crisis. It must be noted that banks’ net worth also drops suddenly by the increase in foreign debt due to the devaluation, which is however not incorporated in the model. Declining net worth of banks leads to a discontinuous rise in capital outflows $\ln LF^*$ (figure 6.5(c)) by equation 6.6 and to a sudden rise in the risk premium $\ln r_p$ (figure 6.5(c)) according to equation 6.8. Since the central bank cannot intervene any longer in the foreign exchange market and the flexible exchange rate moves continuously, the sudden increase in the capital account deficit requires a sudden increase in the current account surplus $\ln T$ (figure 6.5(c)) in order to equalize the balance of payments according to equation 6.13 for which it holds that $\ln \dot{Z} = 0$. In order to stabilize risk-adjusted international short-term bond interest rate parity, the domestic short-term bond rate $i_C$ (figure 6.5(b)) has to increase discontinuously by the expected and constant depreciation rate $\ln \dot{s}$ by equation 6.10. As monetary authorities are assumed to stabilize capital flows by interest rate pegging under flexible exchange rates as well, the sudden rise in capital outflows $\ln LF^*$ and in the risk premium $\ln r_p$ requires an upward jump in the domestic prime rate $i_C$ (figure 6.5(b)) by equation 6.14, which however, does not stop capital outflows and a further depreciation of the home currency due to the dominance of banks’ collateral effect by equations 6.6 and 6.14.

The drop in the domestic prime rate $i_C$, causing a drop in the log of domestic credit $\ln H$ (figure 6.5(c)), the drop in foreign exchange reserves $\ln Z$, as well as the drop in the log of the demand price of capital $P_K$ make banks increase discontinuously the nominal loan rate $j$ (figure 6.5(b)) by equation 6.11. This sudden increase in the nominal loan rate
leads to a further drop in the profit rate $r$ according to equation 6.3, and as described above, to a further deterioration of the cumulative contractionary process.

All real interest rates of the model, namely the real loan rate $j - p$, the real domestic prime rate $i_C - p$, the real short-term interest rate on bonds $i - p$, and the real long-term interest rate on bonds $f - p$ (all depicted in figure 6.5(b)), are also subject to a discontinuous upward jump since the increase in inflation $p$ does not suffice to overcompensate the rising nominal interest rate effect in order to reduce real interest rates. The difference between the profit and the real lending rate $r - (j - p)$ (figure 6.5(a)) also drops discontinuously indicating a further drop in expectations.

The post-currency crisis period is characterized by a further deterioration of the macroeconomic situation due to a further declining state of confidence and due to a rising exchange rate. Accordingly, the dynamic patterns of all endogenous variables in the post-currency crisis period can be explained by the same mechanisms of the pre-currency crisis period and by the effects of a collapsing exchange rate having already outlined in detail above.

**Sensitivity Analysis.** The simulation results are stable within a ±10% variation of all key parameters $h_1, r_{p1}, nw_1, l_{f1}, k_2, r_1, r_2, y_2$, and $y_3$. Except for a +20% increase in parameters $nw_1$ and $l_{f1}$, the solution is even stable within a ±20% variation range. A +20% rise in parameters $nw_1$ and $l_{f1}$ leads to a twin crisis at first, but afterwards to a recovery of the economy despite a decrease in the state of confidence $\rho$. This result can be explained by an improving balance of payments situation due to a rising current account surplus after the speculative attack, leading to a depreciation of the exchange rate according to equation 6.13. The decline in the log of the exchange rate $\ln s$ leads to a decline in the log of the price level $\ln P$ by equation 6.1, thereby increasing Tobin’s $q$, $\ln q$, by overcompensating the contractionary effect of a decline in the state of confidence $\rho$ on the log of the demand price of capital $\ln P_K$. The rise in the log of Tobin’s $q$, $\ln q$, leads to a rise in investment demand, output, share prices, profits, and capital inflows, leading to a relaxation of financial market conditions and thereby to a macroeconomic expansion. This result is a typical (but unrealistic) example of an expansionary devaluation though the economy is subject to a twin crisis.

### 6.10 Simulation of Financial Crises Caused by an Adverse Foreign Interest Rate Shock

The following simulation demonstrates the emergence of a systemic financial crisis caused by a negative foreign interest rate shock and excludes the build-up of endogenous financial fragility. The relevant parameter and exogenous variable set, as well as the forcing function of the exogenous shock simulation are summarized in table 6.5. The simulation is driven, following mainstream theory having been outlined in sections 4.5 and 5.5, by an exogenously increasing foreign prime rate $i_C^0$ according to equation 6.23. In order to be comparable with the boom-bust simulations, the present simulation assumes an identical loan rate semi-elasticity with respect to the stock of loans as the bust phase simulation in section 6.9.3, i.e. it holds that $\epsilon_{L,j_F} = \epsilon_{L,j_BU} > -1$, implying $r_{2_F} = r_{2_BU} > 0$ according to condition 6.25. Assuming a very inelastic loan demand is consistent with the stylized
facts in periods of sudden and large financial tightening, since external finance of long-
term investment projects cannot be reduced instantaneously without causing immediate
illiquidity, but adjusts only gradually. To rule out profit expectation effects, the state of
confidence $\rho_F$ is assumed to be zero throughout the analysis according to condition 6.24.

Table 6.5: Parameters, Exogenous Variables, and Forcing Function During an Adverse
Exogenous Foreign Interest Rate Shock

<table>
<thead>
<tr>
<th>Parameters</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$y_0 = 0$</td>
<td>$y_1 = 0.35$</td>
<td>$y_2 = 0.8$</td>
<td>$y_3 = 0.8$</td>
<td>$\zeta = 0.01$</td>
<td>$r_0 = 2$</td>
</tr>
<tr>
<td>$r_1 = 0.0001$</td>
<td>$r_{2F} = 0.8$</td>
<td>$r_3 = 0$</td>
<td>$r_4 = 0$</td>
<td>$\gamma = 0.5$</td>
<td>$d_1 = 3$</td>
</tr>
<tr>
<td>$d_2 = 5$</td>
<td>$d_3 = 2$</td>
<td>$h_0 = 20$</td>
<td>$h_1 = 4$</td>
<td>$lf_1 = 0.3$</td>
<td>$lf_2 = 0$</td>
</tr>
<tr>
<td>$nw_0 = 30$</td>
<td>$nw_1 = 5$</td>
<td>$rp_0 = 1$</td>
<td>$rp_1 = 0.005$</td>
<td>$k_1 = 2$</td>
<td>$k_2 = 8$</td>
</tr>
<tr>
<td>$\alpha = 0.01$</td>
<td>$j_0 = 2$</td>
<td>$j_1 = 0.0012$</td>
<td>$j_2 = 0.105$</td>
<td>$tr_1 = 0.1$</td>
<td>$tr_2 = 0.9$</td>
</tr>
<tr>
<td>$\phi = 0.3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exogenous Variables</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln P^*(t) = 0$</td>
<td>$\delta(t) = 0$</td>
<td>$\ln K(t) = 0$</td>
<td>$\ln m(t) = 2$</td>
<td>$\ln \bar{s} = 20$</td>
<td>$\rho_F(t) = 0$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forcing Function</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$i^<em>_C(t) = i^</em>_C(0) + \chi t$</td>
<td>$i^*_C(0) = 0$</td>
<td>$\chi = 5$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The dynamic patterns of all endogenous variables depicted in figures 6.6(a), 6.6(b),
and 6.6(c) are almost identical with those of the bust phase simulation. The pre-currency
crisis period is characterized by a fixed exchange rate $\ln \bar{s} = 20$ from time $t = 0$ until
the moment of speculative attack at time $t = 9.16$ (solid line in uppermost right panel
in figure 6.6(a) for $0 < t \leq 9.16$), whereas the post-currency crisis phase is subject to a
flexible exchange rate having an initial value of $\ln s = 20$ at time $t = 9.16$, and following
the flexible exchange rate path for $t > 9.16$ (dotted line in uppermost right panel in
figure 6.6(a) for $t > 9.16$). The time paths of the remaining variables are characterized
by solid lines for the pre-currency crisis phase and by dotted lines for the post-currency
crisis phase. At the moment of speculative attack at time $t = 9.16$, all variables, except
for the log of the exchange rate $\ln s$ and the log of the price level $\ln P$, are subject to a
jump which is caused originally by a discontinuous decline in the log of foreign exchange
reserves from $\ln Z > 0$ for $t < 9.16$ to $\ln Z = 0$ at the moment of speculative attack at
time $t = 9.16$, leading to a downward jump of the log of high powered money $\ln M$, and
resulting in jumps of all other endogenous variables.\footnote{Though the discontinuous reduction in the log of high powered money $\ln M$ (figure 6.6(c)) is additionally caused by a downward jump in the log of the domestic credit component $\ln H$ (figure 6.6(c)), having its origin in an upward jump in the domestic prime rate $i_C$ (figure 6.6(b)) by equation 6.5, all jumps, though mainly influenced by the downward jump of the log of high powered money $\ln M$, are originally caused by the discontinuous decline in the log of foreign exchange reserves $\ln Z$.} The qualitative description of the
panels in figures 6.6(a), 6.6(b), and 6.6(c) starts with the pre-currency crisis phase and
continues with the effects of the speculative attack and the post-currency crisis period.

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The Pre-Currency Crisis Phase. The increase in the foreign prime rate $i^*_0$ according to equation 6.23, makes monetary authorities increase the domestic prime rate $i_C$ (figure 6.6(b)) by equation 6.14, in order to prevent capital outflows and to support the fixed exchange rate. The steady rise in the foreign prime rate $i^*_0$ causes also a steady increase in the domestic nominal short-term interest rate on government bonds $i$ (figure 6.6(b)) in order to guarantee the risk adjusted interest rate parity given by equation 6.10. There arise no capital outflows from international short-term bond transactions since the nominal short-term bond rate $i$, being always $\alpha$ percent higher than the foreign prime rate $i^*_0$, adjusts instantaneously, leaving the capital flow determining interest rate differential $i - \alpha - i^*_0 = 0$ unchanged.

The rise in the domestic prime rate $i_C$ reduces the log of the domestic credit component $\ln H$ (figure 6.6(b)) as to equation 6.5, causing partially a reduction in the log of high powered money $\ln M$ (figure 6.6(c)) which is also reduced by a fall in the log of foreign exchange reserves $\ln Z$ being explained below. The drop in the log of high powered money $\ln M$ causes a reduction of deposit supply requiring either a fall in the log of output $\ln Y$, or a rise in the nominal short-term bond rate $i$, or a rise in the nominal long-term bond rate $f$, or some other combinations which reduce deposit demand. In the present case, deposit market equilibrium as to equation 6.4, is restored by a reduction in the log of output $\ln Y$ (figure 6.6(c)), by an increase in the nominal short-term interest rate on bonds $i$ induced by the rise in the foreign prime rate $i^*_0$ (figure 6.6(b)), and by a decrease in the nominal long-term bond rate $f$ (figure 6.6(b)) running counter partly to deposit market equilibrium by increasing deposit demand and boosting output by increasing government expenditures as to equation 6.2. The rise in the short-term bond rate $i$ leads to fall in the log of the demand price of capital $\ln P_K$ (figure 6.6(a)) according to equation 6.9, and to a decline in the log of Tobin’s $q$, $\ln q$ (figure 6.6(a)) as to equation 6.9 at a constant log of the price level $\ln P$ (figure 6.6(a)) and zero inflation $p$ (figure 6.6(a)), implying a correspondence of all nominal and real interest rates. The fall in the log of Tobin’s $q$, $\ln q$, reduces investment demand and the log of output $\ln Y$ (figure 6.6(a)) by equation 6.2, though there is an expansionary effect on output by the fall in the nominal long-term bond rate $f$ increasing government expenditure. However, in the present case, the decline in investment demand due to a reduction in Tobin’s $q$ dominates, resulting in an overall reduction in the log of output $\ln Y$.

The reduction in the log of output $\ln Y$ causes a decline in sales revenues, leading to a reduction in firms’ profit rate $r$ (figure 6.6(a)) and to a deterioration of firms’ liquidity status by equation 6.3. Arising difficulties in fulfilling payment commitments causes a rising number of nonperforming loans, reducing banks’ profits and the log of banks’ net worth $\ln NW_{BA}$ by equation 6.7, and marking the beginning of an unavoidable banking crisis. Declining collateral values with banks increase on the one hand interest rate costs on foreign loans by an increasing risk premium $\tau p$ (figure 6.6(a)) as to equation 6.8, and induce on the other hand a rising growth of capital outflows $\ln LF^*$ (figure 6.6(a)) by equation 6.6. Though domestic monetary authorities follow foreign monetary policy by maintaining the risk adjusted interest rate parity condition 6.14, they cannot avoid a rising growth of capital outflows due to the dominance of banks’ collateral effect according to equations 6.6 and 6.14. Rising loan outflows and an increasing capital account deficit lead to a declining log of foreign exchange reserves $\ln Z$ (figure 6.6(a)) by equation 6.13, despite an increasing current account surplus $\ln T$ (figure 6.6(c)) induced by the fall in...
the log of output $\ln Y$ by equation 6.12, which however, cannot offset the widening capital account deficit.

A declining amount of the log of high powered money $\ln M$ and a declining log of the demand price of capital $\ln P_K$, indicating rising solvency problems among firms, make banks increase the domestic nominal loan rate $j$ (figure 6.6(c)) by equation 6.11, which leads to a further reduction in firms' profit rate $\tau$ and to a deterioration of firms' liquidity position. The decline in the profit rate $\tau$ causes a further reduction in the log of Tobin's $q$, $\ln q$, in the log of output $\ln Y$, and again in the profit rate $\tau$. Rising bankruptcies among firms aggravate banks' solvency status and lead to further capital outflows and to further declining foreign exchange reserves.

Summing up, a rising foreign prime rate causes a cumulative contractionary macroeconomic process leading eventually to the occurrence of a twin crisis. Though state of confidence effects have been ruled out, a declining negative difference between the profit and the real lending rate $\tau - (j - p)$ (figure 6.6(c)) indicates that, in case profit expectations followed the fundamental $\tau - (j - p)$, the cumulative downward process would be deteriorated by collapsing profit expectations.

**Speculative Attack and Post-Currency Crisis Phase.** Foreign exchange market participants attack the domestic currency when the rising flexible shadow exchange rate, which is induced by the capital account deficit being larger in absolute terms than the current account surplus by equation 6.13, equals the fixed exchange rate value at time $t = 9.16$, and is expected to appreciate further. The discontinuous reduction in the log of foreign exchange reserves $\ln Z$ (figure 6.6(a)) at time $t = 9.16$ causes a downward jump in the log of high powered money $\ln M$ (figure 6.6(c)) and, as a result, in deposit supply. Deposit market equilibrium is restored partially by an upward jump in the nominal short-term bond rate $i$ (figure 6.6(c)) to the amount of the constant expected depreciation rate of the domestic currency $E_t[\ln s] = \ln s$, in order to offset excess supply of short-term bonds. The constant depreciation rate of the domestic currency causes a smooth increase in the log of the domestic price level $\ln P$ (figure 6.6(c)) by equation 6.1, and an upward jump in the inflation rate $p$ (figure 6.6(c)) from zero to a constant positive value. Thus, all jumps in nominal interest rates are larger than jumps in real interest rates. The upward jump in the nominal short-term domestic bond rate causes a downward jump in the log of the demand price of capital $\ln P_K$ (figure 6.6(a)) as to equation 6.9, and in the log of Tobin's $q$, $\ln q$ (figure 6.6(a)). The decline in Tobin's $q$ leads to a sudden drop in investment demand, reducing the log of output $\ln Y$ (figure 6.6(c)), though the downward jump in the nominal long-term bond rate $f$ (figure 6.6(b)) leads to a partly compensating discontinuous increase in government expenditures by equation 6.2. However, as already described in the pre-currency crisis phase, the decline in investment demand is larger in absolute terms than the increase in government expenditure, causing a drop in the log of output $\ln Y$. Summing up, though the downward jump in the nominal long-term bond rate $f$ runs counter to a reduction in deposit demand, deposit market equilibrium is restored by a rising nominal short-term bond rate $i$ and by a decline in the log of output $\ln Y$ according to equation 6.4.

The sudden drop in sales revenues causes a further drop in the profit rate $\tau$, aggravating firms' liquidity and solvency problems, and increasing the amount of nonperforming loans which reduces banks' profits and the log of banks' net worth $\ln NW_{BA}$ (figure 6.6(c)) by
This deterioration of banks' collateral induces on the one hand an upward jump in lending costs on foreign loans by a sudden increase in the risk premium \( r_p \) (figure 6.6(c)) as to equation 6.8, and causes on the other hand a discontinuous increase in the growth of loan outflows \( \ln L^* \) (figure 6.6(c)) by equation 6.6. Though monetary authorities try to stabilize capital outflows by a discontinuous increase in the domestic prime rate \( i_C \), leading also to a downward jump in the log of the domestic credit component \( \ln H \) (figure 6.6(c)) as to equation 6.5, rising capital outflows cannot be avoided due to the dominance of banks' net worth effect according to equations 6.6 and 6.14. A largely rising capital account deficit causes a further appreciation of the log of the flexible exchange rate \( \ln s \) (figure 6.6(a)) according to equation 6.13, in spite of a discontinuous increase in the current account surplus \( \ln T \) (figure 6.6(c)) as to equation 6.12 induced by a downward jump in the log of output \( \ln Y \), which however, cannot offset rising capital outflows.

The downward jump in the log of high powered money \( \ln M \), as well as the downward jump in the log of the demand price of capital \( \ln P_K \), makes banks increase discontinuously the nominal loan rate \( j \) (figure 6.6(c)) by equation 6.11. This increase in lending costs results in a further decline in firms' profit rate \( r \), aggravating liquidity and solvency problems, leading to more nonperforming loans and to an amplification of the domestic banking crisis. This sudden deterioration of banks' solvency status leads to further capital outflows, further tightening of international and financial market conditions, and to a deterioration of the cumulative contractionary process.

All real interest rates in the model, i.e. the real loan rate \( j - p \), the real domestic prime rate \( i_C - p \), the real short-term bond rate \( i - p \), as well as the real long-term bond rate \( f - p \) (all depicted in figure 6.6(b)), are also subject to discontinuous jumps, which are however much smaller than the jumps in nominal rates due to a relatively large increase in domestic inflation \( p \). If state of confidence effects were considered in the model, and profit expectations followed the difference between the profit and the real lending rate \( r - (j - p) \), the macroeconomic contraction induced by the speculative attack would be aggravated additionally by a drop in profit expectations as indicated by the downward jump in \( r - (j - p) \) (figure 6.6(a)). Summing up, a currency crisis generally magnifies the cumulative contractionary macroeconomic process induced by an exogenous rise in the foreign prime rate \( i_C \).

The post-currency crisis period is subject to a further macroeconomic contraction due to a further rise in the foreign prime rate \( i_C \) and in the log of the exchange rate \( \ln s \). All endogenous variables, except for the log of the exchange rate \( \ln s \), the log of the price level \( \ln P \), and the log of foreign exchange reserves \( \ln Z \), are subject to the same time patterns as during the pre-currency crisis phase and can be explained by the proceedings during the pre-currency crisis phase, and by the effects of the speculative attack having been outlined above.

**Sensitivity Analysis.** The simulation results are stable within ±10% variation range for all key parameters \( h_1 \), \( r_{p1} \), \( nw_1 \), \( l_{f1} \), \( j_2 \), \( k_2 \), \( r_1 \), \( r_2 \), \( y_2 \), and \( y_3 \). Except for a +20% variation of parameters \( nw_1 \), \( l_{f1} \), \( l_2 \), \( k_2 \), \( r_2 \), \( y_2 \), and \( y_3 \), the solution is even stable within a ±20% range. A +20% increase of parameters \( nw_1 \), \( l_{f1} \), \( l_2 \), \( k_2 \), \( r_2 \), \( y_2 \), and \( y_3 \) leads at first to a twin crisis, i.e. the parameter results are stable for the pre-currency crisis period, but then to a macroeconomic expansion in the post-currency crisis phase. This recovery effect can be explained, like in the bust phase sensitivity analysis, by an improvement in...
the balance of payments leading to a depreciating log of the exchange rate $\ln s$ and to a declining log of the price level $\ln P$ by equation 6.1. The steady fall in the log of the price level $\ln P$ leads to a rise in Tobin’s $q$ which stimulates investment demand, output, firms’ and banks’ profits, capital inflows, and leads to a general relaxation of financial market conditions.
(a) Evolution of Endogenous Variables During the Boom Phase:

\[ \ln Z: \text{Log of Foreign Exchange Reserves}, \quad \ln s: \text{Log of Nominal Exchange Rate}, \quad \ln P_K: \text{Log of Demand Price of Capital}, \quad \ln P: \text{Log of Price Level}, \quad \ln q = \ln P_K - \ln P: \text{Log of Tobin's } q, \quad p = \dot{P}/P: \text{Price Level's Growth Rate}, \quad r: \text{Profit Rate}, \quad r - j + p: \text{Difference Between Profit and Real Lending Rate.} \]

**Figure 6.3:** Simulation of the Boom Phase
(b) Evolution of Endogenous Variables During the Boom Phase:

\( j \): Nominal Lending Rate, \( j - p \): Real Lending Rate, \( i_C \): Domestic Prime Rate, 
\( i_C - p \): Domestic Real Prime Rate, \( i \): Domestic Short-Term Interest Rate, \( i - p \): Domestic Short-Term Real Interest Rate, 
\( f \): Domestic Long-Term Interest Rate, \( f - p \): Domestic Long-Term Real Interest Rate.

**Figure 6.3:** Simulation of the Boom Phase (continued)
(c) Evolution of Endogenous Variables During the Boom Phase:

\[ \ln LF^* = \ln \dot{L}^* \]: Log of Flows of Foreign Loans to Domestic Banks, \( \tau_p \): risk premium, \( \ln NW_{BA} \): Log of Banks' Net Worth, \( \ln H \): Log of Domestic Credit Component, \( \ln M = \gamma \ln H(t) + (1 - \gamma) \ln Z(t) \): Log of High Powered Money, \( \ln T \): Log of Current Account (Trade Balance), \( \ln Y \): Log of Domestic Output.

**Figure 6.3**: Simulation of the Boom Phase (continued)
(a) Evolution of Endogenous Variables During the Overborrowing Phase and at the Upper Turning Point:

\[ \ln Z: \text{Log of Foreign Exchange Reserves, } \ln s: \text{Log of Nominal Exchange Rate, } \ln P_K: \text{Log of Demand Price of Capital, } \ln P: \text{Log of Price Level, } \ln q = \ln P_K - \ln P: \text{Log of Tobin's } q, \quad p = \frac{P}{P}: \text{Price Level's Growth Rate, } r: \text{Profit Rate, } r - j + p: \text{Difference Between Profit and Real Lending Rate.} \]

**Figure 6.4:** Simulation of the Overborrowing Phase and the Upper Turning Point
(b) Evolution of Endogenous Variables During the Overborrowing Phase and at the Upper Turning Point:

\( j \): Nominal Lending Rate, \( j - p \): Real Lending Rate, \( i_c \): Domestic Prime Rate, \( i_c - p \): Domestic Real Prime Rate, \( i \): Domestic Short-Term Interest Rate, \( i - p \): Domestic Short-Term Real Interest Rate, \( f \): Domestic Long-Term Interest Rate, \( f - p \): Domestic Long-Term Real Interest Rate.

**Figure 6.4:** Simulation of the Overborrowing Phase and the Upper Turning Point (continued)
(c) Evolution of Endogenous Variables During the Overborrowing Phase and at the Upper Turning Point:

\[ \ln LF^* = \ln \hat{L}^* \]: Log of Flows of Foreign Loans to Domestic Banks, \( rp \): risk premium, \( \ln NW_{BA} \): Log of Banks' Net Worth, \( \ln H \): Log of Domestic Credit Component, 
\[ \ln M = \gamma \ln H(t) + (1 - \gamma) \ln Z(t) \]: Log of High Powered Money, \( \ln T \): Log of Current Account (Trade Balance), \( \ln Y \): Log of Domestic Output.

**Figure 6.4:** Simulation of the Overborrowing Phase and the Upper Turning Point (continued)
(a) Evolution of Endogenous Variables During the Bust Phase:

\( \ln Z \): Log of Foreign Exchange Reserves, \( \ln s \): Log of Nominal Exchange Rate, \( \ln P_K \): Log of Demand Price of Capital, \( \ln P \): Log of Price Level, \( \ln q = \ln P_K - \ln P \): Log of Tobin's \( q \), \( p = P/P \): Price Level's Growth Rate, \( r \): Profit Rate, \( r - j + p \): Difference Between Profit and Real Lending Rate.

**Figure 6.5**: Simulation of the Bust Phase
(b) Evolution of Endogenous Variables During the Bust Phase:

$j$: Nominal Lending Rate, $j - p$: Real Lending Rate, $i_C$: Domestic Prime Rate, $i_C - p$: Domestic Real Prime Rate, $i$: Domestic Short-Term Interest Rate, $i - p$: Domestic Short-Term Real Interest Rate, $f$: Domestic Long-Term Interest Rate, $f - p$: Domestic Long-Term Real Interest Rate.

**Figure 6.5:** Simulation of the Bust Phase (continued)
(c) Evolution of Endogenous Variables During the Bust Phase:

\[ \ln LF^* = \ln \dot{\hat{L}}^* \]: Log of Flows of Foreign Loans to Domestic Banks, \( \tau_p \): risk premium, \( \ln \text{NWBA} \): Log of Banks' Net Worth, \( \ln H \): Log of Domestic Credit Component, \( \ln M = \gamma \ln H(t) + (1 - \gamma) \ln Z(t) \): Log of High Powered Money, \( \ln T \): Log of Current Account (Trade Balance), \( \ln Y \): Log of Domestic Output.

Figure 6.5: Simulation of the Bust Phase (continued)
(a) Evolution of Endogenous Variables During Foreign Interest Rate Increase:

\[ \ln Z: \text{Log of Foreign Exchange Reserves}, \ln s: \text{Log of Nominal Exchange Rate}, \ln P_K: \text{Log of Demand Price of Capital}, \ln P: \text{Log of Price Level}, \ln q = \ln P_K - \ln P: \text{Log of Tobin's} \]
\[ q, p = \frac{P}{\hat{P}}: \text{Price Level's Growth Rate}, r: \text{Profit Rate}, r - j + p: \text{Difference Between Profit and Real Lending Rate}. \]

**Figure 6.6:** Simulation of a Foreign Interest Rate Increase
j: Nominal Lending Rate, j – p: Real Lending Rate, ic: Domestic Prime Rate, ic – p: Domestic Real Prime Rate, i: Domestic Short-Term Interest Rate, i – p: Domestic Short-Term Real Interest Rate, f: Domestic Long-Term Interest Rate, f – p: Domestic Long-Term Real Interest Rate.

Figure 6.6: Simulation of a Foreign Interest Rate Increase (continued)
(c) Evolution of Endogenous Variables During Foreign Interest Rate Increase:

\[ \ln LF^* = \ln \tilde{L}^* \]: Log of Flows of Foreign Loans to Domestic Banks, \( rp \): risk premium, \( \ln NWBA \): Log of Banks' Net Worth, \( \ln H \): Log of Domestic Credit Component, \( \ln M = \gamma \ln H(t) + (1 - \gamma) \ln Z(t) \): Log of High Powered Money, \( \ln T \): Log of Current Account (Trade Balance), \( \ln Y \): Log of Domestic Output.

**Figure 6.6:** Simulation of a Foreign Interest Rate Increase (continued)
Chapter 7

Conclusion

The present approach to financial crises offers both new perspectives for economic theory and alternative recommendations for economic policy which are discussed briefly in the following sections 7.1 and 7.2.

7.1 New Perspectives for Economic Theory

The comparison of the model results in chapters 4, 5, and 6 with the stylized facts of financial crises, having been set out in chapter 3, demonstrates clearly that the present approach to financial crises corresponds much better to the stylized facts than standard models having been reviewed in sections 4.5 and 5.5. This better performance is due to the introduction of innovative methods and concepts which have not been considered yet by most standard models. The following discussion highlights the most important innovations of the present approach in comparison with standard approaches, and ends with some proposals for further lines of research.

Regarding the major innovations of the present approach to financial crises, there are six issues to be highlighted. Firstly, the present approach does not follow the general polarization into models of exogenous financial crises on the one hand, and models of endogenous financial crises on the other hand, but provides a synthesis by demonstrating that financial fragility is an endogenous phenomenon which can be observed during each business cycle, but which can only induce a systemic financial crises if there is an exogenous positive shock to expectations. Thus, the present approach points out, in contrast to exogenous shock-driven models, that financial strains are not extraordinary exogenous events, and, in contrast to endogenous financial crisis models, that capitalist market economies are cyclically stable in spite of an endogenous build-up of financial fragility during the boom phase of business cycles.

Secondly, the present approach may possibly help both to prevent, and to predict financial crises much better than in the past, as it links general economic theory, i.e. economic analysis during tranquil times, with the theory of financial crises in a new way, by arguing that a certain degree of financial fragility is a part of “normal” economic life, and that financial crises have to be considered as a variant, or extreme form of general economic theory. By way of contrast, mainstream exogenous shock-driven models view the theory of financial crises as an isolated extra part, because financial crises are considered as pathologies which do not fit general economic theory. As a result, mainstream theory is
built on two different theories, one for tranquil times and one for financial crises' periods, which are not compatible. Endogenous financial crisis models represent the other extreme by arguing that there is no distinction between tranquil periods and financial crises since capitalist systems are inherently financially unstable, implying that there is no theory for tranquil periods.

Thirdly, the present approach employs a promising kind of expectation formation scheme which overcomes the existing polarization into rational expectations on the one hand, and chartist-fundamentalist expectations on the other hand, by arguing that expectations are rational in the long-run, and that short-run expectations are driven both by an assessment of economic fundamentals and by general market sentiment. This synthetic approach to the formation of expectations provides a good theoretical explanation of fluctuations in profit expectations and asset prices over the business cycle, and stresses the empirical fact that macroeconomic activity is driven to a large extent by self-fulfilling expectations giving rise to cumulative upward and downward processes. Furthermore, this synthetic approach emphasizes that economic models should not be based completely on the rational expectations hypothesis, and that long-run rational expectations equilibria are only theoretical reference points which cannot be attained in the long-run, as expectations persistently fluctuate around these equilibria.

Fourthly, the present approach is based on a sophisticated financial structure with many assets and argues, in contrast to exogenous shock-driven and neoclassical mainstream models, that the financial structure is a crucial determinant of real economic activity and financial stability, as it determines aggregate liquidity, solvency, profits, and thereby whether financial constraints become binding or not, even in the long-run. Consequently, the general conclusion of neoclassical standard analysis that both money, and the financial structure are irrelevant in the long-run, has to be rejected. Furthermore, the present approach stresses the influence of financial intermediaries on aggregate economic activity and financial stability, not only in periods of financial distress, but also during tranquil periods, being neglected by standard neoclassical and Keynesian economic theory.

Fifthly, the present approach points out that both tranquil business cycles and financial crisis cycles are driven by an endogenous interaction of profit expectations and the financial structure of an economy. Moreover, the present approach highlights the fact that notwithstanding the existence of a stationary steady state, capitalist economies are only cyclically stable in the long-run, and do not converge to a stationary steady state. Consequently, long-run economic analysis should be based more on non-linear dynamic mathematical models than on linear ones.

Sixthly, the model structure of the present approach is much more complex than the model structures of standard approaches to financial crises, especially with respect to the number of parameters and endogenous variables, and with respect to the number of transmission mechanisms between the real and the financial sphere of an economy. Furthermore, the present approach contains major financial and real indicators as variables and parameters which are used in empirical business cycle analysis and in empirical financial crises' analysis. Consequently, in order to derive meaningful and useful results from theoretical models which can be applied to real-world phenomena, model structures have to be much more complex than models structures of standard approaches, as the
explanation and the prediction of financial crises is a multidimensional phenomenon which influences almost all real sector and financial sector variables of an economy.

Though the present approach to financial crises represents an innovation in financial crisis modelling, it is subject to four major drawbacks which should be starting points for further research. Firstly, though the nonlinear dynamic general function models in chapters 4 and 5 are able to explain the emergence of endogenous business cycles and financial crises, they cannot provide exact information on the time paths of all endogenous variables, as well as on the transitional dynamics. One possible solution, as outlined in section 6.1, is to calibrate or to simulate general function models. However, simulations of complex models are often impossible due to the lack of relevant empirical data, and calibration techniques of nonlinear general function models have to be approximated by linear and exogenous shock-driven models in order to remain formally tractable. Accordingly, future research on business cycles and financial crises should concentrate on the development of quantitative methods to simulate, or to calibrate complex nonlinear dynamic systems.

Secondly, though the synthesis of the rational expectations hypothesis and market sentiment-driven expectations provides a good approximation to the formation of real-world expectations, it provides no formal conditions for the turning points of expectations. Such formal conditions could be empirically estimated and used to predict business cycle turning points, changes in asset price behaviour, and financial crises. Consequently, future research should focus more on formal methods to quantify the real-world formation of expectations.

Thirdly, notwithstanding the fact that the present approach emphasizes the endogenous character of indebtedness, as well as its influence on financial stability, there is no distinction between fluctuations in short-term and long-term indebtedness. In order to be consistent with the stylized facts, future models should be able to show the overproportional rise in short-term indebtedness during the upswing by the introduction of a term structure of interest rates.

Fourthly, the present approach neglects the phenomenon of contagion which could be investigated by multi-country models with interdependent expectation dynamics. Furthermore, future research should be able to distinguish between contagion induced by real factors, and by financial factors.

7.2 Policy Recommendations

This section elaborates policy recommendations which are based on the model results of chapters 4, 5, and 6. The following discussion is subdivided in three paragraphs, analyzing policy measures to prevent, to predict, and to manage financial crises.

Crisis Prevention. The present approach argues that financial crises are caused by exogenous positive shocks to expectations inducing an unsustainable build-up of financial fragility by excess volatility in asset prices, overborrowing and overinvestment. As a result, policy measures to prevent financial crises have to limit the increase in domestic and foreign indebtedness during the boom phase, as well as the overshooting process in profit expectations. As indebtedness and profit expectations are mutually dependent, policy measures which are designed to limit the increase in debt finance, e.g. by the imposition
of additional external financial constraints, also limit the rise in profit expectations, as a lower degree of both domestic and foreign indebtedness implies lower investment, lower actual profits, lower net worth positions, lower asset prices, and thereby a less pronounced chartist-type behaviour of agents. In the same way, policy measures which are designed to limit the increase in profit expectations also limit the increase in indebtedness, as lower profit expectations imply lower asset prices, lower collateral values, and thereby a lower degree of indebtedness.

Respecting policy measures to limit the increase in domestic and foreign indebtedness during the boom phase, the present approach offers four recommendations. Firstly, the valuation of assets serving as collateral has to be based on international standardized valuation methods which determine the value of an asset by its underlying fundamentals and risks, and not by its current market price. This fundamental collateral value has to be equal to the maximum of level of indebtedness which however, has to be additionally positively dependent both on lenders’ and borrowers’ net worth. That is, if both the lender and borrower do not fulfill certain minimum net worth standards, the actual amount of debt finance has to be lower than the fundamental collateral value. To put it differently, higher indebtedness requires both a higher fundamental collateral value, and a higher net worth of the borrower and the lender. However, in order to be effective, these standardized asset valuation methods and minimum net worth standards have to refer not only to on-balance sheet items, but also to off-balance sheet assets and debts as the rapid growth of derivative markets in the past decades indicates an increase in the weight of off-balance assets and debts in balance sheets of the corporate and the financial sector.¹ Further prerequisites for the efficient functioning of standardized asset valuation methods and minimum net worth standards are the introduction of international accounting standards, rigorous disclosure requirements, effective international supervision and regulation of firms and financial institutions, and effective means of enforcement which could be achieved e.g. by the introduction of an international bankruptcy court. A first step to prevent an overvaluation of collateral values, excessive risk taking and overlending is the introduction of international minimum capital adequacy standards for the financial sector by the new Basel Capital Accord (Basel II), forcing financial institutions to evaluate risks in their portfolios, and limiting the amount of lending by the degree of collateral risk, as higher risk taking requires an increase in net worth. However, one main disadvantage of the Basel II accord, contradicting the recommendation made above, is the fact that financial institutions are allowed to evaluate their risk exposures by internal ratings, i.e. there are no general international rules for risk assessment being valid for all financial institutions. Consequently, the degree of financial stability is largely dependent on subjective risk perceptions of financial institutions.

Secondly, notwithstanding the fact that international financial market regulation in the form of asset valuation methods and minimum capital adequacy standards is an indispensable precondition for crisis prevention, it cannot replace domestic financial market regulation and supervision, since in a world of integrated financial markets, international

¹The breakdown of LTCM in 1998, having almost led to a breakdown of the entire U.S. banking system which could be only prevented by effective lender of last resort interventions by the Federal Reserve, has demonstrated that unregulated trading in off-balance sheet assets and debts of a single financial institution can lead to an unsustainable build-up of financial instability, being able to induce a collapse of an entire domestic financial system which possibly spreads out to the international financial system. For the emergence of systemic risk due to off-balance sheet transactions, see also appendix C.
financial stability can be only achieved by domestic financial stability. Accordingly, excessive overborrowing and financial crises can be only prevented if there is an effective domestic supervision and regulation of domestic financial institutions, being based on international standards, and accounting for special features of domestic financial markets.

Thirdly, domestic and international financial market supervision and regulation have to be also a necessary ingredient of financial liberalization policies. Fast financial sector and capital account liberalization without standardized asset valuation methods, minimum net worth standards, safety nets, proper accounting standards, government supervision, etc., lead inevitably to excessive overborrowing and financial crises. By way of contrast, gradual and supervised liberalization processes are a robust basis for financial sector and economic development, and generate much higher welfare in the long-run than fast and unregulated financial liberalization policies. Furthermore, to limit large fluctuations in capital flows being associated with financial liberalization policies especially in emerging market countries, short-term portfolio flows should be limited in the early liberalization period, e.g. by the introduction of a Tobin tax, or even by temporary capital controls, whereas long-term foreign direct investments should be encouraged.

Fourthly, moral hazard has to be limited by transferring the risk associated with an investment project entirely back to the investor. In order to limit overborrowing in foreign currency, implicit or explicit government guarantees to support fixed exchange rate regimes have to be abandoned. Lacking guarantees and a higher degree of exchange rate flexibility make investors hedge against foreign exchange risk and reduce risky investment projects. Furthermore, the International Monetary Fund has to abandon its policy of bailing out private international investors by the provision of rescue packages in case of a crisis. However, a bailing-in policy of the private sector requires also that the International Monetary Fund refrains from promoting widespread and quick financial sector and capital account liberalization combined with stabilization policies which induce moral hazard. In order to prevent overborrowing and excessive risk taking by domestic financial systems, government guarantees for financial institutions regarded as too big to fail have to be abandoned. However, in order to be successful, this policy measure requires a restructuring of domestic financial markets transforming narrow oligopolies into competitive market structures. As long as this transformation is not completed, too-big-to-fail policies should not be abandoned since a failure of only one of the most important financial institutions can trigger a systemic financial crisis.²

Regarding policy measures to limit the overshooting of profit expectations during the boom phase, the present approach recommends a monetary policy approach which does not only stabilize inflation and output, but also profit expectations via a stabilization of the level of asset prices when they are too volatile, i.e. when there is excess volatility caused by unrealistic profit or unrealistic inflation expectations as outlined in sections

² Though government guarantees in the form of too-big-to-fail policies, as well as in the form of bail out policies by the International Monetary Fund have not been considered explicitly by general function models in chapters 4 and 5, their inclusion in the dynamic version of the models would induce both an additional rise in the state of confidence parameter \( \rho \) in the boom phase due to the government’s promise to bear losses in case of default (inducing also an additional rise in the debt-asset ratios \( \lambda \) and \( \lambda^* \)), and an additional decline in the bust phase when government guarantees are going to be suspended (inducing also an additional decline in the debt-asset ratios \( \lambda \) and \( \lambda^* \)). In graphical terms, the introduction of government guarantees would give rise to financial crises’ cycles with much larger amplitudes than those in figures 4.7, 5.7 and 5.8.
2.3.4 and 2.3.5. However, stabilizing asset prices when they are too volatile does not imply that monetary authorities should target specific levels of asset prices as there are also fundamentally justified movements in asset prices, which can be caused e.g. by general productivity shocks. Rather, central banks should prevent large misalignments in asset prices giving rise to an enormous increase in financial instability. It has to be emphasized that central banks should not only prevent asset prices from overshooting during boom phases, but also from undershooting during bust phases, being discussed in more detail below.

**Crisis Prediction.** The high incidence of financial crises in the post Bretton Woods era has led to the development of empirical early-warning systems of currency, banking, and twin crises by central banks, domestic and international regulation authorities, and research departments of private and official institutions to predict future crises, or even to prevent them by emergency measures. However, past experience with these early-warning systems has shown that in most cases they are only useful to register financial crises, but not to predict future financial crises.

This poor record can be explained partly by the fact that the choice of leading indicators of early-warning systems is generally based on empirical studies of the stylized behaviour of macroeconomic variables during periods of financial distress which do not consider balance sheet indicators. The present approach however, has demonstrated that especially balance sheet variables are very good leading indicators of financial distress, as profit expectations, asset prices and real economic activity generally tend to follow the actual behaviour of liquidity, and profit variables. As a result, the performance of early-warning systems could be improved considerably by the inclusion of balance sheet data of a large number of firms and financial institutions.

Another reason for the limited predictive power of early-warning systems may be the fact that they do not consider explicitly misalignments of asset prices, reflecting the misalignment of profit expectations. The present approach has pointed out that especially stock prices are a very good indicator for the state of profit expectations, which are also a leading indicator, as financial market and real sector variables tend to follow changes in expectations. Consequently, the predictive power of early-warning systems could be improved considerably by developing quantitative methods determining the degree of misalignment of asset prices, being a leading indicator of overborrowing and overinvestment.

**Crisis Management.** It should be a ground rule for crisis management that in case of a financial crisis, domestic and international authorities should avoid costs for those which did not cause the crisis, and to call those into account having contributed to the build-up of financial fragility by overborrowing and overlending. Consequently, crisis managers should generally minimize economic costs in the form of output losses, bankruptcies and unemployment, high inflation or deflation, and high interest rates, as these costs predominantly hit the entire population of a crisis country, while only a small fraction of the

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3 Examples of early-warning systems can be found in International Monetary Fund (1998a), chapter IV, Kaminsky and Reinhart (1998, 1999), and Glick and Hutchinson (1999).

4 Following the terminology of section 3.4, these kinds of studies have been labelled as studies of the first class.
population and, especially in emerging market crises, foreign investors caused the crisis. This ground rule implies firstly, that domestic monetary and fiscal policies should prevent a crisis economy from slipping into a deep depression, and secondly, that international authorities, and especially the International Monetary Fund, should refrain from bailing out private investors generally, as well as from standing aside and letting nature run its course in case a country has been hit by a crisis.

Regarding the management of financial crises by domestic monetary policy, the present approach offers four recommendations which are consistent with the ground rule discussed above. Firstly, central banks should generally act as an efficient lender of last resort by short-run liquidity supports to still solvent financial institutions in order to prevent a breakdown of the domestic financial system. Secondly, monetary policy should guarantee the efficient functioning of domestic deposit insurance systems to prevent widespread banking panics. Thirdly, monetary policy should be expansionary to stabilize profits, liquidity, net worth positions, and thereby profit expectations, asset prices, output and the price level. By way of contrast, if monetary policy does not react quickly on collapses in asset prices by lowering interest rates, or even becomes contractionary, it reinforces the economic downturn, as there is no stabilization of the drop in liquidity positions, profits, net worth positions, asset prices, output and inflation, which validates investors pessimistic profit expectations and induces a further deterioration of the cumulative downward process. Fourthly, following the recommendation of expansionary monetary policy in case of a financial crisis, monetary policy under fixed exchange rates should not follow the generally adopted rule to increase interest rates sharply in case of a crisis in order to stabilize foreign and domestic investors' confidence, and thereby the fixed exchange rate by limiting capital outflows. Historical experience has demonstrated that contractionary monetary policy under fixed exchange rates in case of a crisis does not restore confidence, but undermines confidence as predicted by the present approach, as higher interest rates lead to further collapses in asset prices, liquidity positions, profits, net worth positions, leading to further capital outflows and deteriorating the economic downturn. Consequently, to prevent a collapse of fixed exchange rate regimes and a subsequent debt explosion due to a high stock of foreign debt, monetary authorities should make use of temporary capital controls, or a high short-run taxation of short-term portfolio outflows to stabilize domestic profits, asset prices, output and the exchange rate, which stabilizes foreign investors' confidence and reduces capital outflows.

Respecting the management of financial crises by domestic fiscal policy, the present approach provides two recommendations. Firstly, the main aim of fiscal policy in case of a crisis should be to stabilize profits, liquidity positions, net worth positions, asset prices and output by a large fiscal expansion, increasing aggregate demand, output and profits. However, a stabilization of profits by budget deficit financing can be only successful in case the size of the government sector is big enough to ensure that a drop in private investment can be completely offset by an increase in government expenditures, implying that policies which reduce the role of the state to minimum should be abandoned. Consequently, the generally adopted fiscal policy rule to cut government expenditures in case of a financial crisis to restore investors' confidence is as counterproductive as contractionary monetary policy, since it deteriorates the cumulative contraction following the collapse of asset prices. Secondly, budget deficits to stabilize profits should be offset by budget surpluses in expansionary phases which also serve to prevent crises as they constrain ag-
aggregate demand. Otherwise, rising deficits in case of a crisis may possibly undermine investors' confidence and deteriorate the economic downturn. Consequently, an efficient crisis management by fiscal policy requires a sound fiscal management during tranquil times aiming at a long-run balanced fiscal budget.

Respecting the management of financial crises by domestic and international financial market regulation authorities, the present approach recommends three policy measures. Firstly, in case of a crisis, insolvent financial institutions should be closed immediately to avoid widespread bank runs due to asymmetric information. However, this policy measure requires that insolvent financial institutions can be clearly distinguished from still solvent institutions which is only possible with international accounting standards and rigorous disclosure requirements. Secondly, regulation bodies should refrain from a strict enforcement of capital adequacy standards in case financial institutions do not fulfill minimum capital standards but are still solvent, in order to prevent further disintermediation effects which deteriorate the economic downturn. Thirdly, to dampen the adverse effects of currency crises in case of large foreign debt stocks, the International Monetary Fund should not offer general rescue packages to bail out private investors, but should use its funds as an international lender of last resort in cooperation with central banks to avoid bankruptcies of still solvent financial institutions by short-run liquidity supports in foreign currency.