## List of Charts

| Chart 3.4.1 | Impulse Response Function. Snake 1973.03-1979.03 | 130 |
| Chart 3.4.3 | Impulse Response Function. EMS wide bands | 135 |
Chapter 1

Overview

In January 1995, four Latin American countries, Argentina, Brazil, Uruguay and Paraguay joined their destinies within a common and ambitious enterprise called MERCOSUR. MERCOSUR, the Common Market of the South, represents an important economic integration area that generates a GDP of $US 600 billion, providing a market of 200 million people spread over an area of 12 million square km. It comprises 70 percent of the total land mass of South America, stretches from the tropical jungles of northern Brazil to the sub-Antarctic zone of Argentina, and includes some of the world's most important agricultural and mineral resources.

It constitutes the Latin American response to the overall trend towards regional economic integration which includes NAFTA, EU and ASEAN.

Although economic integration is not a new issue in Latin America, this new integrationalist trend is significantly different from previous Latin American experiences of economic integration, such as LAFTA (Latin American Free Trade Association), LAIA (Latin American Integration Association), because of the economic philosophy which underlies it. Whilst past attempts at integration were based on an import-substitution strategy of development, with an infant industry approach playing a decisive role, a new development model has gained popularity within the region, labeled by Williamson (1991) as the "Washington consensus", with the new economic policies being primarily based on a neo-liberal model with the emphasis on market forces. Consequently, Latin American states are facing important structural economic reforms.

Markets are being opened to international competition; the goods, labor and capital markets are being deregulated; and central governments are undergoing restructuring. Thus, governments have recognized the importance of achieving macroeconomic stability as a precondition for faster growth. MERCOSUR constitutes an important factor within this process. It increases the efficiency and competitiveness of member countries by enlarging the size of the market, taking advantage of economies of scale and increasing returns. This facilitates the acceleration of economic development across the region through a more efficient use of available resources.

Initially, MERCOSUR performance has been more than successful, as intra-MERCOSUR trade has increased significantly, and, since the widened market has attracted foreign direct investment, the member countries have been able to enjoy investment at a higher level than their national saving rates would make possible. However, some difficulties within the process have been introduced by the high variability of the intra-MERCOSUR exchange rate, and in particular by the real exchange rate between the Argentine peso and the Brazilian real. If a process of trade integration is to be successful, it seems inevitable that member countries must agree to maintain a

---

1 MERCOSUR in Spanish, Mercado Común del Sur, also MERCOSUL in Portuguese.
2 MERCOSUR was created in March 1991 by the Treaty of Asunción, which called for the signatories to establish a full common market arrangement among its members by January 1995.
3 Almost one third of total South America's population.
relatively stable intra-currency relationship. Although the Treaty of Asuncion mentions as one of the main four objectives of MERCOSUR the necessity to coordinate macroeconomic policies, no explicit consideration has been paid to this issue. Hence, the MERCOSUR countries have adopted unilateral exchange rate agreements with respect to the US dollar, but they have not developed any explicit link among their own currencies. While Argentina has operated a currency board system since 1991, which is an extreme version of a fixed exchange rate system, Brazil applies a fixed exchange rate system with a permissible band of fluctuation around a central value, Uruguay a crawling peg, and Paraguay allows the domestic currency to float. Exchange rate corrections take place in a fully unilateral and discretionary way without taking into account the other MERCOSUR currencies. The elimination of intra-MERCOSUR tariffs will not be efficient if at the same time the sharp variability of nominal exchange rates artificially affects the relative prices of different products. Thus, high exchange rate volatility introduces a negative effect on trade within the region, discouraging the integration process. The question as to the choice of the optimal exchange rate system to be adopted among MERCOSUR countries becomes critical if MERCOSUR states attempt to go further along the path of increasing their trade flows of goods and services. Although there exists a "general consensus" in the academic as well as in the political world concerning the necessity of some kind of exchange rate coordination, no valid response to the problem has as yet been made. In the Treaty of Asuncion, monetary and exchange rate agreements have been neglected, and until now there has not been any research undertaken in this specific field. Hence, the purpose of this study is to contribute to filling this gap by providing some alternative answers to this issue. The analysis is based on three pillars: a theoretical review of exchange rate systems; a review of the European experience; and an analysis of the Latin American experience. The study is organized as follows. In Chapter 2, first, I will analyze the interdependence effect among countries when they are linked under two extreme exchange rate regimes, fixed and floating. I will develop a two-country Mundell-Fleming-Dornbusch model and I will compare the effects of fiscal and monetary policy on the individual country implementing them and on the neighbor country. I will discuss the coordination problem that arises in the presence of fixed exchange rates, which is known in the literature as the N-1 problem. I will then review the time-inconsistency approach. I will introduce a theoretical model that allows comparison of the inflation outcome that results from a binding rule and that which arises from a discretionay monetary policy, and I will discuss some solutions for overcoming the time-inconsistency problem.

In chapter 3, a review of the European experience is presented. The European integration process was followed by the introduction of different exchange rates agreements. Thus, in the opinion of the European Commission, some fixity across exchange rates had to be introduced if the full benefits of integration were to be reaped. Although the argument also applies to the MERCOSUR case, no exchange rate agreement has as yet been introduced in that context. The experience of the European Union constitutes an excellent example of a successful economic integration process. It has been working for more than three decades, and it thus becomes important to draw

---

4 See footnote 2.
5 See footnote 2.
some lessons from this experience. Although at first sight there are important differences between the EU and MERCOSUR in the degree of industrialization, average GDP per capita and size of the market, some similarities also exist, especially between the Southern European members of the EU and the MERCOSUR countries. But the main resemblance is probably to be found in the overall integration process, in the historical and political basis that gave impulse to the economic integration. In both cases, member states decided to follow a new path after having faced a political and economic disaster, in Europe the Second World War, in Latin America the debt crisis of the 1980s and several authoritarian regimes. The European Economic Community began as a joint cooperation between two countries, Germany and France, who had historically been traditional enemies during the last two world wars, and afterwards was opened to other European countries. MERCOSUR began with cooperation between two countries, Brazil and Argentina, whose permanent political and military rivalry had in the past imposed restrictions upon economic cooperation and had created obstacles to trade between them. At a later date, it was opened up to their two closest neighboring countries, Uruguay and Paraguay, and recently to Chile and Bolivia as associate members. Other similarities are present with respect to rigidities in labor markets, as well as to the existence of different attitudes towards inflation rates among the member countries, due mainly to past experiences with hyperinflationary processes. In this chapter, an analysis of the historical experience makes it clear that the search for stability among the domestic currencies of European members was a constant theme since the break down of the Bretton Woods system destroyed the underlying net. The search for appropriate exchange agreements has persisted over more than three decades. During this period, different agreements have been introduced, the Snake being followed by the European Monetary System, with discussion now being centered upon the achievement of a single currency. It has been a "trial and error" process, and it has not yet been completed. In this chapter, I will also analyze in some detail the results delivered by the European Monetary System as regards price and exchange rate stability. Especially, I will investigate the dynamic response of nominal and real exchange rates to monetary and real shocks by inquiring whether the EMS has introduced some significant changes in those responses.

In Chapter 4, I will analyze the Latin American experience. First I will review previous attempts at integration, as well as the economic circumstances under which they were undertaken, and the reasons for their failure. Second, I will present some stylized facts of the macroeconomics profile of the MERCOSUR countries that permits the underlying asymmetries and the problems that they raise to be seen. Third, I will examine the relevant MERCOSUR experience with fixed exchange rate agreements. To do so, I will analyze the circumstances under which they emerged: they have primarily formed part of stabilization plans, and therefore I will review the factors that have been common to them. Finally, I will present the two most recent experiences with exchange rate agreements between Argentina and Brazil. They constitute two original and ingenious mechanisms to cope with currency substitution and inertial inflation and have attracted the attention of other Latin American countries and non-Latin American countries as well. Additionally, taking into account the fact that Argentina and Brazil constitute the two largest partners in MERCOSUR, from the political point of view a common exchange rate agreement will not be feasible without the support of these two members. Even more, in the past they have experienced the
most serious macroeconomic imbalances and therefore the role of stabilization plans and exchange rates is crucial for them.
The last chapter introduces three alternative proposals regarding the exchange rate policies for the MERCOSUR countries: a currency board system, target zones with a peg to the US dollar, and a peg to a basket of currencies, the last of which in my view follows from the overall analysis of this study.
Chapter 2: A Theoretical Approach

2.1 Introduction

Although the economic controversy with respect to the choice of exchange rate regime has persisted for a very long time, it still remains at the center of economic discussion. Since the breakdown of the Bretton Wood system, under which countries had for the previous quarter century kept their exchange rates fixed, economists have shown concern about the advantages and disadvantages of alternative exchange rate systems, although there has been much disagreement between them. The debate concentrated on different topics of economic theory during that period. The views advanced by Friedman in his controversial 1953 article still suffused the way of thinking of most economists in the early 1970's. Friedman's main aim was to attain unrestricted free trade and the freedom of each country to pursue internal stability following its own policies. He argued that the most efficient policy to achieve this goal was to adopt a flexible exchange rate. According to him, the alternatives would be either direct controls on trade and internal prices, or income adjustments, or changes in official reserves. He considered flexible exchange rates as particularly appropriate to respond to monetary disturbances, and supported the idea that a floating exchange rate could prevent the transmission of disturbances among countries whereas fixed rates would induce them. With exception of Europe, since the 1970s the major industrial countries have adopted flexible exchange rate arrangements and market pressures have been allowed to operate freely, generating large fluctuations in exchange rates. Johnson (1970) emphasized that floating rates allow governments to pursue their own internal goals without consequences for the balance of payments. Under fixed exchange rates, on the contrary, government's attempts to manage their internal and external balance would lead to restrictions on trade. He did not agree with the argument that fixed exchange rates might induce monetary and fiscal discipline. On the contrary, he argued that governments would always be able to pursue expansionary policies, even while adopting a fixed exchange rate system, because the option of changing the fixed parity was still available.

Kindleberger (1970) argued in favor of fixed exchange rates by alleging that a permanent fixed parity would be optimal for international trade. He did not believe that floating would give national authorities any extra degree of freedom, since they would be likely to adopt exchange rate targets. Summarizing, the literature of early 1970's emphasized the desirability of allowing market forces to determine exchange rate levels. In this sense, fixed exchange rates would increase levels of protection since governments, in order to maintain external balance, would introduce tariffs and quantitative controls on trade. But, floating exchange rates would provide an additional degree of freedom for domestic policy. Thus, by adopting floating exchange rates, governments only acquire the possibility to determine a domestic rate of inflation that differed from that in the rest of the world.

---

6 Representative studies of this point of view can be found in Johnson (1970) as well as in the contributions to the so-called Bürgerstock Papers edited by Halm (1970).

7 Governments can always announce a devaluation.
However, the introduction of floating exchange rates introduced high variability within financial markets and thus the economic discussion was reopened. Renewed interest in the economics of exchange rates reflects the fact that exchange rate arrangements are important. Changes in exchange rates have important effects, with consequences not only for prices, wages and interest rates but also for production levels and employment opportunities. Therefore, large and unpredictable changes in exchange rates present a major concern for macroeconomics stabilization policy. Traditionally, it has been argued that an increase in price uncertainty resulting from a more volatile exchange rate would lead to a reduction in the volume of trade and other international transactions. The empirical evidence concerning developed countries is, however, contradictory, though conclusive evidence has been presented that exchange rate uncertainty has damaged trade in developing countries.

The discussion as to ability of different degrees of exchange rate flexibility to stabilize domestic economies has attracted the attention of many economists. The first formal treatment of the basic insight had already been developed by Poole (1970), although his analysis did not concentrate on the advantages of fixed versus floating exchange rates but on a related problem for the closed economy. He assumed that governments have the implicit objective of stabilizing the level of output. However, they can only use one instrument for the purpose: either they have an interest rate target or a money stock target, but not both. Thus, he demonstrated that, in general, if shocks affecting domestic economies are mainly real in nature, adopting an interest rate target constitutes a better choice. On the contrary, if shocks are predominately monetary in nature, then following a money stock target will be optimal. Boyer (1978) extended Poole's analysis to the open economy. He considered that, if the objective of monetary policy is to stabilize output, fixed exchange rates are optimal when the IS curve is stable and monetary shocks are present. But if only real shocks occur, a fixed money supply and a floating exchange rate would be a better option.

After the innovative article of Kydland and Prescott (1977), the credibility argument attracted great interest among economists. Barro and Gordon (1983) and Cukierman and Meltzer (1991) followed this approach that generated a new wave of literature. According to this view, economies that show a lack of credibility and high inflation rates could benefit from adopting a fixed exchange rate regime. Credibility can be improved by committing to a fixed exchange rate of a country with a traditionally low inflationary history. In this sense, by pegging its domestic currency to a traditionally low inflationary currency, a country will import the credibility from the foreign country.

New approaches introduce political economic considerations and apply new techniques such as game theory. Hamada (1985) suggested that, when analyzing the optimal exchange rate agreement, economists should not only focus on cost-benefit analysis but also take into account the negotiating process that will emerge between the participants that reveal the benefit-cost structure that each regime confers on the

---

9 See Diaz Alejandro (1976).
participating countries. Fischer (1988) analyzed the case in which two countries will each be better off if they coordinate their policies. Thus both countries could adopt expansionary policies, but in the absence of cooperation and/or coordination mutually beneficial expansion would be prevented. Genberg (1989) discussed the traditional point of view that, under floating exchange rates, it is no longer necessary to harmonize the economic policies. Floating exchange rates make it possible for the country to set its policy instruments independently from the rest of the world. But this does not of itself imply that it will be an optimal policy. Since floating exchange rates do not insulate the economy from foreign shocks, it may be in the interest of the domestic authorities to react to policies initiated abroad. A satisfactory functioning of a floating rate system may thus require policy harmonization. The question is whether harmonization under floating exchange rate regime is more or less expensive than harmonization under fixed exchange rates.

Marston (1985) and Canzoneri, Henderson and Rogoff (1981) derived the conditions under which a flexible exchange rate was preferable to a fixed one. Fixed exchange rates are superior (inferior) to floating if the variance of the aggregate composite shock is sufficient large (small) relative to the variance of the consolidated shock. In particular, if the domestic money demand is very unstable or if domestic monetary control is very imprecise, then fixed exchange rate will stabilize output. Alternately, if the demand function for domestic goods is highly unstable, a floating rate is preferable. Flood (1982) derived the following conclusions: some degree of exchange rate management will be better than either free floating or complete fixity. If the authorities only have a choice between a fixed rate regime and pure floating, then the latter will be better in presence of some wage indexation. Henderson (1984) researched the conditions under which two large countries show a common interest in either floating exchange rate or a fixed exchange rates, as well as those that lead to conflicts of interest. He found that there is no policy conflict when there are shifts in demand between home and foreign goods (both would be in favor of floating) and when there are shifts in asset preferences between home and foreign assets (both would be in favor of fixed rates). Nevertheless, if there are shifts in labor productivity in either country, conflicts will arise. A shift in asset preferences from one country to another will lead to exchange rate and interest rate variation and therefore will induce fluctuations in output, unless accommodating fluctuations in assets surplus are forthcoming. A fixed exchange rate would allow such changes in assets supplies to come about automatically and thereby insulate the real economy from asset market disturbances. A switch in demand between home and foreign goods requires relative price and real wage adjustments in both countries. If wages are rigid, adjustment will be accomplished with minimum output loss when the exchange rate is allowed to adjust. A shift in labor in the home country requires a real wage adjustment there, whereas none is necessary abroad. The home country would prefer some degree of exchange rate flexibility to help in the adjustment process but the foreign country will be better off with a fixed exchange rate. Helpman (1981) compared the welfare levels that are attained under different exchange rate systems, floating, fixed and one side peg. He

12This problem is known in the literature as prisoner dilemma. Two partners could be better-off if they would co-operate. The absence of coordination though induces to a worse situation. For details Rapoport and Chammah (1965) and Schotter (1981).
analyzed the implications of those regimes with respect to global efficiency and the
distribution of welfare as well as the determination of financial variables such as
prices, exchange rates and interest rates. He showed that the equilibrium allocation of
consumption is efficient in every exchange rate system and that, in a floating exchange
rate system as well as in a one-sided peg regime, it corresponds to the equilibrium
allocation of consumption in a barter economy. Independently of the exchange rate, all
perfect foresight equilibria are Pareto optimal, which is an extremely strong result
because it implies, in Helpman's framework, that exchange rates are irrelevant from the
efficiency point of view. It may happen that different exchange rate regimes have
different distributional implications in the sense that, under some of them, one
particular country is better off than the others. The equivalence result depends on the
ability of governments to pursue non-distorting absorption policies whenever they are
needed in order to accompany an exchange rate regime. Every exchange rate system is
associated with its specific financial market clearing conditions. It is plausible that a
particular exchange rate system performs better than others under certain types of
imperfections (wage contracts, market imperfections, etc.) whose existence may have a
bearing on the relative desirability of alternative exchange rate regimes. In general, in
the literature, economists compare different exchange rate regimes under different
initial assumptions, with the conclusions, of course, depending on them. Helpman
(1981), Razin (1986) and Mc Kibbin and Sachs (1986) sought empirical evidence as to
the global performance of alternative exchange rate arrangements. They developed a
simulation model of the world economy and showed that the performance of each
regime depends crucially on the performance and the nature of the shocks affecting the
economies. With country specific shocks, fixed exchange rates performed poorly; with
global shocks, such as oil price rises, fixed exchange rates performed tolerably well.
For other types of shocks, mainly monetary shocks, the system proposed by Mc
Kinnon offers a better solution.\footnote{Mc Kinnon (1984) suggested that the problem under flexible exchange rate system was
mainly due to the fact that the rules governing the creation of the stock of international money
were not well defined. He assumed that large shocks in the currency preferences of economic
agents led to large movements of the world money stock. In his opinion, these movements
could have been avoided by designing better rules concerning the monetary policy of the major
countries. The suggestion of Mc Kinnon, known in the literature as Mc Kinnon rule, consists
of a fixed exchange rate regime with a coordinated determination of the world money stock.
For details see De Grauwe (1994).}

In this study, I shall concentrate my analysis on the optimal exchange rate arrangement
for the MERCOSUR case. As a methodological approach, the analysis can be reduced,
firstly, to the comparison from the theoretical point of view of two extreme alternative
systems: flexible versus fixed exchange rates. Although in the real world "ideal cases,"
do not exist but only a relative approximation to one of the two extreme cases in the
form of differing degrees of flexibility, in order to simplify the problem it is reasonable
to start with pure theoretical cases to be able to draw some conclusions.

I begin, therefore, by analyzing the transmission mechanisms of both exchange rate
regimes by means of the well-known Mundell-Fleming model, which offers an
excellent framework in which the effect of different policies can be compared as well
as the introduction of different assumptions. Second, I introduce the Dornbusch model
by incorporating dynamic behavior into the traditional Mundell-Fleming model and adding the Phillips curve and exchange rate expectations. Third, I discuss the coordination problem that arises under a fixed exchange rate regime which is known as the N-1 problem. Finally, I concentrate on credibility issues by introducing the time inconsistency approach, and I analyze the consequences that follow from different policy options (commitment versus discretionary policy) and its relation to the institutional design of exchange rate regimes. The high complexity of the issue under analysis allows for the adoption of diverse theoretical frameworks by focusing on different aspects of the same problem. Thus, in this study I have omitted the optimal currency area theory (OCA), the problem of the choice of the exchange rate regime under inflationary financing of budget deficits (seignorage approach\textsuperscript{14}), as well as balance of payments crises. With respect to the first issue, the initial studies on optimal currency areas were done by Mundell (1960) and McKinnon (1966). This theory analyzes the benefits and costs of adopting a single currency across several regions or countries. The benefits are larger than the costs and thus the monetary area is an optimum if the economic structure of the countries is relatively similar and if the labor and goods markets are highly flexible. A profuse empirical literature related to this topic has recently been published applying modern econometric techniques. The focus has concentrated on the analysis of the symmetry of shocks applied mainly to the cases of Europe, USA and Canada\textsuperscript{15}. The underlying rationale is as follows: if shocks are symmetrical across regions, the area is likely to be an OCA. However, the results provided by these empirical analyses are not very conclusive and are unable to give concrete answers and policy recommendations. Firstly, no one area seems to be an optimum, not even the USA which already is working under a single currency. Secondly, the empirical analysis is done "a priori", before a single currency has been adopted and hence it cannot consider the changes that would arise were a single currency to be "de facto" introduced.

Concerning the inflationary financing of budget deficits issue and balance of payment crises, Agell, Calmfors and Jonsson (1996) discuss the problem of defining the exchange rate regime in the presence of a desirable seignorage revenue. They argue that, if governments use the inflation tax\textsuperscript{16} to finance their expenditure, different exchange rate regimes will have different repercussions for fiscal policy because they will affect seignorage revenue. De Kock and Grilli (1993) analyze similar issues and conclude that it is not possible to rank different exchange rate regimes from the Pareto point of view, since governments that care about their tax revenue must account for the fact that different exchange rate systems have implications for the flexibility of future seignorage revenue. Jensen (1994) develops a model in which a small open economy is operating with a high rate of unemployment because of the existence of distortionary

\textsuperscript{14} Seignorage is the revenue collected by the government as a result of its monopoly power to print money. Because the central bank can print money without cost, the seignorage can be measured as the purchasing power of the money put into circulation in a given period. See Sachs and Larrain (1993).


\textsuperscript{16} Inflation tax is the capital losses suffered by money holders as a result of inflation. See Sachs and Larrain (1993).
taxes in the labor market. As the government accumulates seignorage over time, it can use the proceeds to gradually phase out those distortionary labor market taxes. In this framework, a binding policy rule that makes it more difficult to raise seignorage revenue, such as a credible fixed exchange rate, will only serve to slow down the adjustment towards the steady state. Under a fixed exchange rate, the problem of the inflationary financing of budget deficits is closely related to the balance of payment crises. While under a flexible exchange rate the government can collect an inflationary tax, under a fixed exchange rate a monetary financing of a budget deficit will induce a loss of reserves. Consequently, if a country has a persistent budget deficit, reserves will be continuously falling and eventually the central bank will run out of reserves and will no longer be able to intervene in the foreign exchange market. Thus, it will have no other option than to allow the exchange rate to depreciate, either as a devaluation of the local currency or by adopting a floating exchange rate regime. However, the collapse of a pegged exchange rate regime when a central bank runs out of reserves is a traumatic process and is known in the literature as a balance of payments crisis or an exchange rate crisis. Krugman (1979)\textsuperscript{17} presented a formal model describing the exchange rate collapse. Initially, the loss of reserves is gradual and equivalent to the budget deficit. As reserves fall to a low level, however, the public becomes aware of this fact and suspects an imminent collapse of the exchange rate system. Therefore, households suddenly move massively to convert their domestic holdings into foreign currency because they anticipate a sharp rise in inflation. Although all the aspects mentioned above are very important, the starting point of the seignorage approach is to assume that there might be some gains for the domestic economy of having an inflation rate higher than the rest of the world. In the case under analysis, MERCOSUR, the countries do not have the option of choosing a higher inflation in order to collect inflationary tax. Because in the past they have abused the seignorage, the member countries are unable to raise inflation without rapidly entering onto the path of the hyperinflation. Additionally, the inflationary policies have damaged the economies because of the distortions that they have introduced. Therefore, the seignorage approach does not constitute an optimal approach for the countries under consideration.

\textbf{2.2 The Mundell-Fleming Model}

The Mundell-Fleming model constitutes an extension of the IS-LM framework to the open economy. Its foundations are found in the writings of Mundell (1960, 1961, 1963, 1964 and collected in 1968) and Fleming (1962). It has become a reference model of the open economy to which other models can be confronted. According to Krugman (1993), the Mundell-Fleming model supplemented with price reaction functions and price expectations constitutes the only theoretical model that permits concrete answers to be given to economic policy problems. The model is thus extremely comprehensive and can be manipulated to analyze the international

\textsuperscript{17}Additional references on currency crisis are found in Flood and Garber (1984). Wyplosz (1986) discusses the importance of capital controls in order to overcome a currency crises. For recent analyses see Tavlas (1996), Bordo and Schwarz (1996), Kenen (1996).
transmission mechanism of monetary and fiscal policies and the effects of a variety of disturbances originating at home or abroad on the variables: output, exchange rate and interest rates for different exchange rate regimes, for differing degrees of capital mobility and also for different assumptions about expectation formation of economic agents.

The Mundell-Fleming model was initially developed as a short-run approach for the small, open economy. Consistently with the Keynesian assumptions, prices and wages are fixed, aggregate demand is perfectly elastic and actual output is then determined. Over the decades, the model has been extended in several directions: developments of the model for alternative exchange rate regimes and different degrees of capital mobility can be found in Swoboda and Dornbusch (1973) and Mussa (1982). Recent surveys of several open economy macroeconomic issues discussed in the context of this model are contained in Frenkel and Mussa (1985), and Kenen (1985). Marston (1985) presented a survey of application of stabilization policies. Obstfeld and Stockman (1985) provide a survey on exchange rate dynamics relating to this and other competitive models. Frenkel and Razin (1987) developed a version that integrates the different aspects of the Mundell-Fleming model into a unified analytical framework by distinguishing between the short- and long-run effect and discuss an application related to the government budget and the role of the exchange rate regime. In this study, I shall present, first, a traditional two-country version which permits the interdependence between economies linked by goods and bonds markets to be analyzed. It is also feasible to extend the analysis to a larger number of countries, although the economic interpretations become quite abstruse.

Firstly, the traditional Keynesian assumptions are considered: prices and wages are fixed, hence output is demand determined because the economy has not reached the full employment level. There is perfect capital mobility, thus the domestic interest rate is equal to the international interest rate. Price and exchange rate expectations are assumed to be static and therefore the nominal and real interest rates are identical. I will analyze the comparative statics of the short run impact of monetary and fiscal shocks on foreign and domestic output under flexible and fixed exchange rates. Secondly, I will present a two-country version of the extension of the model derived from the original analysis of Dornbusch (1976), which allows for the dynamic analysis of the variables and introduces the Phillips curve and rational expectations. Finally, I will apply the Dornbush framework to the fixed exchange rate regime.

---

19 Dornbusch (1973), Frenkel and Mussa (1985) and Frenkel and Razin (1987), among others, present a two-country version of the Mundell-Fleming model.
20 Gandolfo (1986) presents a N-country version model.
2.2.1 Flexible Exchange Rate

The Model

The Goods Market

Under a flexible exchange rate system, the good market equilibrium condition can be expressed as equations (2.2.1.1) and (2.2.1.2) for the home and foreign countries respectively. In these equations, \( y^d_i \) represents the domestic aggregate demand; \( y_i \) is the output level, \( e \) the nominal exchange rate and \( P_i \) the price level, \( g_i \), the government expenditure; \( r_i \) the real interest rate. The subindex 1 represents home and 2 the foreign country. All variables, except the interest rate, are expressed in logarithmic terms.

Aggregate demand depends positively on the real exchange rate, foreign output and on the government demand and negatively on the real interest rate. The structural parameters are assumed to be identical in both countries and adopt values between 0 and 1. \( \delta \) represents the exchange rate elasticity and denotes the proportion by which aggregate demand would rise in presence of an increase of 1% of the real exchange rate, \( \sigma \) is the interest rate semi-elasticity; and finally, \( f \) represents the import-income elasticity and explains the impact of the foreign propensity to import on domestic aggregate demand.

In this section, I shall assume that the exchange rate is fully flexible and therefore its value is determined in the exchange rate market. There is no central bank interventions.

\[
\begin{align*}
(2.2.1.1) \quad y^d_1 &= \delta(e - p_1 + p_2) + g_1 - \sigma r_1 + fy_2 \\
(2.2.1.2) \quad y^d_2 &= \delta(e - p_1 + p_2) + g_2 - \sigma r_2 + fy_1.
\end{align*}
\]

Domestic and foreign output, nominal exchange rate and interest rates are endogenous variables, while the government expenditure is exogenous. Because output is demand determined as in the keynesian tradition and then

\[
(2.2.1.3) \quad y^d_j = y_j.
\]

---

21 The parameter \( g \) can be interpreted as all exogenous variables that represent the domestic absorption, as autonomous consumption, autonomous investment, government expenditure. For simplicity, I will refer only to the government expenditure but the analysis can be extended to consumption and investment in analogous way.

22 For details respect to the derivation of the logarithmic form see Argy (1994) and Maennig (1992).

23 The model assumes that the Marshall-Lerner condition holds: \( \eta_m + \eta_x > 1 \), where \( \eta_x \) and \( \eta_m \) are exchange rate elasticity of demand for exports and exchange rate elasticity of demand for imports respectively.

24 In this case because expectations are static there is no difference between nominal and real interest rates.

25 The two countries are symmetric.

26 \( \log X = x \)
The Money Market

In each country the money market is in equilibrium whenever the demand for money equals the supply of money. As usual, the demand for money depends positively on domestic income and negatively on the nominal interest rate.

\[(2.2.1.4) \quad M^d_j = P_j L_j (Y^d_j, i_j).\]

The supply of money $M_j$ is made up of the domestic component $D_j$ and the foreign component $R_j$,

\[(2.2.1.5) \quad M^s_j = D_j + R_j.\]

I shall consider a more general version of the model by deflating the money real balances by the consumption price index (CPI) $P_{ci}$ which is defined as the weighted average of the domestic price and the foreign price of goods expressed in domestic currency,

\[(2.2.1.6) \quad p_{ci} = \beta p_1 + (1 - \beta)p_2 + (1 - \beta)e \quad \text{and} \quad p_{ci} = \beta p_2 + (1 - \beta)p_1 + (1 - \beta)e.\]

However, in this part of the analysis I shall assume $\beta = 1$.\(^{28}\)

In equilibrium,

\[(2.2.1.7) \quad (D_j + R_j)/P_j = L(Y_j, i_j).\]

The demand for money adopts the following functional form:

\[(2.2.1.8) \quad M^d_j = Y_j^\phi (\exp)^{-\lambda_i}.\]

$\lambda$ represents the interest rate semi-elasticity of money demand and $\phi$ the income elasticity, which is the percentage increase in money demand in response to a 1 per cent increase in domestic income.

Therefore expressed logarithmically,

\[(2.2.1.9) \quad \ln M_j = \phi \ln Y_j - \lambda_i.\]

By equalization of money demand and money supply, then:

\[(2.2.1.10) \quad \ln (D_j + R_j) - \ln P_j = \phi \ln Y_j - \lambda_i\]

\[(2.2.1.11) \quad \ln M^s_j - \ln P_j = \phi \ln Y_j - \lambda_i.\]

Then the money market equilibrium condition expressed in logs can be defined as:

---

\(^{27}\)See De Grauwe (1989a) and Scarth (1988).

\(^{28}\)In this part, this assumption does not play a relevant role; and it reduces the complexity of the algebra significantly. I will relax this assumption later on.
Money market equilibrium conditions in both countries are represented by the equation (2.2.1.13) and (2.2.1.14). The money supply in both countries is controlled by the respective central bank. Domestic economic agents only hold domestic money and vice versa. 29

\begin{align*}
(2.2.1.13) & \quad m_1 - p_1 = -\lambda_i + \phi y_1 \\
(2.2.1.14) & \quad m_2 - p_2 = -\lambda_i + \phi y_2.
\end{align*}

**Interest Parity Condition**

As in the traditional version of the Mundell-Fleming model price and exchange rate expectations are assumed to be static, and the nominal interest rate is equal to the real interest rate. The Fisher condition for the closed economy can be expressed as follows:

\begin{equation}
(2.2.1.15) \quad i = r + \pi^e.
\end{equation}

where \( i \) is the nominal interest rate, \( r \) the real interest rate and \( \pi^e \) the expected inflation. In this case \( \pi^e = 0 \).

Because of the assumption of perfect capital mobility, in absence of a risk premium and exchange rate expectations, the domestic interest rate is equal the foreign interest rate. The Fisher condition for the open condition is as follows:

\begin{equation}
(2.2.1.16) \quad i_1 = i_2 + E_t(e_{t+1} - e_t) + \rho,
\end{equation}

\( E_t(e_{t+1} - e_t) = 0 \) represents the static exchange rate expectation, and \( \rho = 0 \) the risk premium.

\begin{equation}
(2.2.1.17) \quad i_1 = i_2.
\end{equation}

**Comparative Statics**

In order to solve the model, I will consider the goods market and the money market equilibrium in both countries, that means equations (2.2.1.1), (2.2.1.2), (2.2.1.3), (2.2.1.13), (2.2.1.14) and the interest parity equilibrium condition (2.2.1.17). By replacing (2.2.1.17) in (2.2.1.1), (2.2.1.2), (2.2.1.13) and (2.2.1.14) the following system of 4 equations is obtained,

\begin{align*}
(2.2.1.18) & \quad y_1 = \delta (e - p_1 + p_2) + g_1 - \sigma i + f y_2 \\
(2.2.1.19) & \quad y_2 = -\delta (e - p_1 + p_2) + g_2 - \sigma i + f y_1
\end{align*}

29 Currency substitution has not been considered. For details see Girton and Roper (1981), Calvo and Rodriguez (1977), Kuori (1976), Gärtner (1990).
(2.2.1.20) \[ m_1 - p_1 = -\lambda i + \phi y_1 \]
(2.2.1.21) \[ m_2 - p_2 = -\lambda i + \phi y_2 \]
which contains 4 endogenous variables, both output levels \( y_1, y_2 \), nominal interest rate \( i \), and nominal exchange rate \( e \). The exogenous variables are \( m_1, m_2, g_1, g_2 \) and price levels, \( p_1 \) and \( p_2 \), which are fixed in this part of the analysis.

By differentiating the system of equations (2.2.1.18), (2.2.1.19), (2.2.1.20) and (2.2.1.21), it is possible to analyze the comparative statics of the effects of changes in the exogenous variables on the endogenous variables.

In this case, I consider only the impact of a positive domestic fiscal shock \((d g_1)\) and a positive domestic monetary shock \((d m_1)\) on domestic and foreign output, exchange rate and interest rates.

**Fiscal Shock**

A domestic expansionary fiscal shock will induce a disequilibrium in the goods market. Given that the aggregate demand determines output \((y_1^d = y_1)\), domestic output will increase. The final effect on domestic output will be positive, as the multiplier explains.

\[
\frac{dy_1}{d g_1} = \frac{\lambda}{2\lambda(1-f) + \phi(\lambda - f)} > 0
\]
because by assumption \(0 < f < 1\).

A higher domestic output will disequilibrate the money market, money demand will increase because money supply remains constant, the domestic interest rates will increase in order to reestablish the equilibrium, and so the multiplier is positive. This increase in the interest rate, however, will moderate the positive impact of the fiscal policy on domestic output through the crowding out effect on domestic investment:

\[
\frac{d i}{d g_1} = \frac{\phi}{2\lambda(1-f) + \phi(\lambda - f)} > 0.
\]

Under perfect capital mobility, a transitory higher domestic interest rate will induce large capital inflows. Nevertheless, because of the interest parity condition, interest rates in both countries will return to equality but at a higher level than the original. The capital inflows induced by a temporarily higher domestic interest rate will appreciate the domestic currency as the multiplier shows:

\[
\frac{d e}{d g_1} = \frac{1}{2\delta} < 0.
\]

The spill-over effect on foreign output will be positive. This effect is the consequence of the increase in domestic output together with the appreciation of the domestic currency. Although the fiscal shock increases the domestic and foreign interest rate, which has a negative impact on foreign output, this effect is more than compensated for the output and exchange rate effects and the final impact is as follows:

\[
\frac{dy_2}{d g_1} = \frac{\lambda}{2\lambda(1-f) + \phi(\lambda - f)} > 0.
\]
Figure 2.2.1.1 (on page 24) represents the effects of an expansionary fiscal policy in country 1 in the traditional IS-LM diagram. An expansionary fiscal policy shifts IS\textsubscript{1} curve to the right and income y\textsubscript{1} and interest rate rise. The higher income in country 1 induces an increase in the demand for foreign products, and IS\textsubscript{2} shifts to the right. However, the shift of IS\textsubscript{2} curve in country 2 is smaller than the shift originated in country 1 and thus there is in the short run an interest rate differential that induces capital movements between countries. (From country 2 to country 1). The domestic currency will appreciate in country 1 and therefore the IS\textsubscript{1} curve will move back to the left. There is some reduction in income in country 1, but is still higher than its initial level. In country 2, the exchange rate will depreciate and hence the IS\textsubscript{2} will shift again to the right reinforcing the output increase. In the final equilibrium position, both output levels are higher and the interest rate is also higher. The spill-over effect of the fiscal policy has induced a positive impact on output in the foreign country.

**Monetary Shock**

By applying the same procedure as before, it is possible to analyze the effect of a domestic expansionary monetary shock on the endogenous variables (y, e, i). An expansion of the money supply will disequilibrate the money market. Money supply will be larger than money demand and domestic interest rates will decrease in order to re-establish the equilibrium, so that the effect on interest rates will be negative:

\[(2.2.1.26) \frac{di}{dm_1} = (f-1)/[2(\lambda(1-f)+\phi\sigma)] < 0.\]

Lower interest rates will generate a positive impact on the aggregate demand through investment and therefore domestic output will increase.

\[(2.2.1.27) \frac{dy_1}{dm_1} = [\lambda(1-f)+2\phi\sigma]/2[\lambda(1-f)+\phi\sigma] > 0.\]

In the capital market, lower interest rates will induce capital outflows, thus leading to a depreciation of the domestic currency.

\[(2.2.1.28) \frac{de}{dm_1} = \lambda(1-f^2)+\phi\sigma(1+f)/2\phi[\lambda(1-f)+\phi\sigma] > 0.\]

The impact on the foreign output will be negative, although the monetary expansion increases domestic output and hence the exports of the foreign country, and reduces the domestic interest rate. The depreciation of the domestic currency will more than compensate the first two effects, and the final result will be a negative impact on foreign output. The monetary policy works as a "beggar my neighbor policy".\(^{31}\)

\[(2.2.1.29) \frac{dy_2}{dm_1} = \lambda(f-1)/(2\phi(\lambda(1-f)+\sigma\phi) < 0.\]

Figure (2.2.1.2) on page 24 presents the effect of an expansionary monetary policy in a IS-LM diagram. The monetary expansion originated in country 1 shifts the LM\textsubscript{1} curve

\(^{30}\) Compare with the multipliers presented above.

\(^{31}\) McDonald (1988), Gartner (1994).
to the right. The interest rate declines and therefore income in country 1 rises. The increase in income in country 1 increases the demand for foreign goods. The IS$_2$ curve of the foreign country, therefore, shifts to the right. In country 1, two effects take place, on the one hand, the increased demand for foreign goods additionally worsens the current account; on the other hand, the decline in the domestic interest rate induces net capital outflows and the domestic currency will depreciate, which in turn has an effect on the domestic goods market, and IS$_1$ shifts to the right.

Country 2 experiences an appreciation of its currency and a reduction in its exports, so IS$_2$ shifts to the left. Finally, the income of country 1 will increase, while that of country 2 will decline. There is a negative spill-over effect on output in country 2.

Summarizing, under a floating exchange rate regime, on the one hand a positive domestic fiscal shock increases domestic output and induces a positive spill-over effect on output in the foreign country, interest rates are higher than initially and the domestic currency (in terms of country 1) will appreciate.

On the other hand, a positive domestic monetary shock impacts positively on domestic output, and it also induces a spill over effect on the foreign country, but this time is negative. Interest rates will be lower and the domestic currency will depreciate.

### 2.2.2 Fixed Exchange Rate

#### The Goods Market

Under a fixed exchange rate system, in the absence of devaluations, the exchange rate will be held constant and thus it can drop out of the goods market equilibrium condition of both countries. Because prices are held constant, it is feasible to write the good market equilibrium condition as equations (2.2.2.1) and (2.2.2.2). Aggregate demand depends positively on government expenditure ($g_1$) and on foreign output and negatively on real interest rates.

\[\begin{align*}
  (2.2.2.1) & \quad y_1^d = g_1 + f y_2 - \sigma_1 \\
  (2.2.2.2) & \quad y_2^d = g_2 + f y_1 - \sigma_2 \\
  (2.2.2.3) & \quad y_j^d = y_j.
\end{align*}\]

Output is as before demand determined.

#### The Money Market

Under a fixed exchange rate regime, both money markets are linked through the fixed parity of the exchange rate. Therefore, the aggregated money market equilibrium condition can be expressed as follows:

\[ (2.2.2.4) \quad M_1 + M_2 = P_1 L_1(Y_1, i_1) + P_2 L_2(Y_1, i_1). \]

\[ \text{\scriptsize Compare with goods market equilibrium condition in the case of flexible exchange rates.} \]
The individual money demands show the same functional form as in the previous case, depending positively on output and negatively on interest rates. The individual money supply of both countries is composed, as usual, of foreign currency and each domestic component.

(2.2.2.5) \[ M_1 = R - R_2 + D_1 \]

(2.2.2.6) \[ M_2 = R - R_1 + D_2 \]

The total amount of foreign reserves is assumed to be constant and fixed:

(2.2.2.7) \[ R = R_1 + R_2 = \text{constant}. \]

Therefore, the aggregate money supply can be defined as follows:

(2.2.2.8) \[ M_u = M_1 + M_2 = R + D_1 + D_2. \]

In equilibrium, money demand is equal to money supply

(2.2.2.9) \[ R + D_1 + D_2 = P_1 L_1(Y_1, i_1) + P_2 L_2(Y_2, i_2), \]

and

(2.2.2.10) \[ R + D_1 + D_2 = M_u (R, D_1, D_2). \]

The aggregate money supply is a function of both domestic components and of the reserves. By replacing,

(2.2.2.11) \[ M_u (R, D_1, D_2) = P_1 L_1(Y_1, i_1) + P_2 L_2(Y_2, i_2). \]

Because of the perfect capital mobility assumption, the interest parity equilibrium condition holds:

(2.2.2.12) \[ i_1 = i_2, \] thus the subindex can be eliminated.

Expressing the aggregated money market logarithmically:

(2.2.2.13) \[ m_u - p_1 - p_2 = \phi y_1 + \phi y_2 - 2\lambda i. \]

As in the flexible exchange rate case, price expectations are static and thus nominal interest rates are equal to real interest rates

---

33In this case it is assumed that the reserve currency R is either gold or a currency of a third country for example the US dollar. If for example country 1 were the currency country then the money supply equation of both countries would be \( M_1 = D_1 \) and \( M_2 = D_2 + R_2 \). For details see Neumann (1988).
Replacing (2.2.2.12), (2.2.2.14) and (2.2.2.15) in (2.2.2.1) and (2.2.2.2), and considering (2.2.2.13), I obtain both goods and money market equilibrium conditions for the home and for the foreign country:

\[
y_1 = g_1 + f y_2 - c_i \\
y_2 = g_2 + f y_1 - c_i \\
m - p_1 - p_2 = \phi y_1 + \phi y_2 - 2\lambda i.
\]

The goods and money market equilibrium conditions consist of a 3-equation system with 3 endogenous variables \(y_1, y_2\) and \(i\), hence the system is determined and can be solved.

By differentiating the system, as before, I analyze the impact effect of an expansionary domestic monetary and a fiscal shock on the endogenous variables.

### Fiscal Shock

A domestic positive fiscal shock will have an expansionary impact on the home income. The aggregate demand will increase and therefore will affect domestic output positively.

\[
\frac{dy_1}{dg_1} = \frac{2\phi - c_i}{(1+f)[2\lambda(1-f)+2\sigma\phi]} > 0.
\]

\[
\Delta = (1+f)[2\lambda(1-f)+2\sigma\phi] \text{ is always positive for } 0 < f < 1.
\]

The increase in aggregate demand will induce tensions in the domestic money market and the interest rate will rise in order to reestablish the equilibrium.

\[
\frac{di}{dg_1} = \frac{\phi(1+f)}{(1+f)[2\lambda(1-f)+2\sigma\phi]} > 0.
\]

The effect on foreign income is ambiguous: it will be positive or negative depending on the relative values of the income-, export- and interest rate elasticities. Thus \(2\phi - c_i < 0\).

The expansionary effect on the home income will have a positive impact on the foreign output through the increase in the demand for imports and a negative impact through the higher interest rates. The higher the interest elasticity \((\sigma)\) of the demand for investment and the income elasticity of money demand \((\phi)\) the more contractive will be the effect on the foreign output. On the other hand, the higher is the country 1's propensity to import \((f)\) and the higher the interest elasticity of money demand \((\lambda)\) the larger will be the positive impact on foreign output.

\[
\frac{dy_2}{dg_1} = \frac{(2\phi - c_i)}{(1+f)[2\lambda(1-f)+2\sigma\phi]} > 0, \text{ and } \frac{dy_2}{dg_1} < 0 \text{ if } 2\phi > \sigma\phi.
\]

and \(dy_2/dg_1 < 0\) when \(2\phi > \sigma\phi\).
when $2\lambda - \sigma \phi < 0$
if $2\lambda < \sigma \phi$.

Figure 2.2.2.1 shows the impact of an expansive fiscal policy originated in country 1. Initially, output in country 1 increases and therefore induces higher demand for imports of goods which are produced in country 2. Both IS curves shift to the right. The interest rate has increased while the money supply remains constant. Thus, in the very short run there is a tendency for the interest rate to be higher in country 1 than in country 2. This is due to the income effect on money demand, which is higher in country 1 than in country 2 because the direct effect on the goods market in country 1 is, of course, higher than the indirect effect through exports in country 2. There is a capital flow from country 2 to country 1 and therefore an increase of the monetary base in country 1 and a decrease in country 2. While this capital flows effect reinforces the output increase in country 1, it moves in a negative way in country 2, leaving undetermined the final effect on output. Therefore, the final effect on $y_2$ depends on the export elasticity (shift of IS$_2$ curve to the right) and on the shift of the LM$_2$ curve to the left. Finally, the spill-over effect on country 2 can be positive or negative depending on the export elasticity, the income elasticity of the money demand, and on interest rate elasticity.\textsuperscript{34}

**Monetary Shock**

As it was shown before, under fixed exchange rates, money markets in both countries are closely linked, and monetary policy is not longer independent.\textsuperscript{35} Thus if, for example, country 1 initiates an expansive monetary policy, the central bank of country 2 will only operate in order to guarantee the fixed parity of the exchange rate. After all adjustments have taken place, the redistribution of reserves between the two countries will differ from its initial level.

**Distribution of Money Supply Across Countries**

Before analyzing the impact of an expansionary monetary policy on outputs and interest rates, I will consider the effect of the monetary policy with respect to the redistribution across countries.\textsuperscript{36} I will consider an expansionary monetary policy initiated by country 1 which translates into an increase of its monetary domestic component ($D_1$).\textsuperscript{37} At the same time, the reserves in country 1 ($R_1$) decrease and those of to country 2 increase ($R_2$). The total increase in the money supply is identical to the increase in the domestic component of the first country.

\textsuperscript{34} Compare above $2\lambda - \sigma \phi < 0$.

\textsuperscript{35} In section 2.4, the N-1 problem is detailed explained. Additionally, different solutions to this problem are presented.


\textsuperscript{37} The domestic component of country 2 $D_2$ remains unchanged.
The redistribution across countries is as follows:

\[ (2.2.2.12) \quad dM_1 = dD_1 + dR_1 = (1/2)dD_1 \]
\[ (2.2.2.13) \quad dM_2 = dD_2 + dR_2 = (1/2)dD_1 \]

The money supply in each country increases by half the increase in the domestic component of country 1. This means that the reserves of country 1 will decrease by an amount \((1/2)dD_1\) and the reserves of country 2 will increase by \((1/2)dD_1\). The offset coefficient in this case is 0.5.\(^{38}\)

**Effect of the Monetary Policy on Output and Interest Rates**

The mechanism of transmission works as follows: the central bank of country 1 undertakes an open market operation by increasing its domestic component \(D_1\), and there is a tendency for the domestic interest rate to decline and to differ from the foreign interest rate. Because of the assumption of perfect capital mobility, this situation induces a large net capital outflow. Pressures appear in the exchange rate market, where there is a tendency for the exchange rate to depreciate. Because the exchange rate is fixed, both central banks will intervene in the market by defending the agreed exchange rate parity. The central bank of country 1 will sell foreign reserves and the central bank of country 2 will buy foreign reserves. Through this operation, the interest rate will remain equal across countries. However, as it was shown above, the monetary expansion distributes itself between the money markets of both countries in equal proportions. Therefore, the domestic and foreign interest rates will equalize at a level which is lower than the original one.

\[ (2.2.2.14) \quad \frac{d\delta}{d\mu} = (f^2 - 1) / [(1+f)(2\lambda(1-f) + 2\sigma\phi)] < 0, \]
and \(0 < f < 1\).

A lower interest rate induces an increase in domestic investment and in this way influences the aggregate demand and finally impacts positively on domestic output.

\[ (2.2.2.15) \quad \frac{dy_1}{d\mu} = \sigma(1+f) / [(1+f)(2\lambda(1-f) + 2\sigma\phi)] > 0. \]

The increase in domestic output and lower interest rates impact positively on the foreign output, this spill-over effect will be larger, the larger is the income elasticity \((f)\) and interest rate elasticities of investment \((\sigma)\).

\[ (2.2.2.16) \quad \frac{dy_2}{d\mu} = \sigma(1+f) / [(1+f)(2\lambda(1-f) + 2\sigma\phi)] > 0. \]

---

\(^{38}\) For details on the offset coefficient see Giavazzi and Giovannini (1988).
Table 2.2
Two Country Mundell-Fleming Model

Effect of a Domestic Shock on Domestic and Foreign Variables

<table>
<thead>
<tr>
<th>Flexible exchange rate</th>
<th>Fixed exchange rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monetary Shock</td>
</tr>
<tr>
<td></td>
<td>Monetary Shock</td>
</tr>
<tr>
<td>p_1 - p_2</td>
<td>+</td>
</tr>
<tr>
<td>e</td>
<td>+</td>
</tr>
<tr>
<td>θ</td>
<td>0</td>
</tr>
<tr>
<td>y_1</td>
<td>0</td>
</tr>
<tr>
<td>y_2</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 2.2.2.2 shows the impact of an expansive monetary policy originated in country 1. Initially the interest rate decreases, once LM_1 in country 1 shifts to the right. The monetary expansion increases domestic output and will push both the current account and capital account into a deficit. In country 2, the increase in the exports will push IS_2 curve to the right, and output in country 2 will increase. The increase in the foreign output (y_2) will shift IS_1 to the right. Because the interest rate in country 2 is, in the short run, higher than in country 1, there will be a capital flow from country 1 to country 2 and the LM_2 curve shifts to the right. Capital movements will take place until both interest rates have equalized at a lower level than originally and both output levels will be higher. Table 2.2 summarizes the impact of both shocks on domestic and foreign variables in both exchange rate regimes.

2.2.3 Concluding Remarks

The main message of the two-country Mundell-Fleming model can be summarized as follows: spill-over effects of domestic policies on foreign countries and vice versa are unavoidable in both exchange rate regimes. Under a floating exchange rate regime, an expansionary fiscal policy will have a positive impact on foreign output while an expansionary monetary policy will have contractive effect on the output of the foreign country. On the contrary, under a fixed exchange rate system an expansive monetary policy has a positive impact on the output of the foreign country, while the impact of an expansionary fiscal policy will be positive or negative depending on the degree of income and interest rate elasticities.

Therefore, the conclusion of this first section is that not even the flexible exchange rate system insulates completely from foreign shocks: the high mobility of capital ensures that foreign monetary or fiscal policies are transmitted to the domestic economy.
through the impact on interest rates. However, while countries working under a floating exchange rate regime are able to follow independent monetary policies, under fixed exchange rates they lose this autonomy, with monetary policy becoming completely endogenous.
Figure 2.2.1.1.
Flexible Exchange Rate Fiscal Policy

Figure 2.2.1.2.
Flexible Exchange Rate Monetary Policy
Figure 2.2.2.1.
Fixed Exchange Rate Fiscal Policy

Figure 2.2.2.2.
Fixed Exchange Rate Monetary Policy
2.3 Dynamic Effects: the Dornbusch Model

The Dornbusch "overshooting" model constitutes an extension of the Mundell-Fleming model and was set out in the original and innovative article published by Dornbusch in 1976. Dornbusch extended the perfect capital mobility version of the Mundell-Fleming flexible exchange rate model by incorporating exchange rate expectations and analyzed the dynamic of price and exchange rates adjustment in the basic framework of open economies. The Dornbusch model focuses on the exchange rate implications of economic policies and in particular on the propensity of the exchange rate to over- or undershoot its equilibrium value. The crucial assumption of the model is the asymmetric adjustment speeds of goods and financial markets. Thus, asset markets react quickly as compared with goods markets. While price adjustment is assumed to be gradual, "sticky" in the terminology applied by Dornbusch (1976), exchange rates and interest rates can jump in anticipation of future developments. Actually, because prices cannot react immediately, the exchange rate overreacts by overshooting or undershooting its equilibrium level. In this section, I shall introduce a two-country version of the Dornbusch model that I will then use to compare the effect of monetary and fiscal shocks in the long-run and the short-run dynamics. As in the Mundell-Fleming model presented previously, I consider two countries home and foreign. The subindex 1 corresponds to the respective variables of the first country, and 2 to those of the second. Each country produces domestically one good. Output is at the full employment level. All the variables are expressed in logs, with the exception of the interest rate, and the structural parameters are assumed to be the same in both countries.

2.3.1 Flexible Exchange Rates

The Model

The Goods Market

The assumed adjustment pattern of prices is described by the equation (2.3.1.1) and (2.3.1.2) for the home and foreign country respectively.

\[ y' = \text{aggregate demand}, \quad q = \text{the full employment output level}, \quad \Delta p = \text{the change in price level}. \]

Prices will increase (decrease) whenever there is an excess of demand (supply). For both countries, the price reaction functions are expressed by (2.3.1.1) and (2.3.1.2) and represent the Phillips curve unadjusted for expectations.

---

40 The addition of price expectation would reproduce the augmented Phillips curve, which constitutes an extension of the Dornbusch model. For details see Buitier and Miller (1981), Bhandari and Turnovsky (1982), Mussa (1982). The augmented Phillips curve can be expressed as follows: \[ p = E_t \Delta p + \varphi(y-q). \] Expectation of future inflation can follow different
\[ \dot{p}_1 = \varphi(y_1 - q_1) \]
\[ \dot{p}_2 = \varphi(y_2 - q_2) \]

\( \varphi \) is the velocity of price adjustment. Thus price behavior encompasses two extreme cases: \( \varphi = 0 \) represents fixed prices as in the traditional Mundell-Fleming presented in the previous section; and on the other extreme \( \varphi = \infty \) represents the neo-classical case with perfect price flexibility, where \( y^d_1 = q_1 \) i.e. output cannot deviate from the equilibrium level. In the traditional Dornbusch model, \( 0 < \varphi < \infty \) because prices are assumed to be sticky and therefore adjust slowly to excess of demand or supply. In the original version of the Dornbusch model, it is assumed that the money growth rate is zero, and the steady state inflation is also zero. Therefore, no steady state inflation term is included in the Phillips curve.\(^{41}\)

Equations (2.3.1.4) and (2.3.1.5) represent the aggregate demand for home and foreign country
\[ y^d_1 = g_1 - \sigma r_1 + f y_2 + \delta(e - p_1 + p_2) \]
\[ y^d_2 = g_2 - \sigma r_2 + f y_1 - \delta(e - p_1 + p_2) \]

In both countries the aggregate demand depends positively on the real exchange rate, on the fiscal policy and on the foreign output and negatively on real interest rates.\(^{42}\) Output is demand-determined then:

\[ y^d_j = y_j \]

By replacing (2.3.1.4), (2.3.1.5) and (2.3.1.6) in (2.3.1.1) and (2.3.1.2) I obtain both goods market equilibrium conditions.
\[ \dot{p}_1 = \varphi[g_1 - \sigma(i_1 - \dot{p}_1) + f y_2 + \delta(e - p_1 + p_2) - q_1] \]
\[ \dot{p}_2 = \varphi[g_2 - \sigma(i_2 - \dot{p}_2) + f y_1 - \delta(e - p_1 + p_2) - q_2] \]

forms either adaptive or backward looking or rational. The former was proposed by Friedman \( p^* = p_{t-1} + \beta(p_{t-1} - p_{t-1}) \) the expected inflation for the following period is a weighted average between the inflation expected for the past period plus a percentage of the error incurred in the inflation forecast of the previous period. The introduction of rational expectation will transform the Phillips curve into its Lucas curve version, where output is always on its full employment level and will deviate of it only in the presence of unexpected stochastic shocks. \( E_{t-1}(p_{t-1}) = p_{t-1} + v_i \) where \( v_i \) is the error term which follows a random walk behavior with \( E_{t}(v_i) = 0 \) and \( E(v_i,v_i) = 0 \). In average the error term is always zero and is not autocorrelated with the past error terms. The Phillips curve "a la Lucas" would be as follows: \( y_t = a(p_t - E_{t-1} - p_{t-1}) + v_i \)

By assuming money growth rate different of 0, the expression adopts the following form \( \dot{p} - \pi = \alpha(y - q) \) and \( m = \pi \). Buiter and Miller (1981) analyze the effect of including a money growth term in the Phillips curve equation.

In the original version presented by Dornbusch (1976) both money and goods markets depend on nominal interest rate. Buiter and Miller (1981) show, however, that this limitation does not influence the prediction of the model since in the long run \( \dot{p} = 0 \).
By rearranging terms,

\[(2.3.1.9) \quad \dot{p}_1 = \varphi/(1-\varphi\sigma)[g_1 - \sigma i_1 + f y_2 + \delta(e-p_1+p_2) - q_1] \]

\[(2.3.1.10) \quad \dot{p}_2 = \varphi/(1-\varphi\sigma)[g_2 - \sigma i_2 + f y_1 - \delta(e-p_1+p_2) - q_2] \]

and \((1-\varphi\sigma)>0\) when \(\varphi<1/\sigma\), the price adjustment velocity must be smaller than the inverse of the investment interest rate elasticity.

### The Money Market

In equilibrium, the demand for money equals the supply for money. Money demand depends positively on output and negatively on the nominal interest rate. Real balances are explicitly deflated by the CPI\(^4\) (consumer price index) of each country.\(^{45}\) As before, CPI is calculated as a weighted average of domestic prices and import prices and therefore the exchange rate appears on both money functions.\(^{46}\) \(\beta\) weights the home prices and \((1-\beta)\) the foreign. This time, however, the assumption \(\beta=1\) is relaxed and thus \(0<\beta<1\).

All the variables are expressed in logs, \(\phi\) is the income money demand elasticity, \(\lambda\) the interest rate semielasticity of money demand for real balances.

\[(2.3.1.11) \quad m_1-p_{c1} = \phi y_1 - \lambda i_1 \]
\[(2.3.1.12) \quad m_2-p_{c2} = \phi y_2 - \lambda i_2 \]
\[(2.3.1.13) \quad p_{c1} = \beta p_1 + (1-\beta)p_2 + (1-\beta)e \]
\[(2.3.1.14) \quad p_{c2} = \beta p_2 + (1-\beta)p_1 + (1-\beta)e. \]

---

\(^{43}\) In order to reduce the complexity of the algebra the real interest rate is deflated by domestic prices instead by the consumption price index. As the domestic investment is mainly influenced by national component, in this case the omission of the consumer price index does not have a relevant impact on the final result.

\(^{44}\) In the model presented originally by Dornbusch (1976) \(\beta=1\) and thus money demand was only deflated by domestic prices. However, Dornbusch only analyzed the effect of a monetary shock. By deflating the real balances by the CPI is possible to obtain an effect of the fiscal policy different of zero. Alternatively, it is possible to introduce the output equilibrium level as depending on the real exchange rate and therefore the fiscal policy has also a positive effect. See Reither (1992).


\(^{46}\) See Argy and Salop (1979) and Branson and Buiter (1983).
and by replacing (2.3.1.13) and (2.2.1.14) in (2.3.1.11) and (2.3.1.12) respectively, I get:

\[
\begin{align*}
(2.3.1.15) & \quad m_1 - \beta p_1 \cdot (1-\beta) p_2 - (1-\beta) e = \phi y_1 - \lambda i_1 \\
(2.3.1.16) & \quad m_2 - \beta p_2 \cdot (1-\beta) p_1 - (1-\beta) e = \phi y_2 - \lambda i_2.
\end{align*}
\]

**Uncovered Interest Parity Condition**

(2.3.1.17) \( i_1 = i_2 + E_t(e_{t+1} - e_t) + \rho \).

Assuming perfect capital mobility, domestic interest rate is equal to the foreign interest rate corrected by the devaluation expectation plus the risk premium. I assume \( \rho = 0 \). The model is robust to this assumption.

(2.3.1.18) \( E_t(e_{t+1} - e_t) = \dot{e} \).

From (2.3.1.17) and (2.3.1.18)

\[ (2.3.1.19) \quad \dot{e} = i_1 - i_2, \]

Economic agents form their exchange rate expectations rationally. Since the model does not involve uncertainty in any form, then rational expectations are equivalent to perfect foresight. In this sense, the anticipated capital gain term is set equal to the actual appreciation of the foreign currency.

**Monetary and Fiscal Shocks**

**The Long Run Comparative Statics**

Equations (2.3.1.9), (2.3.1.10), (2.3.1.15) and (2.3.1.16) form a system that can be reduced to a 2 equations system by subtracting the variables of country 2 from those of country 1. Then all variables can be interpreted as relative values of country 1 respect to country 2.

---

47 Notice that in this case money demand is depending on aggregate demand \( y_i \). In the original version of Dornbusch (1976) money demand was depending on potential output and therefore, the LM curve was an horizontal line. In this case the LM curve has the typical positive slope.

48 See Branson (1988).

49 In this case domestic and foreign bonds are perfect substitute.

50 In the original version of the Dornbusch model risk premium was not considered. Branson (1988) analyzes the effect of changes in the risk premium in a Dornbusch framework.

51 The model does not include an error term.

52 See Jordi and Clarida (1992), Aoki (1981).
The goods market equilibrium condition (2.3.1.20) is obtained by subtracting equation (2.3.1.10) from (2.3.1.9).

(2.3.1.20) \[ \dot{p}_1 - \dot{p}_2 = \varphi/(1-\varphi\sigma)(g_1-g_2-\sigma(i_1-i_2)+f(y_2-y_1)+2\delta e - 2\delta(p_1-p_2) - (q_1-q_2)]. \]

The money market equilibrium condition is obtained by subtracting (2.3.1.16) from (2.3.1.15) and replacing by (2.3.1.19)

(2.3.1.21) \[ m_1 - m_2 = -(1-2\beta)(p_1-p_2)+2(1-\beta)e+\psi(y_1-y_2)-\lambda(e). \]

Equation (2.3.1.20) and (2.3.1.21) form a system that permits the comparative statics and the dynamic of the exchange rate \( e \) and the relative prices \( p_1-p_2 \) to be analyzed. However, in the long run equilibrium: \( \dot{p}_1 - \dot{p}_2 = 0 \) and \( \dot{e} = 0 \). By differentiating the whole system it is possible to obtain the following expression for the long run:

\[
\begin{bmatrix}
2\delta & -2\delta \\
-(1-2\beta) & 2(1-\beta)
\end{bmatrix}
\begin{bmatrix}
d\ddot{e} \\
d\ddot{p}_1 - \ddot{p}_2
\end{bmatrix}
= \begin{bmatrix}
-1 & 0 \\
0 & 1
\end{bmatrix}
\begin{bmatrix}
d(g_1-g_2) \\
d(m_1-m_2)
\end{bmatrix}.
\]

The determinant of the matrix is \( 2\delta > 0 \).

**Monetary Shock**

An increase in the relative money supply raises the relative price \( p_1-p_2 \) and the exchange rate, \( e \) proportionally to the increase in the money supply. Hence money is neutral and therefore the corresponding multipliers are equal 1 as the expressions (2.3.1.22) and (2.3.1.23) show.

(2.3.1.22) \[ \frac{d(m_1-m_2)}{d(p_1-p_2)} = 1^{53} \]

(2.3.1.23) \[ \frac{d(m_1-m_2)}{de} = 1. \]

---

53The increase in the relative money supply is due to a domestic monetary expansion and/or foreign monetary contraction or a combination of both as long as they are not totally compensated with each other.
Fiscal Shock

An increase in the relative fiscal policy\(^{54}\) increases the relative price and appreciates the exchange rate.

\[ \frac{d(g_1-g_2)}{d(p_1-p_2)} = 2(1-\beta) > 0, \]
\[ \frac{d(g_1-g_2)}{de} = 1-2\beta < 0. \]

Dynamic Analysis

In order to analyze the dynamic behavior, equation (2.3.1.21) is solved with respect to the nominal exchange rate. Equation (2.3.1.20) and (2.3.1.26) form a dynamic two-equation system. Both equations represent the nominal and the real exchange rate.

\[ \dot{p}_1-\dot{p}_2 = \varphi(1-\Phi\sigma)[(g_1-g_2) + \sigma(\dot{e}) + f(y_2-y_1) + 2\delta e - 2\delta(p_1-p_2)-(q_1-q_2)] \]

\[ \dot{e} = 1/\lambda[-1(1-2\beta)(p_1-p_2) + 2(1-\beta)e + \phi(y_1-y_2)-(m_1-m_2)] \]

Setting \( \dot{e} = 0 \) and \( \dot{p}_1-\dot{p}_2 = 0 \) the following system is obtained for the long run:

\[ \frac{p_1-p_2}{e} = 1/2\delta [(2\delta e + (g_1-g_2) + f(y_2-y_1) - (q_1-q_2)] \]
\[ e = \lambda/2(1-\beta)[(1-2\beta)(p_1-p_2) + \phi(y_1-y_2) + (m_1-m_2)] \]

Figure (2.3.1.1) depicts the money equilibrium condition in the space \( p_1-p_2, e \). Setting \( \dot{e} = 0 \) on (2.3.1.26) yields a negative sloped curve that represents the locus of points along which the money market is in equilibrium with zero expected change in the exchange rate. An increase in the exchange rate requires a reduction in the domestic price relative to the foreign so that neither consumer prices change nor any disturbance is introduced into the monetary market.

A higher home price level will imply a lower level of real balances and a higher interest rate \( i_1 < i_2 \). If \( i_1 < i_2 \), then from the uncovered interest parity condition \( \dot{e} \) must be positive. Under rational expectations a point above (below) the curve implies that the nominal exchange rate is rising (decreasing) as the arrows show.

Figure 2.3.1.2, depicts the good market equilibrium condition, which is an upwardly sloping curve. A point below the curve represents a situation in which the relative price of the home goods is too low to be consistent with the equilibrium. There is then an excess of demand for the home goods and excess supply of foreign goods, and then \( p_1-p_2 \) should rise in order to re-establish the equilibrium.

In figure 2.3.1.3, the dynamics of both markets is depicted showing a divergent path and a downwardly sloped convergent path. The latter is called the "saddle path", so termed because it always leads to the equilibrium and expectations are realized. All

\(^{54}\)The expansionary relative fiscal policy implies an expansion of the domestic fiscal policy or a contraction of the foreign fiscal policy or a combination of both.
other paths are unstable and constitute speculative bubbles. Along them, the expectations can be realized from one period to the next but they do not lead to the equilibrium.\textsuperscript{55} If for any reason the economy is pushed away from the equilibrium, it is assumed that rational actors will always find the stable saddle path that converges to the new equilibrium. This is the common assumption under rational expectations.\textsuperscript{56}

**Monetary Shock**

An unanticipated monetary expansion abroad and or a monetary contraction at home is depicted in figure 2.3.1.4. The economy is at the starting point on A. A reduction of \((m_1-m^2)\) will shift both the \(\hat{e}\) curve and the saddle path towards the origin. The new saddle path leads to a new equilibrium at C. Following the monetary impact, the exchange rate jumps from the old saddle path to the new one at B, because prices have not yet reacted. In anticipation of the future fall in the relative price level, the currency immediately appreciates. The relative price level \((p_1-p_2)\) and the exchange rate will gradually move along the new path SS' in the direction of C; prices will change until the new equilibrium level is reached at C. Initially, the interest rate rises at home relative to abroad, consistent with the expectation that the exchange rate will raise. The interest rate at home will once again equal the foreign interest rate once price level at home has increased relative to the foreign. Immediately after the monetary shock, the exchange rate overshoots its new equilibrium level. The initial jump downwards of the exchange rate is consistent with the expectation that it will rise again. The interest rate at home rises less relative to that abroad, consistent with the expectation that the exchange rate will appreciate after the overshooting impact. Figure 2.3.1.5 depicts the time paths of the relative variables, prices, nominal interest rate, exchange rate and money supply.

**Fiscal shock**

The figure 2.3.1.6 shows the result of an expansionary policy abroad. Initially, the economy is at the point A. The shock shifts the goods market equilibrium condition to the right. The exchange rate will jump to the new saddle path SS at B and it will move along SS until reaching the equilibrium at C. Initially, the exchange rate will depreciate but by less than required at the final equilibrium. Once the relative price level begins to adjust, the exchange rate will continue depreciating until it has reached the equilibrium point C. In this case, the exchange rate undershoots the equilibrium level in response to a real disturbance. Fig 2.3.1.7 depicts the time paths of the relative variables prices, nominal interest rates, exchange rate and fiscal policy.

Summarizing, in the two-country Dornbusch model under flexible exchange rates, a foreign monetary and/or fiscal shock has an impact on the domestic variables through changes in the exchange rate. The exchange rate jumps after the impact effects but continues adjusting until reaching the new equilibrium level. However, while an unanticipated expansionary monetary policy abroad induces an overshooting effect, an


\textsuperscript{56} See Begg (1987).
expansionary fiscal policy abroad creates an undershooting effect. The most important conclusion to be drawn from the two-country Dornbusch model is that, under a flexible exchange rate system, the nominal exchange rate will react with high volatility in response to both monetary and real shocks.

2.3.2 Fixed Exchange Rates

Although the Dornbusch model was originally constructed to explain the variability of flexible exchange rates, the framework of the model can be applied to the case in which both countries are linked by a fixed exchange rate.

The Model

The Goods Market

The price adjustment mechanism remains the same as in the case of flexible exchange rates and is described by equations (2.3.2.1) and (2.3.2.2) for the home and foreign country respectively.

(2.3.2.1) \[ p_1 = \phi(y_1 - q_1) \]
(2.3.2.2) \[ p_2 = \phi(y_2 - q_2) \]

The aggregate demands for the home and foreign countries depend positively on the fiscal parameter \( g \), negatively on real interest rates and positively on the real exchange rate. However, the exchange rate is now fixed \( \varepsilon \).

(2.3.2.3) \[ y_1' = g_1 - \sigma r_1 + f y_2 + \delta (\varepsilon - p_1 + p_2) \]
(2.3.2.4) \[ y_2' = g_2 - \sigma r_2 + f y_1 - \delta (\varepsilon - p_1 + p_2) \]

The Money Market

In equilibrium, money demand is equal money supply in both countries. Real balances are considered as deflated by the consumer price indexes, \( P_{c1} \) and \( P_{c2} \) which are the average of domestic and foreign prices. Money demand depends negatively on the nominal interest rate and positively on the level of aggregate demand.

(2.3.2.5) \[ M_1 = P_{c1} L(i_1, Y_1) \]
(2.3.2.6) \[ M_2 = P_{c2} L(i_2, Y_2) \]

Consumer price indexes are as follows:

(2.3.2.7) \[ p_{c1} = \beta p_1 + (1-\beta)p_2 + (1-\beta)\varepsilon \]
(2.3.2.8) \[ p_{c2} = \beta p_2 + (1-\beta)p_1 + (1-\beta)\varepsilon \]
Under the assumption that the exchange rate is fixed both money markets are linked and money supply is endogenous.  

\[(2.3.2.9)\] \[M_1 = D_1 + R_1 = P_{e1} L_1(Y_1, i_1)\]
\[(2.3.2.10)\] \[M_2 = D_2 + R_1 = P_{e2} L_2(Y_2, i_2)\]

The money supply of the home country is made up of the domestic component \((D_1)\) and the foreign reserves \((R_1)\). In the same way, the money supply of the foreign country is made up of the domestic component \((D_2)\) and the foreign reserves \((R_2)\). The foreign reserves of both countries are assumed to be held constant, therefore:

\[(2.3.2.11)\] \[R = R_1 + R_2 = \text{constant}.\]

The common equilibrium in the money market is:

\[(2.3.2.12)\] \[M_u = M_1 + M_2 = D_1 + D_2 + R = P_{e1} L_1(Y_1, i_1) + P_{e2} L(Y_2, i_2)\]

and

\[(2.3.2.13)\] \[D_1 + D_2 + R = M_u(D_1, D_2, R).\]

\(M_u\) represents the common monetary supply and depends on both domestic components \(D_1\) and \(D_2\) and on the foreign reserves.

By rearranging terms,

\[(2.3.2.14)\] \[M_u(D_1, D_2, R) = P_{e1} L_1(Y_1, i_1) + P_{e2} L(Y_2, i_2).\]

Under a fixed exchange rate, as was shown in the Mundell-Fleming model, money supply is completely endogenous.  

It is assumed that an expansionary monetary policy will take place whenever the home country (country 1) increases its domestic component of its monetary base \((D_1)\) through an open market operation. The foreign country will never induce, independently, a change in its domestic component \((D_2)\), but changes in its monetary base will occur whenever the foreign country has to defend the fixed parity.

By expressing the common money market in logs, the following expression is obtained, representing the common monetary equilibrium equation.

\[(2.3.2.15)\] \[m_u - p_{e1} - p_{e2} = y_1 + y_2 - 2\lambda i\]


\[58\] Compare with section 2.2

\[59\] Buiter (1985).

\[60\] The aggregation with logarithmized values present some problems because the underlying relationship is additive in nature. Since both countries are symmetric the above specification can be used as a reasonable good approximation. See Buiter (1986) for details on aggregation of logarithmized money supplies.
and by replacing \( p_{c1} \) and \( p_{c2} \) by the respective expressions (2.3.2.7) and (2.3.2.8) then, I get:

\[
(2.3.2.16) \quad m_o - p_{t1} - p_{t2} - 2 \hat{c} (1-\beta) = y_1 + y_2 - 2\lambda i.
\]

**Fisher Condition**

\[
(2.3.2.17) \quad i_1 = r_1 + \hat{p}_1
\]

\[
(2.3.2.18) \quad i_2 = r_2 + \hat{p}_2.
\]

For each country, the nominal interest rate is equal to the real interest rate plus the expected rate of inflation. Expectation as to inflation are formed rationally.

\[
(2.3.2.19) \quad \hat{p}_j = \hat{p}_j^e.
\]

**Uncovered Interest Parity**

\[
(2.3.2.20) \quad i_1 = i_2 + \hat{e}.
\]

As before, there is perfect capital mobility and thus the domestic interest rate is equal to the foreign interest rate plus the expected change in the exchange rate. But because of the fixed exchange rate assumption \( \hat{e} = 0 \), thus interest rates must equalize between both countries\(^{61}\).

\[
(2.3.2.21) \quad i_1 = i_2.
\]

The change in the real exchange rate, however, can be expressed as the difference of both real interest rates:

\[
(2.3.2.22) \quad \hat{\theta} = r_1 - r_2.
\]

Replacing by (2.3.2.17) and (2.3.2.18)

\[
(2.3.2.23) \quad \hat{\theta} = i_1 - \hat{p}_1 - (i_2 - \hat{p}_2).
\]

But because \( i_1 = i_2 \) then,

\[
(2.3.2.24) \quad \hat{\theta} = \hat{p}_2 - \hat{p}_1.
\]

\(^{61}\) See footnote 42 of this chapter.

\(^{62}\) In this analysis I assume that the exchange rate is fixed at a credible value. The introduction of other assumption leads to the analysis of currency crisis and peso problem. See DeGrauwe (1992).
The real exchange rate can only depreciate/appreciate if the change in prices is not exactly the same in both countries. Because of the symmetry assumption, the velocity of price adjustment is identical in both countries.

**Solving the Model**

By replacing both aggregate demands on the price reaction functions, the following expressions are obtained:

\[
\begin{align*}
\dot{p}_1 &= \varphi [g_1 - \sigma (i_t \dot{p}_t) + f y_2 + \delta (\bar{e} - p_1 + p_2) - q_1] \\
\dot{p}_2 &= \varphi [g_2 - \sigma (i_t \dot{p}_t) + f y_1 - \delta (\bar{e} - p_1 + p_2) - q_2].
\end{align*}
\]

Therefore,

\[
\begin{align*}
\dot{p}_1 &= \varphi/(1-\sigma \varphi) [g_1 - \sigma i + f y_2 + \delta (\bar{e} - p_1 + p_2) - q_1] \\
\dot{p}_2 &= \varphi/(1-\sigma \varphi) [g_2 - \sigma i + f y_1 - \delta (\bar{e} - p_1 + p_2) - q_2].
\end{align*}
\]

and as before \((1-\sigma \varphi)>0\) 63.

**Comparative Statics**

**The Long Run Effect**

In this section, the effect of monetary and fiscal shocks will be analyzed once all the variables have reached their equilibrium level. In the long run, prices \(\dot{p}_1=0\) and \(\dot{p}_2=0\) because all the necessary adjustments have already taken place and outputs of both countries have reached their potential level, \(y_1=q_1\) and \(y_2=q_2\) 64.

**Monetary Shock**

I analyze the case in which country 1 initiates an expansive monetary policy. The effects on both prices and interest rates are as follows: an increase in the monetary base of country 1 induces an increase in both domestic and foreign in the same magnitude \(1/2\) (see 2.3.2.29 and 2.3.2.30). A symmetric effect is obtained because both countries have the same parameters and have the same size. The final effect on the interest rate is zero.

---

63 See flexible exchange rate case of Dornbusch model.
64 See Jarchow (1994).
There is no effect on the real exchange rate, because price levels in both countries increase by exactly the same amount. A real appreciation can only take place if prices in country 1 rise more than prices in country 2. However, the symmetry assumption eliminates the possibility of real appreciation in the short run as well as in the long run because, by assumption, prices will increase not only exactly by the same amount but also with the same speed of adjustment.

Actually, if the countries had a different economic structure, in the sense that the flexibility of labor markets differed between them, it would be possible to obtain temporarily an appreciation of the real exchange rate in response to the monetary shock.

As the expression (2.3.2.33) shows, there is no effect on the real exchange in the long run.

\[
(2.3.2.33) \quad \dot{\theta} = \dot{p}_1 - \dot{p}_2 = 1/2 - 1/2 = 0
\]

If price flexibility were higher in country 2 than in country 1, in the short run country 1 would enjoy a real depreciation of its domestic currency. On the contrary, if the stickiness of prices in country 2 were higher than in country 1, then country 1 would observe a real appreciation of its domestic currency. In contrast with the case of flexible exchange rate, in this case neither overshooting nor undershooting of the real exchange rate is observed. The fixed exchange rate has simply reduced exchange rate variability, however inflation is transmitted from one country to another.

**Distribution of Money Supply across the Countries**

An expansionary monetary policy of country 1 leads to a new distribution of the monetary base and reserves across the two countries. The reserves of country 1 fall and the reserves of the country 2 rise.

\[
(2.3.2.34) \quad dM_1 = dD_1 + dR_1 = (1/2)dD_1,
\]

\[
(2.3.2.35) \quad dM_2 = dD_2 + dR_2 = (1/2)dD_1.
\]

---

66 Notice that the speed of price adjustment depend on the flexibility of labor markets. Prices are sticky because wages are not perfectly flexible. See Taylor (1979).
67 The effect is identical to the one obtained in the Mundell Fleming model under fixed exchange rate. See section 2.2.
The money supply in both countries increases by the same amount as the domestic component of the first country.

\[ (2.3.2.36) \quad dM_u = dD_1. \]

Both individual money supplies increase by one-half of the increase in the domestic component of country I. This means that the reserves of country I will decrease by an amount \((1/2)dD_1\) and the reserves of the second country will increase by \((1/2)dD_1\).

**Short Run Adjustment**

The mechanism of transmission works as follows: the central bank of country I introduces an open market operation by increasing the domestic component of its monetary base. First, there is a tendency for the domestic interest rate to fall, which therefore induces capital outflows and an exchange rate depreciation. Because the exchange rate is fixed, both central banks will intervene in the market to defend the fixed parity. The central bank of country I will sell foreign reserves and the central bank of country 2 will buy foreign reserves. Through this operation, the interest rate is maintained equal in both countries and the monetary expansion is distributed across them. Second, the smaller interest rate leads to a rise in investment, thus pushing output in both countries \((y_1 \text{ and } y_2)\) above their respective natural levels \(q_1\) and \(q_2\). This situation is facilitated because prices are sticky and do not react instantaneously, otherwise there would be no effect on output. The expansion in domestic output increases the imports of both countries, but, because the two countries are symmetric, exports increase by the same amount as imports. Third, the excess demand will cause prices to rise in both countries. That will reduce real balances and the interest rate will return to its initial level. Output in both countries will decline and finally will come back to the initial equilibrium level \(y_1 = q_1\) and \(y_2 = q_2\).

Once all adjustments have taken place, prices in both countries will be higher and the interest rate will return to its initial level.

Summarizing: a monetary shock will induce a price rise in both countries. However, so long as the two countries are symmetric and therefore have the same speed of price adjustment, there is no effect on either the real exchange rate nor on real and nominal interest rates. In the case of a monetary shock, neither overshooting nor undershooting of the real exchange rate is observed. In this sense, under a fixed exchange rate, although the inflationary impact is transmitted from country I to country 2, the fixed exchange rate system eliminates the variability not only of the nominal exchange rate but also of the real exchange rate.

---

68 The short run effect is similar to the one obtained under a Mundell-Fleming model.

69 This conclusion is quite strong because implies that fixed exchange rate would reduce not only nominal variability but also real. Rose (1996) tests empirically the hypothesis whether fixed exchange rate reduce nominal variability by increasing variability in real markets. He concludes that fixed exchange rate reduces variability and they do not shift variability over time.
Fiscal Policy

An expansionary fiscal policy originated in country 1 $d_{g1}$ has the following effects on prices and interest rates. In the appendix 3, detailed explanation with respect to the algebra is provided.

\begin{align*}
(2.3.2.37) \quad & \frac{d p_1}{d g_1} = \frac{2(\lambda - \sigma)}{4\sigma} > 0 \\
(2.3.2.38) \quad & \frac{d p_2}{d g_1} = -\frac{2(\lambda + \sigma)}{4\sigma} < 0 \\
(2.3.2.39) \quad & \frac{d i}{d g_1} = \frac{1}{2\sigma} > 0.
\end{align*}

Price change in each country. However, while they rise in country 1, they fall in country 2, as expression (2.3.2.37) and (2.3.2.38) show, but the change, although in opposite direction, is exactly the same.

\begin{align*}
(2.3.2.40) \quad & \frac{d p_1}{d g_1} = - \frac{d p_2}{d g_2}.
\end{align*}

The effect on real exchange rate is positive: prices rise in the first country and fall in the second, and thus there is a real appreciation of the exchange rate for country 1. See expression (2.3.3.41).

\begin{align*}
(2.3.2.41) \quad d \theta = d p_2 - d p_1 = -\frac{2(\lambda + \sigma)}{4\sigma} - \frac{2(\lambda - \sigma)}{4\sigma} = \frac{2(\lambda + \sigma)}{2\sigma} < 0.
\end{align*}

Short Run Adjustment

An expansionary fiscal policy $d_{g1}$ implies an expansion in the aggregate demand of country 1 $y_1^d$. On the one hand, initially prices do not react and there is an increase in output $y_1$. In country 1 the demand for money increases and there is a rise in the interest rate. Because there is a tendency to an exchange rate appreciation, the central bank of country 1 buys reserves and therefore there is an expansion in the monetary base of country 1. In the short run, aggregate demand $y_1^d$ will be higher than $q_1$, and prices will react after a while. The increase in prices reduces the real balances, and the interest rate increases again, reducing the aggregate demand. Finally, output returns to its equilibrium level, prices have increased and interest rate is higher.

On the other hand, the effect in country 2 is as follows: there is a tendency to an exchange rate depreciation, thus central bank of country 2 intervenes in the exchange rate markets by selling foreign reserves, therefore the monetary basis of country 2 declines, and the interest rate of country 2 is equal to that in country 1. Aggregate demand in country 2, $y_2^d$ is lower than the output equilibrium level and therefore, prices will fall and aggregate demand will eventually become equal to the output equilibrium level. At the final equilibrium level, prices will be higher in country 1 and lower in country 2 than initially and the interest rate will be higher.

Summarizing, a fiscal shock originated in the first country induces a price increase in the first country and a price reduction in the second. In contrast to the case of a monetary shock, the final effect on the real exchange rate is a domestic appreciation. Because the behavior of the real exchange rate depends exclusively on both price adjustments and they are sticky by assumption, the adjustment of the real exchange
rate is smooth and thus neither overshooting nor undershooting is observed and the
dynamic of the exchange rate is absent. Table 2.3 summarizes the long-run effect of a
monetary and a fiscal policy under a flexible and a fixed exchange rate system in a
Dornbusch two-country model.

**Table 2.3**
Two Country Dornbusch Model
Long Run Effect of a Monetary and Fiscal Policy

<table>
<thead>
<tr>
<th>Flexible exchange rate</th>
<th>Fixed exchange rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monetary Shock</strong></td>
<td><strong>Fiscal Shock</strong></td>
</tr>
<tr>
<td>$p_1-p_2$</td>
<td>$0$</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>$0$</td>
</tr>
<tr>
<td>$\theta$</td>
<td>$0$</td>
</tr>
<tr>
<td>$y_1$</td>
<td>$0$</td>
</tr>
<tr>
<td>$y_2$</td>
<td>$0$</td>
</tr>
</tbody>
</table>

### 2.3.3 Concluding Remarks

The following conclusions are drawn from the Dornbusch two-country model
previously presented. First, in the short run, while prices have not reacted, $dp_1=dp_2=0$,
the model delivers the same results as the Mundell-Fleming model presented in the
previous section. This is reasonable, given that in the short run, the Dornbusch model
has the same structure as a Mundell-Fleming model because of the price stickiness.
Therefore, the effects of monetary and fiscal policy on outputs $y_1$ and $y_2$ and the
interest rate are exactly the same as those obtained in the first section. However, in the
long run, no effect is observed on the output level. Second, in the case of a flexible
exchange rate system, the effect of a nominal shock induces an overshooting effect in
the nominal and real exchange rates. On the contrary, the real shock induces an
undershooting effect on nominal and real exchange rates. However, in the case of a
fixed exchange rate system, a nominal shock has no effect on the real exchange rate.
However, price increases are transmitted from one country to another. A fiscal shock
induces an appreciation of the real exchange rate. This is the result of a price increase
in the country that induced the expansionary fiscal policy and a price decrease in the
other one. However, in contrast to the results obtained in the case of a flexible
exchange rate, the real exchange rate adjusts smoothly and neither overshooting nor
undershooting is observed. Third, the fixed exchange rate has reduced variability not
only in the nominal exchange rate, which is by assumption fixed, but also in the real
exchange rate.
Figure 2.3.1.1  Money Market Equilibrium Condition

Figure 2.3.1.2  Goods Market Equilibrium Condition
Figure 2.3.1.3 Saddle Path

Figure 2.3.1.4 Monetary Policy
Figure 2.3.1.5 Time Path of the Variables
Monetary Policy
Figure 2.3.1.6
Fiscal Policy

The diagram illustrates the relationship between the price levels $p_1$ and $p_2$, and the exchange rate $e$. The lines $S$ and $S'$ represent different supply conditions, with $S'$ indicating a shift in supply. The arrows $\hat{p}_1 - \hat{p}_2 = 0$ and $\hat{e} = 0$ indicate equilibrium conditions in the market. Points A, B, and C are critical points on the graph, indicating different states or equilibria in the fiscal policy context.
Figure 2.3.1.7 Time Path of the Variables Fiscal Policy
2.4 The N-1 Problem in a Fixed Exchange Rate System

In the models presented in section 2.2 (Mundell-Fleming) and 2.3 (Dornbusch model), in the case of fixed exchange rates, countries have a coordination problem to solve. Actually, every fixed exchange rate system faces the difficulty of how to set the system-wide level of the money stock or the interest rate. This issue is described in the literature as the N-1 problem. In a system of N countries, there are only N-1 exchange rates and therefore only N-1 monetary authorities that are free to set their monetary policy independently. Thus, the system has one degree of freedom. The problem that arises is how to assign this degree of freedom, or in other words, which central bank will have the assignment of using this degree of freedom. From the theoretical point of view, there are two alternatives: an hegemonic solution, where only one central bank determines monetary policy for the system as a whole, or a cooperative solution.

In this section, these two possible solutions are analyzed by means of a very simplified two-country money market model. The money markets in both countries are as follows:

Money demand

\[
\begin{align*}
M_1^{d}/P_{c1} &= L_1(Y_1,i_1) \\
M_2^{d}/P_{c2} &= L_2(Y_2,i_2).
\end{align*}
\]

Money supply

\[
\begin{align*}
M_1 &= R_1 + D_1 \\
M_2 &= R_2 + D_2.
\end{align*}
\]

The money demand is defined in the usual way as depending upon domestic output and interest rates. A rise in interest rates reduces the demand for money and an increase in output increases it.

The money supply consists of two components: the domestic components \( D_1, D_2 \) (credit to the government sector) and \( R_1, R_2 \) the foreign reserve component.

The total amount of reserves is fixed. Perfect capital mobility is assumed and therefore the uncovered interest parity condition holds.

\[
i_1 = i_2 + \dot{e} .
\]

---

71 Money supplies are deflated by the CPI, however in this case it does not play a relevant role.
73 See previous sections.
74 The interest rate of country 1 will exceed the interest rate of country 2 in order to compensate holders of assets of country 1 for the expected loss.
and is the expected rate of depreciation because the exchange rate is assumed to be fixed. Then \( i = 0 \), and therefore interest rates in the two countries are brought into equality.

\[(2.4.7) \quad i_1 = i_2.\]

Figure 2.4.1 depicts the system graphically. Money supply and demand are represented with the money demand curve downward sloping and the money supply as a vertical line. The money market is in equilibrium when the both curves intersect in both countries, and the interest parity condition is satisfied (when interest rates are equal between countries).

At points such as A and B, money demand equals money supply in both countries and the interest rates are equalized. However, there are infinitely many combinations of points for which this condition is satisfied. For each of these infinite combinations there is only one level of money stock and one level of interest rate. Therefore, a fixed exchange rate is compatible with any possible level of the interest rate and the corresponding money stock. The system is not determined, and this is exactly the N-1 problem, which produces one degree of freedom in the system.

There are two possible solutions to this problem: a symmetric (cooperative) or an asymmetric (hegemonic) one.\(^{75}\)

### 2.4.1 The Asymmetric or Hegemonic Solution

The hegemonic solution consists in allowing one country (the reserve currency country) to take the leadership role.\(^{76}\) If, for example, country 1 is the hegemonic country and fixes its monetary stock independently at the level \( M_1 \), then the interest rate will be \( i_1 \). Country 2 has no choice but to take the interest rate as a parameter. \( i_2 \) will be identical to \( i_1 \) and therefore the money supply of country 2, \( M_2 \), is uniquely determined. Country 2 has to accept the monetary supply imposed by country 1 and in this sense has no autonomy to determine its own monetary policy. Country 1 is the leader and country 2 is the follower.

This is the case of a hegemonic arrangement\(^{77}\) and country 1 has the role of anchoring the money stock in the system. Hence the degree of freedom that the system allows is used by country 1 to set its monetary policy totally independently of country 2.

---

\(^{75}\) Another way of solving the N-1 problem is through an external reserve such as gold. In the gold standard system, the amount of total reserves was given externally and none of the participating members was able to increase this amount. See Neumann (1988) for further details.

\(^{76}\) In the real world the market decided which is the stronger currency.

\(^{77}\) The Bretton Woods was an hegemonic system in which the US dollar was the reserve currency.
2.4.2 Symmetric or Cooperative Solution

Intervention Rules

The second possibility of solving this N-1 problem consists in both countries taking a joint decision as to the levels of their money stocks and interest rates. This decision is no longer independent as it was in the hegemonic case, but relies on the cooperation of both countries. In this sense, both countries could decide jointly the level of $M_1$ and $M_2$ or the level of the common interest rate. In Figure 2.4.2 the cooperative solution is proposed with intervention rules. Assume that a change in preferences has taken place in country 2 and that then the interest rate in country 1 is higher than in country 2.\(^8\)\(^9\) This differential between the two interest rates is the expected rate of devaluation/appreciation. Thus, if the domestic interest rate in country 2 is higher than in country 1, people expect the currency in country 2 to devalue. In the foreign exchange rate market, the expectation of a future devaluation of currency 2 leads speculators to sell currency 2 and buy currency 1. In order to prevent the market rate of currency 2 from dropping below the agreed fixed exchange rate, the central bank of country 2 must buy its own currency and sell currency 1. This situation is only possible through the short term financing that forces country 1 to provide the necessary amounts of its currency to country 2.\(^8\)\(^1\) This intervention has symmetric effects on the money stocks in the two countries. The money stock of country 2 will decline and that of country 1 will increase. The latter arises from the fact that the sale of currency 1 by country 2 increases the amount of currency 1 in circulation. In Figure 2.4.2, the money stock of country 2 should move leftwards and that of country 1 should move rightwards. As a result, the interest rate in country 2 would increase and would decline in country 1. However, suppose that country 1 sterilizes, offsetting the effect of the intervention and not allowing the interest rate to decline, by maintaining constant the money stock. When the central bank of country 2 sells currency of country 1, and the central bank of country 1 buys back this currency by an open market operation, the final effect of the sterilization policy is that the weak currency is forced to undertake


\(^{79}\)The original EMS proposal was aimed at promoting the cooperative solution, with the ECU acting as the indicator of divergence that would operate as an instrument to promote symmetry in the system. When a market exchange rate of a currency strongly deviated from its central rate, it would show in the indicator of divergence. The country involved would then be singled out to take necessary action. This implied that a country with a strong currency would be required to expand its monetary policy and the country with the weak currency would contract its monetary supply. The second way to allow the symmetric solution was provided by the system of interventions in the foreign exchange rate market. The rule is as follows: when two currencies hit their upper limits, the intervention would be in each others' currency so that the monetary effect in the two countries would be symmetrical. For details see Giavazzi and Giovannini (1992) and Gros and Thygesen (1992).

\(^{80}\)For reasons of simplicity, I have not drawn the movements in the money demand curve.

\(^{81}\)It is clear that country 2 has a limited amount of currency 1; and, therefore, the intervention is limited if it is not being supported by country 1.
all the adjustment. The money stock of country 2 is forced to contract and the interest rate is allowed to increase to a much higher level. The money stock of country 1 remains unchanged and the adjustment follows an asymmetric pattern. See Fig. 2.4.3.

2.4.3 Concluding Remarks

This section 2.4 has had the objective of illustrating the possibilities and problems that a fixed exchange rate system introduces with respect to the coordination of monetary policy.

In a fixed exchange rate system money, the money supply is completely endogenous and both money markets are closely linked. Because of perfect capital mobility, interest rates must equalize across countries and there is an infinite number of combinations of money stocks that are compatible with an identical interest rate. This is precisely the so-called N-1 problem. Because of the peculiarity of the system itself, a fixed exchange rate system has a degree of freedom. The problem that arises is how to assign this degree of freedom, in other words, which country will enjoy this degree of freedom by independently determining monetary policy. From the theoretical point of view, there are two possible ways of solving this problem, the hegemonic or asymmetric and the cooperative or symmetric solution. In the first, one country, the hegemon, assigns the monetary policy and the other has to follow. In the second, the symmetric solution consists in both countries coordinating their monetary policies and agreeing on the total stock of money. The symmetric solution can only work in the presence of intervention rules: thus the central bank of the strong currency must support the other central bank.

The hegemon has historically been dominant in all exchange rate systems (Bretton Woods, the gold standard). The EMS was initially designed as a symmetric system, but has ultimately operated as an asymmetric or hegemonic system with the DM as the hegemonic currency.
Figure 2.4.1
Money Market Equilibrium in a Two Country Model

Figure 2.4.2
Symmetric Solution
Figure 2.4.3
Aymmetric Solution

![Diagram showing asymmetric solution with two graphs, one for \( M_1 \) and another for \( M_2 \). Each graph has a line indicating the solution, with points labeled A and B.]
2.5 Time Inconsistency and the Credibility Problem

2.5.1 Introduction

In previous sections, it was shown that although there are spill-over effects in both fixed and flexible exchange rates, under flexible exchange rates the governments have full discretion on their own monetary policies. On the contrary, when exchange rates are fixed and there is perfect capital mobility, national governments lose all control over monetary policy, which becomes fully endogenous so that discretion is completely eliminated. Additionally in the previous analysis concerning the Dornbusch model, it was demonstrated that a flexible exchange rate induces higher variability not only in the nominal exchange rate but also in the real exchange rate. This is because, during their dynamic adjustment, exchange rates overshoot or undershoot their new equilibrium level. Therefore, although the fixed exchange rate system introduces some constraints on government policies, there are some advantages related to its adoption. There are also other factors that favor the adoption of a fixed exchange rate system, in addition to the credibility that it introduces. The theoretical framework that formally explains the advantages of adopting rules in pursuing monetary policy, and interpreting the fixed exchange rate as a rule, are based on the literature known as time inconsistency, which analyzes the problem that arises from introducing discretion into government policies.

The traditional theory of macroeconomic policy dealt with the economic consequences of given policy rules. However, the consequences and the policy objectives were supposed to be known in advance and therefore once the optimal rule was identified, the policymaker only needed to implement it and the private sector adapted to it. In contrast to the traditional literature, this new approach, which constitutes a branch of the so-called New Classic Macroeconomics, deals with the problems that arise from including politically strategic behavior in macroeconomic models. It assumes that policymakers are typically rational and maximizing agents who respond to incentives and constraints in the same way as the rest of the economy. The policy formation process is now at the center of the analysis. The starting point of this new approach consists in the analysis of a principal-agent problem, where the citizens are the principals, who delegate the formulation of economic policy to an agent. The agent selects the policy that maximizes his objectives, subject to the relevant constraints. The

---

82 Wyplosz (1986) among others shows that, under a fixed exchange rate, the government can conduct an independent monetary policy if there are capital controls.

83 A policy plan is time inconsistent if, given the fact that it is expected by the private sector, the optimal plan made for the period t+j at time t is different from the optimal plan made for that period at time t+j. Thus, if a policy is time inconsistent, the government would wish to deviate from it during its implementation. In this sense, time inconsistency and credibility are two sides of the same coin.

84 The new classical macroeconomic framework assigns a key role to expectations which are assumed to be rationally formed. The leading representatives of this school of thought are Sargent, Lucas, Wallace and Barro.

responses by the principals constitute, in this theory, an additional constraint. The normative problem is given by the fact that it is necessary to design incentives with the objective that the agent implements a policy that maximizes the collective interests of the citizens (principals).

The time inconsistency approach thus analyzes the credibility problems that arise when governments have full discretion in the design of monetary policy and the private sector, by forming its expectations fully rationally, can anticipate potential government strategic behavior. Time inconsistency arises because the effectiveness of government policy depends not only on the current policy, but also on the expectations of future policy. Ex ante, before some choices have been made by the private sector (principals), an optimal policy induces a defined response. However, ex post, once choices have been made, the response to policies may be different from the ex ante response, which makes the government's ex post constraints different from the ex ante constraints. The presence of a distortion or a lack of policy instruments makes the ex ante optimal policy a second best rather than a first best. Therefore, there is an ex post incentive to deviate from the ex ante optimal policy. If the government is able to commit itself to the ex ante optimal policy, the incentive to deviate is absent.

In this section, I will introduce the concept of time inconsistency and review the literature on this issue. Then I will present a very simplified model in the tradition of Kydland and Prescott (1977), which allows comparison of the social losses of following a rule and discretionary policy under certainty and in the presence of shocks. Finally, I will review the theoretical solutions proposed to solve the time inconsistency problem and draw some conclusions from the analysis.

2.5.2 Social Losses under Discretionary Policy vs Commitment

The initial theoretical developments on time inconsistency problems were due to the seminal articles of Kydland and Prescott (1977) and Barro and Gordon (1983). Later extension and further developments can be found in the studies by Persson and Tabellini (1993), Lohmann (1992), Rogoff (1985), Fischer (1995), Walsh (1995) and Mc Callum (1995).

The starting point of this analysis consists of a simple repetitive game between two sectors: the labor union and the monetary authority. Monetary authorities might have an incentive to increase the money growth in order to get an increase in output above its natural rate. However, once the workers become aware of this fact, they will adjust their inflationary expectations and at the end of the process there will be no gain in either output or employment, and inflation will be higher than at the initial point. Kydland and Prescott's basic observation is that if expected inflation is low, so that

---

86The time inconsistency approach was initially analyzed in relation to monetary policies by Kydland and Prescott (1977) and Barro (1983). However, new developments of the literature apply the time inconsistency framework in the context of fiscal policy. See Persson and Tabellini (1990), Edwards and Tabellini (1991) and Alesina and Tabellini, (1989) and also in a context of trade policies. See Fernandez and Rodrik (1990), Gärtner (1994).

87Because of government sovereignty it becomes hard to find real binding commitments that are enforced upon policymakers. In the final analysis, policy commitments can always be altered.
marginal cost of additional inflation is low, policymakers will pursue expansionary policies to push output temporarily above its natural level. Nevertheless, because the public knows that policymakers have this incentive, they will not expect low inflation and therefore no output increase will take place and the inflationary policy pursued by the policymakers will only lead to higher inflation.

2.5.3 The Model

In this section, in order to clarify the concepts presented above, I will formalize the ideas described in the previous section. The analyzes draws mainly upon research due to Kydland and Prescott (1977) and Barro and Gordon (1983). However, the version presented here is much more simplified although it contains the main message. It is assumed that aggregate demand disturbances and inflation expectations can affect aggregate supply. Aggregate supply is given by following expression.\(^{88}\)

\[(2.5.3.1) \quad y_t = q_t + b(\pi - \pi^e)\]

\(y_t\) is the aggregate supply, \(q_t\) is the natural output level, i.e. the level at which the economy is in full employment, \(\pi\) represents the actual inflation and \(\pi^e\) is the expected inflation.

Equation (2.3.5.1) is derived as follows. Given a Cobb-Douglas production function:

\[(2.5.3.2) \quad Y_t = \alpha K_t^{\alpha} L_t^{\beta},\]

where \(Y_t\) is output, \(K_t\) is capital and \(L_t\) is labor applied to produce output.\(^{89}\) \(\alpha\) and \(\beta\) are the factor shares of capital and labor respectively.

By expressing the function (2.3.5.2) in logs, I get:

\[(2.5.3.3) \quad y_t = \alpha k_t + \beta l_t; \quad \text{and} \quad \alpha + \beta = 1.\]

Under perfect competition, labor is being employed to the point at which the real wage rate is equal to the marginal product; and capital stock being fixed in the short run, then:

\[(2.5.3.4) \quad y_t = b(p_t - w_t),\]

where \(b\) is the share of wages to profits \(b = \beta / \alpha\), \(p_t\) is the price of goods and \(w_t\) is the nominal wage rate.

By assuming absence of indexation and that workers set wages during negotiations to assure full employment at the natural rate, then the wage contract will be:

\[(2.5.3.5) \quad w_t = (-1/b)q + E_{t-1} p_t\]

---

\(^{88}\)See Romer (1996).

\(^{89}\)For details on Cobb Douglas production function see Henderson and Quandt (1985).
where \( E_{t-1} \) is the price expected for the period \( t \) in the previous period \( t-1 \) when the negotiation were taking place.

Then, by replacing (2.5.3.5) in (2.5.3.4), I obtain:

\[
y_t = q_t^2 + b(p_t - E_{t-1}p_t)^{90}
\]

and defining \( \pi = p_t - p_{t-1} \) and \( \pi^e = E_{t-1}p_t - p_t \) it is possible to arrive to the expression (2.5.3.1), where \( y \) is the log of output, \( q \) is the natural level of output. Following Kydland and Prescott (1977) I assume that \( q \) is lower than the social optimal natural level (\( y^* \)):

\[
q < y^*.
\]

In the literature, several theoretical explanations are attributed to this situation, for example, the existence of tax rates that do not allow individuals to capture the full effect of additional labor supply.\(^91\) Taxes on labor and unemployment contributions reduce disposable income, therefore the social cost of unemployment exceeds its private cost. Taxes reduce disposable wages, which in turn are lower than the labor marginal productivity of an employed person. When an employed person loses his job, he simultaneously loses the disposable income that he was perceiving at the time when he was employed. However, society as a whole loses the (private) disposable income plus the additional taxes contributions. Another explanation can be found in the existence of imperfect competition: private firms do not capture the full benefit of additional output. Another explanation (Hibbs, 1987) is given by the fact that governments depend on voters and therefore the common interest might not necessarily coincide with the interest of a particular group of society that supports the government party.

Inflation is assumed to be costly if it is higher than a certain level\(^92\). The cost of inflation increases as inflation rises. In order to capture these two effects I will define, as is usual in the literature, a loss function which the government will minimize. The loss function (\( L \)) is quadratic on the one hand, on the difference between actual output \( y \) and the socially optimal output \( y^* \) and on the other hand, on the actual inflation rate \( \pi \) and the socially optimal inflation rate \( \pi^* \).\(^93\)

\[
(2.5.3.7) \quad L = (y - y^*)^2 + a(\pi - \pi^*)^2
\]

\( a > 0 \).

There is a relation between the socially optimal output and the natural output:

\(^90\) Notice this is the usual form of the Lucas supply curve. Assuming \( q_t = 0 \) then \( y_t = b(p_t - E_{t-1}p_t) \)

\(^91\) See Wagner (1992) and Romer (1996).

\(^92\) From the seignorage point of view there is a certain optimal level of inflation. However, optimal inflation needs not necessarily be zero.

\(^93\) The loss function is thought for the closed economy and thus the exchange rate does not appear in the function. However, the analysis can be extended for the open economy by assuming that to fix the exchange rate in a credible way implies on the one hand \( \dot{e} = 0 \), and on the other hand, to adopt an optimal inflation rate. This inflation rate will be the inflation rate of the foreign country to which the domestric country has been pegged its currency, and which is by assumption much lower than the domestic one.