(2.5.3.8) \( y^* = kq \) and \( k > 0 \).

The function \( L \) can be interpreted as follows: social costs increase if either output and/or inflation deviate from its socially optimal level. The parameter \( a \) represents the relative importance given to the effect of inflation in social welfare.\(^{94}\)

In order to simplify the algebra, I will assume that \( \pi^* = 0 \) and therefore the loss function has the following form.\(^{95}\)

(2.5.3.9) \[ L = (y - y^*)^2 + a\pi^2. \]

The policymaker also controls money growth, which determines the behavior of aggregate demand \( y_t \). Because of the absence of uncertainty the policymaker can choose directly the rate of inflation, subject to the constraint that inflation and output are linked according to the aggregate supply curve \( y_t = q_t + b(\pi_t - \pi^e) \). The policymaker faces two possibilities of conducting its monetary policy, either he can announce and follow a binding commitment, then he chooses the inflation rate that minimizes the loss function \( L \) with the result that inflation rate will be \( \pi = \pi^e \), and the output level will be \( y_t = q_t \) but \( q_t < y^* \). The policymaker can choose inflation, taking expectation of inflation as given.\(^{96}\)

By substituting (2.5.3.1) in (2.5.3.9), I get:

(2.5.3.10) \[ L = [(q + b(\pi - \pi^e) - kq)^2 + a(\pi)^2]. \]

The government will minimize (2.5.3.10) with respect to \( \pi \) and therefore following expression is obtained:

(2.5.3.11) \[ \min L, \partial L / \partial \pi = 0. \]

(2.5.3.12) \[ 2[(q(1-k) + b(\pi - \pi^e))b + 2a(\pi)] = 0. \]

and by solving the expression (2.5.3.12) for \( \pi \) the optimal inflation under discretion \( \pi^d \) is obtained:

(2.5.3.13) \[ \pi^d = \frac{b^2\pi^e + bq(k-1))}{a+b^2}. \]

However, in the steady state, the actual rate of inflation will equal the expected rate, because people form expectation rationally, hence:

\( \pi = \pi^e \)

\(^{94}\)Note that the parameter \( a \) is a preference parameter that can vary across countries even across political parties.

\(^{95}\)The results are totally independent of the functional form of the loss function.

\(^{96}\)This situation can occur if expected inflation is determined before money growth. Because people forms expectation rationally, however, it can do only if the government announces a lower rate of money growth and unexpectedly increases it.

\(^{97}\)The second order condition for a minimum will be: \( L_2^2 = 0, 2\pi b + a\pi > 0. \)
Then by replacing in (2.3.5.13)

(2.5.3.14) \( \pi^d = b/a(k-1)q \).

By replacing (2.3.5.14) into the loss function, I obtain:

(2.5.3.15) \( L^d = q(1-k)^2 + a\left[b/a(k-1)q\right]^2 \).

Because \((1-k)^2 = (k-1)^2\) then,

(2.5.3.16) \( L^d = (k-1)^2 + b^2/a(k-1)^2q^2 \).

Simplifying the expression (2.3.5.16) delivers the loss function under discretion

(2.5.3.17) \( L^d = (k-1)^2q^2(1 + b^2/a) \).

The expression (2.3.5.17) represents the loss that the government will incur if implements a discretionary monetary policy, as the expression shows that it is positive. In order to compare this policy with the situation that would arise if the government followed a rule, I will next calculate the social loss under a policy when the government follows a rule.

If the government does so, inflation and expected inflation will be equal to 0. Because the public knows that the government will not pursue an inflationary policy, it will expect zero inflation \( \pi = \pi^e = 0 \).

Replacing then into the loss function (2.5.3.9), the following expression is obtained, which represents the value of the loss function if the government follows a rule

(2.5.3.18) \( L^r = (k-1)^2q^2 \).

The expression (2.3.5.18) is also positive. However, on comparing both loss functions (2.3.5.17) and (2.3.5.18), we observe that the loss under discretion is much bigger than under the rule.

Then, by subtracting (2.3.5.18) from (2.3.5.17), I get:

(2.5.3.19) \( L^d - L^r = (k-1)^2q^2(1 + b^2/a) - (k-1)^2q^2 \)

(2.5.3.20) \( L^d - L^r = b^2/a > 0 \).

Because \( b^2/a > 0 \), the loss under discretion is larger than under a rule. Expected inflation rises to the point at which the policymaker taking \( \pi^e \) as given chooses the actual rate of inflation, which equals \( \pi^e \). Ultimately, the policymaker only raises inflation without any gain in output.\(^9\) The reason why the ability to choose inflation after expected inflation is determined makes the policymaker worse off is due to the fact that the

\(^9\) This results do not depend on this specific functional forms. See Romer (1996). See for example Wagner (1992), or Barro (1983), Persson and Tabellini (1990), Backus and Driffill (1985) who adopts another functional form of the loss function and arrive to the same outcome.
policy of announcing an inflation rate \( \pi \) and afterwards producing an inflation rate after expected inflation is determined is not consistent.\(^9\) If the policymakers announces that inflation will be equal to zero and the public forms expectation rationally, the policymaker will deviate from the policy once expectation have been formed. The public's knowledge that the policymaker would do this causes it to expect inflation greater than zero, this expected inflation worsens the menu of choices that the policymaker faces.

Actually, the source of the problem is not the fact that the policymaker has discretion itself but the knowledge by the public that he does have it. If in fact the policymaker has discretion but the public believes he has not, then the policymaker will announce that inflation will be zero and thereby cause expected inflation to equal zero. The policymaker can however set inflation according to (2.3.5.13). Because (2.3.5.13) is the solution to the minimizing problem of the loss function of the policymaker given expected inflation, to deviate from the rule will increase social welfare. Dynamic inconsistency arises because the optimal policy is not consistent in the long run.\(^1\)

However, if the policymaker could cheat the public and lead them to believe that inflation will be \( \pi = 0 \), and people really believe it, but then introduces \( \pi^d \) the actual inflation will be:

\[
\pi^d = b_2 \pi e + b q (k-1)/a + b^2.
\]

By replacing \( \pi^e = 0 \), the actual inflation that cheats the public will be:

\[
\pi^c = b q (k-1)/a + b^2.
\]

By introducing the actual inflation of cheating into the loss function, I get:

\[
L^c = [q(1-k) + b(q(k-1)/a+b^2)]^2 + a \{b q(k-1)/a+b^2\}^2.
\]

Simplifying the expression yields:

\[
L^c = q^2(1-k)^2[a/(a+b^2)].
\]

Then (2.5.3.24) represents the loss that the government would incur if it can really cheat the public.

Now, by comparing the government loss function when the policymaker follows the rule (2.5.3.18) and (2.5.3.24) when the policymaker can really cheat the people and lead them to believe that inflation will be zero but pursue an inflationary policy, we see that the loss function is smaller because \( a+b^2 \) is bigger than 0.

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\(^1\) By introducing fully indexed wages, the problem of time inconsistency can be eliminated. Argy (1994) argues that the inconsistency disappears if wages are ex-post automatically indexed to the price level of period t, because the real wage cannot fall, output cannot increase and the monetary expansion is absorbed in higher prices. This situation follows even if the monetary expansion is fully anticipated, because the problem of discretion completely disappears. The paradoxical result is that wage indexation reduces the equilibrium rate of inflation to its optimal level of zero because the incentive to cheat vanishes.
There are therefore some gains of cheating the public if the government really can do it. The problem is that if the game could only be played once, as in our one-period model, then people still do not know government incentives and therefore they can be cheated. However, in the next period people will have learned policymaker's behavior and therefore will not allow the government to cheat them. Even if the government would like to obtain a result as \( L^h \), it will obtain \( L^d \) and therefore will be in a worse situation than if it had followed a rule.

Dynamic inconsistency is applied in the literature not only to monetary policy but in other contexts as well. Recent surveys of this kind of literature can be found in Blackburn and Christensen (1989), Rogoff (1987), Persson (1988), Chari, Kehoe and Prescott (1989). Application of the time inconsistency problem to fiscal issues can be interpreted as follows: if policymakers wish to encourage capital accumulation by adopting a low tax rate, once capital has been accumulated, taxing it is non-distortionary, thus it is then optimal for policymakers to tax it at a higher rate. Calvo (1978) analyzes the case when setting \( \pi = \pi^\ast \) is inconsistent not only because of an output unemployment tradeoff but also because of government debt which is denominated in nominal terms. An unanticipated inflation shocks acts as a lump sum tax on debt holders. The corollary is that even, if monetary shocks do not have real effects on output, a low inflationary policy can be dynamically inconsistent. Indexed bonds according to the inflation would eliminate the time inconsistency problem. Other examples with time inconsistency are related with the indebtedness problem (Krugman, 1995). Thus debtor countries can surprise their creditors by defaulting on foreign debt. Therefore, because creditors mistrust future possible defaults the outcome is that foreign borrowing is much lower than the optimal. Canzoneri and Henderson (1987) and Crawford (1983) present surveys on international policy coordination and external debt. Governments can fail to honor patents after invention have been made (Barro and Grilli, 1994). As a result, because people understand the government's incentives, the equilibrium level of invention will be too low.

In general governments could profit from promising that they will resist the temptation to surprise people, yet the main problem remains: how can these commitments be made credible?

### 2.5.4 Rules versus Discretion and the Presence of Stochastic Shocks

In the previous analysis it was demonstrated that, under discretionary monetary policy, inflation rises above the optimal rate and no gain in output is obtained. Kydland and Prescott (1977) argue that in order to avoid this situation monetary policy should be determined by rules rather than discretion. However, there are basically two main problems in designing rules. First, it is not easy to design rules that are really binding.

---


102 \( \pi^\ast \) is the optimal inflation it must not be necessary 0.

103 During the foreign debt crisis of 1982 creditors interrupted lending to all developing countries and even those countries which have not intention of deflating suffered from this phenomenon.
Policymakers can announce that they will determine monetary policy according to a defined procedure, for example pegging the exchange rate or making the money stock grow at a constant rate. However, if the public believes the commitment and expects low inflation, the government could raise social welfare by departing from the announced policy and choosing a higher rate of money growth. Thus, the public has no reason to believe this announcement. Only if the monetary authority relinquishes the ability to determine the money supply does a rule solve the problem.

Secondly, rules cannot account for completely unexpected circumstances\(^{104}\) and if an unexpected shock appears the policymaker has no instrument with which to respond. Rogoff (1985)\(^{105}\) formally analyzes the problem when the economy is affected by shocks. Under plausible assumptions, a policymaker whose preferences between output and inflation differ from those of society does not respond optimally to shocks. Thus choosing to whom to delegate monetary policy produces better results in terms of average inflation but a worse outcome in terms of response to disturbances. Therefore, Rogoff concludes that there is an optimal level of anti-inflationary policy for central bankers.

I present a very simplified version of the model developed by Rogoff (1985). I follow the same model presented in the previous section. I now consider that aggregate supply is a stochastic function.\(^{106,107}\)

\[(2.5.4.1)\]
\[y_t = q_t + b(p_t - E_{t-1}p) + u_t,\]

where \(u_t\) is a disturbance term with mean equal zero, not serially correlated and with a constant variance.

\[(2.5.4.2)\]
\[E_t(u_t) = 0 \text{ and } E_t(u_t^2) = s^2,\]

Replacing the aggregate supply in the loss function (2.5.3.9) yields:

\[(2.5.3.9)\]
\[L = (y - y^*)^2 + a(p)^2,\]

\[(2.5.4.3)\]
\[L = [(q + b(p-E_{t-1}p) + u_{t-1} - kq)^2 + a(p)^2].\]

\(^{104}\)During the 1980s, the USA experienced a severe liquidity crisis which originated in the stock market crash. By adhering to its monetary target, the government could not react to help the banking system, severely affecting economic activity. By adopting a currency board system in 1991, Argentina committed itself to backing the monetary base 100% with foreign reserves. The financial crisis induced by an external shock such as the Mexican devaluation in December 1994 led to a significant fall in output. No rule that could have anticipated all these kinds of external shocks.\(^{105}\)

Rogoff (1985) analyzes the trade-off between flexibility and rules. The elimination of the time inconsistency problem by the introduction of rules can in some cases be very costly.\(^{106}\)

Because this time, I will apply expectation to the whole function. Expected inflation at time \(t-1\) is expressed as \(E_{t-1}p\) instead of \(p^e\), but this does not alter the meaning.\(^{107}\)

Note that the only difference between equation (2.5.4.1) and (2.5.3.1) is the stochastic shock.
Ordering the expression:

(2.5.4.4) \[ L = [(q(1-k) + b(p-E_{t-1}p) + u_{t})^2 + a(p)]^2. \]

By minimizing the loss function as before:

(2.5.4.5) \[ 2ap + 2[(k-1)q + bE_{t-1}p] - u_{t}b = 0, \]

(2.5.4.6) \[ p = 1/(a+b^2) [b(k-1)q + b^2E_{t-1}p - u_{t}b]. \]

Taking expectation to the whole expression, then

(2.5.4.7) \[ E_{t-1} = 1/(a+b^2) [b(k-1)E_{t-1}q + b^2E_{t-1}E_{t-1}p - bE_{t-1}u_{t}. \]

But, \( E_{t-1}p = p \) because inflation expectations are formed in the previous period rationally and \( E_{t-1}(E_{t-1}p) = E_{t-1}p \). q1 the natural output is not a stochastic variable and, therefore, \( E_{t-1}q_{t} = q_{t} \) and the mean of the error \( u_{t} \) is equal to zero by assumption \( E_{t}(u_{t}) = 0. \)

(2.5.4.8) \[ E_{t-1}p = (1/a+b^2) [b(k-1)q + b^2E_{t-1}p], \]

and simplifying the expression:

(2.5.4.9) \[ E_{t-1}p = [b/a(k-1)q]. \]

This is the inflation rate that minimizes the loss function. By introducing (2.5.4.9) in (2.5.4.6) and simplifying, then,

(2.5.4.10) \[ p = (b/a)(k-1)q - u_{t}b/(a+b^2). \]

From (2.5.4.9) and (2.5.4.10)

(2.5.4.11) \[ p - E_{t-1}p = -u_{t}(b/a+b^2). \]

And introducing (2.5.4.11) into the loss function and taking expectations of the squared function and simplifying:

(2.5.4.12) \[ E_{t-1} L^d = q^2(1-k)^2(1+b^2/a) + s^2(1/a+b^2). \]

The expression (2.5.4.12) represents the expected loss function under uncertainty that arises when the policymaker acts under discretion.

On the contrary, if the policymaker now follows a rule and sets inflation equal to zero, the inflation rate as well as the expected inflation rate will equal zero. Therefore,
replacing p and $E_{t+1}p$ by zero in (2.5.4.4), the loss function under uncertainty is as follows:

$$E_{t+1}u = (1-k)^2 q^2 + s^2 .$$

By comparing (2.5.4.13) and (2.5.4.14) $L^d$ and $L^r$, we observe that the first term is larger under discretion while the second is smaller. This can be interpreted as follows: in the absence of shocks, the second term is equal to zero and therefore the rule is preferred to the discretionary policy. This was the situation analyzed in the previous section. On the contrary, if shocks are present, the discretionary policy is preferred to the rule, because the losses will be smaller this time.

The intuitive interpretation is very simple: in the absence of shocks, the rule always will be preferred to the discretionary policy. A binding rule will avoid the possibility of the policymaker cheating the public, and the public will be sure that the policymaker will not do so. However, there is no rule that can foresee unexpected shocks and therefore some flexibility in the monetary policy can allow the policymaker to react to unexpected shocks and to moderate their impact. The argument presented above means that, under plausible assumptions, a policymaker whose preferences between output and inflation differ from those of society does not respond optimally to shocks. Thus, there is a trade-off in choosing somebody to whom to delegate monetary policy who strongly dislikes inflation. In terms of average inflation, it will lead to a lower inflation rate but to a worse result in terms of response to disturbances. As a result, there is some optimal level of conservatism in the design of monetary policy. Thus an extremely conservative monetary policy is not necessarily the first best.

### 2.5.5 Multiple Period Horizon

The social loss function presented in the previous section represents a one period function. It is possible to assume that the government maximizes a multi-period loss function and therefore the policymaker will minimize the discounted present value of a multi-period loss function (Wagner, 1992):

$$L = a L_{t+1} / (1+d)^i ,$$

where $d$ represents the discount factor applying to the whole of the given infinite horizon. The function $L$ is similar to the loss function in the previous case. The value of the discount factor plays a crucial role. The higher is $d$, the stronger are the preferences of the policymaker for the present and the lower the valuation he places upon future losses. If $d$ tends to infinity, the policymaker evaluates only a one period loss function. If governments have a longer horizon, they need to offset all future losses discounted to the present against the one-period short-run gain. Hence it is no longer evident that the government will pursue shortsighted policies. If the discount
rate is not too high, the authorities might well opt for a longer-term strategy. Taking the reputational aspect into account, inflation can be set close to the optimal rate. However, this situation also offers some problems because of the limited permanence of a political party in government. A political party could pursue an expansive monetary policy while still in power because it believes that it will not win the next democratic polls and therefore the next government, which is composed by another party, will have to carry the costs.

2.5.6. Dealing with the Time Inconsistency Problem

In the analysis presented above, it was shown that discretionary policies give rise to inefficiently high inflation without obtaining any gain in output. The question is thus what can be done to avoid this situation. The first approach consists in designing monetary policy according to strict rules. Nevertheless, as we have also seen, it is not easy to design really binding rules which governments cannot abandon. Second, if strictly binding commitments could be implemented, they present other problems; thus they might be very inflexible in the presence of shocks. Rules can be extremely costly if unexpected shocks arise.

There is an additional empirical problem: some of the countries that enjoy a low inflation rate do not necessarily conduct their monetary policy according to strictly fixed rules.

In the literature, some suggestions have been made to overcome the time inconsistency problem. Theoretical models in this context were originally introduced by Rogoff (1985, 1987), Barro and Gordon (1983) Persson and Svensson (1984), Tabellini (1987) and Kotlikoff, Persson and Svensson (1988). Two mechanisms that permit the time inconsistency problem to be solved without incurring the high cost of fixed rules and which seems to be of practical relevance are delegation and reputation.

Reputation can be applied whenever policymakers are in office for more than one period and if the public ignore their preferences. The public may not know policymakers's preferences between output and inflation or whether their announcements on future policies are really binding. In this situation, policymakers behavior through time will provide some information about the characteristics of a particular policymaker and thus affect the public's expectations in future periods. The lower the inflation observed today, the lower the expectations of inflation in future periods. This gives policymakers an incentive to keep inflation low. Because of the simplicity of the central idea, the basic result is that uncertainty about policymaker preferences itself reduces inflation. However, this does not seem to be either theoretically robust or realistic. Central banks appear to be very concerned with establishing reputations as being hard-nosed against inflation and first of all as being credible. If the public were certain of policymakers' preferences and beliefs, there would be no reason for such

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108 This was actually the suggestion made by Kydland and Prescott (1987).
109 This case was analyzed in section 2.5.4.
110 For example, the USA and Germany.
111 See Backus and Driffield (1985).
behavior. Only if the public is uncertain and if expectations matter will these concerns be quite important.

The second way to overcome the dynamic inconsistency of low inflation monetary policy is to delegate policy to individuals who do not share the common view about the relative importance of output and inflation. The central idea is due to Rogoff (1985). Inflation is lower when monetary policy is controlled by someone who is known to be especially adverse to inflation. When the monetary policy is controlled by such a person, the public realizes that the policymaker has no desire to pursue expansionary policy and as a consequence expected inflation will be low. Several authors, among them Bade and Parkin (1982), Grilli, Masciandaro and Tabellini (1991), Barro and Grilli (1994), Alesina and Summers (1991), Schiemann (1992), investigated how this mechanism could be implemented in practice. They analyzed the way in which the public can be convinced that monetary policy is under the control of an inflation- adverse monetary authority. All the authors arrived at the conclusion that the anti-inflationary reputation of a central bank is closely related to its degree of independence from the government. Alesina (1988) argues that central bank independence provides a measure of the delegation of policymaking to conservative policymakers. The greater the independence of the central bank, the less is the possibility of the government inducing inflationary policies. Empirical investigation of the relation between these measures of independence and inflation produce a consistent result: independence and inflation are strongly negatively related. Posen (1993) and Romer (1996) suggest that this analysis has some limitations. The outcome that there exists a correlation between central bank independence and low inflation is "per se" a fact and does not indicate which is the direction of the causality. Pollard (1993) suggests that the index applied to measure central bank independence is biased in favor of finding a relationship between independence and low inflation. The measures often introduce some weight on whether the board of the central bank gives low inflation as its principal goal. It is not clear that theories of dynamic inconsistency and delegation predict that the greater the independence of the central bank the lower will be inflation. The argument that they do predict this implicitly assumes that both central bank and government policymakers' preferences do not vary systematically with central bank independence. Nevertheless, the delegation hypothesis implies that they will. For example, if monetary policy depends on the central bank's and the government's preferences, with the weight attached to the bank's preferences increasing with its degree of independence. Then, when the bank is less independent, government officials should compensate by appointing more inflation-averse individuals to the

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113 Rogoff (1985) and Persson and Tabellini (1990) discuss the characteristics of an optimal central bank.
115 Posen (1993) observes that those countries whose citizens are particularly averse to inflation are likely to try to insulate their central banks from political pressures. He presents the example of Germany whose citizens dislike inflation and the institutions governing the German central bank (Bundesbank) appear to have been created mostly because of this desire to avoid inflation. Therefore Germany's low inflation is due more to the general inflationary aversion than to the independence of the central bank.
bank. Similarly, when the government is less able to delegate policy to the bank, voters should elect more inflation-averse governments. These effects will mitigate and might even offset the effects of reduced central bank independence.\textsuperscript{116} There are two additional theoretical solutions proposed to eliminate the time inconsistency problem. They are actually special cases of those explained above. The first consists in introducing punishment and the second incentive contracts in the design of the rules of monetary authority behavior. The underlying idea is that the time inconsistency problem arises because society has no means to punish the government if it deviates from the announcement. Therefore, society could profit if punishment measures could be introduced. Punishment\textsuperscript{117} is usually described as a sub-model of reputation in an infinite horizon model. These models present the problem that they are usually multiple equilibrium models and therefore difficult to compute. Low inflation is in turn sustained by beliefs that if the policymaker were to choose high inflation, the public would punish him by expecting high inflation in the following periods. Incentive contracts are arrangements in which the central banker is penalized (either financially or through loss of prestige) for inflation, therefore the appropriate choice of penalties produces the optimal policy.\textsuperscript{118} However, although the introduction of incentive contracts seem to be intellectually attractive, in the real world it is not so clear what is the practical relevance of such kind of contracts.

2.5.7 Concluding Remarks

In this section, I have analyzed the theoretical background that supports the idea that governments would choose a fixed exchange rate regime as a committing rule. The explanations are found in the time inconsistency literature. I have presented a very simplified model based on Barro and Gordon (1983) that allows comparison of the effects of the introduction of a discretionary policy against those of a rule. Under conditions of certainty, it was demonstrated that the rule leads to a better solution. Second, I have compared the solution that the government would obtain if it could lead the public to believe that he would follow the rule but in fact were to follow a discretionary policy. It was shown that this solution leads to lower losses than following the rule. This is exactly the reason why the time inconsistency problem arises: public knows that the government could profit if it announces a rule which it could then avoid.

Third, I transformed the model previously presented into a stochastic one, and again compared the social costs of following the rule as against a discretionary policy. In this case, it was shown that, in the presence of unexpected shocks, the discretionary policy leads to a better solution. The rule cannot account for unexpected shock and therefore

\textsuperscript{116}See Romer (1996).
\textsuperscript{117}Barro and Gordon (1983), Rogoff (1987).
\textsuperscript{118}Persson and Tabellini (1993), Walsh (1995), and Persson and Svensson (1984) suggest that the time inconsistency problem could be eliminated if some incentive can be introduced to make attractive to the next period government to follow the time consistent policy initiated in the previous period. Tabellini (1987) shows that a low inflationary rule can be time consistent if there is an infinite-life decision body, which decides under the simple majority rule which party will be reelected.
leaves the monetary authority without instruments to react to shocks hitting the economy.

Finally, I discussed several proposals advanced to cope with the time inconsistency problem: Delegation, reputation, incentive contracts and punishment. By delegating monetary policy to an authority which is by nature against inflation, the time inconsistency problem would be eliminated. If the government is more than one period in office, it can benefit from following an anti-inflationary policy because it will generate a reputation of being hard nosed against inflation. Punishment is a variant of reputation. The governments deviate from rules because there is no cost to them of doing so. Therefore, the society as a whole would benefit if governments that deviate from the rules could be punished. Incentive contracts are a second variant of the same instrument. Institutional arrangements should be constructed in such a way that those in charge of or designing the monetary policy could profit by reducing inflation and would suffer the consequences of introducing inflation.

The adoption of a fixed exchange rate regime implies that the central bank commits itself to follow a rule in pursuing monetary policy by relinquishing its the discretionary power. The conduct of monetary policy according to binding rules becomes specially important in countries with a long history of high inflationary policies as in the case of most of MERCOSUR economies. Although a fixed exchange rate is not the only alternative to the introduction of binding rules in the design of monetary policy, it is a very attractive one because of the credibility effects that it introduces into the system. First, a fixed exchange rate system is easy to understand for the public and therefore much easier to follow and monitor than either a monetary or an inflationary target. Second, it contains itself some punishment effects if the government deviates from the rules in the form of pressures in the exchange rate markets and the consequent exchange rate crisis. Therefore, under a fixed exchange rate regime, in the presence of capital mobility it becomes very costly for the authorities to introduce expansionary monetary policies. Third, a fixed exchange rate allows reputation to be imported from a traditionally conservative central bank (Giavazzi and Giovannini, 1988). In countries with a long inflationary history, it might take decades to build up a new reputation of being a conservative central bank.

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119 There are other kind of committing rules, e.g. monetary targets and inflation targets. For details see Reither (1996).


121 This is the so called impossibility theorem. See Isard (1995).
2.6 Summary and Conclusions

The objective of this chapter has been to present a theoretical framework that allows the analysis of optimal exchange rate policy for MERCOSUR countries. First, in order to compare the advantages and disadvantages of flexible and fixed exchange rates, I introduced a two country Mundell-Fleming model. The model is framed for the very short run when prices are fixed and expectations are static and, therefore, some effects on output levels are observed. The main conclusion that can be drawn from this model is that monetary as well as fiscal shocks induce spill-over effects on foreign output. However, the impact depends on the nature of the exchange rate regime, and also on the kind of shock, monetary or fiscal. In the case of a flexible exchange rate system, an expansionary monetary policy induces an increase in domestic and in foreign output as well. On the contrary, an expansionary fiscal policy induces an expansion in domestic output, but a contraction in foreign output. Nevertheless, if a fixed exchange rate regime has been adopted, an expansionary monetary policy induces a positive effect on domestic and foreign output. In this case, the effect of an expansionary fiscal policy on domestic output is positive. The effect on foreign output is not unequivocal and depends on income and exchange rate elasticities.

Second, the Mundell-Fleming model was extended by introducing the modification suggested by Dornbusch (1976). Thus, exchange rate expectations and a Phillips curve were introduced, and dynamic behavior was also incorporated. Again within a two country framework, the model allowed the analysis of the effect of a fiscal and a monetary policy, on the one hand in the long run, once all adjustments have taken place and there are no longer any effects on output levels, though some effects on price levels persist. Additionally, the dynamic adjustment of nominal and real exchange rates in response to nominal and fiscal shocks was analyzed in detail. Under a flexible exchange rate system, a nominal shock as well as a fiscal shock introduces large variability in both nominal and real exchange rates, which translates into the overshooting and undershooting effect of nominal and real exchange rates. Because prices are sticky and show a delay in reaction, the impact of a monetary shock forces an overreaction in the nominal and real exchange rate, which is the well-known overshooting effect of the exchange rate. A fiscal shock, on the contrary, induces an undershooting effect. In this sense, the exchange rate does not reach the new equilibrium level immediately, though a lower one, and continues moving until it has reached the new steady state. However, a fixed exchange rate regime in a two-countries Dornbusch structure model, in contrast, delivers totally different results. On the one hand, a monetary shock has no effect at all on the real exchange rate. Both price levels increase by the same amount and at the same speed, eliminating the possibility of an appreciation/depreciation. An expansionary fiscal shock initiated in country 1 and/or a contractive shock initiated in country 2 induces a real appreciation of the country 1's currency. Nevertheless, high volatility is no longer observed; on the contrary, there is a soft adjustment until the new steady state is reached.

I drew the following conclusion from this section: a fixed exchange rate system with perfect capital mobility forces the countries to give up autonomy in their monetary policy. Moreover, this kind of institutional arrangements provides a clear advantage: the high volatility of the exchange rate is eliminated. The model demonstrates that the
volatility is not transferred to other parts of the system, but is simply reduced because one of the unknown variables has dropped out of the system. In a Mundell-Fleming-Dornbusch model, fixed exchange rates reduce not only nominal but also real variability.

Third, I analyzed in detail the problem that arises in all fixed exchange rate system and which is known in the literature as the N-1 problem. In a fixed exchange rate system in which N countries participate, there are N-1 exchange rate parities. The system has, by construction, one degree of freedom because money supply for each country is endogenous and under perfect capital mobility interest rates must equalize across countries. The practical problem is given by the fact that either one country independently or all countries in a cooperative way have to decide how the money stock will be assigned. Although from the theoretical point of view, there are two possible solutions: the asymmetric or hegemonic and the symmetric or cooperative. From Bretton Woods to the EMS, all fixed exchange rate systems have worked "de facto" in an asymmetric way. Therefore, the adoption of a fixed exchange rate implies for the non-hard currency countries a complete surrender of autonomy in their monetary policy. On the contrary the anchor country can afford to follow a completely independently monetary policy.

Fourth, I introduced in the last section an alternative approach to exchange rate policy that concentrated on other aspects that have not been considered in the previous sections. This part analyzed credibility issues and the problem that arises from time inconsistent policies. Time inconsistency arises because governments can obtain benefits if they announce a rule yet can ultimately avoid it without that the public fully realizing that they have done so. The time inconsistency appears exactly because the public knows that the government could obtain some gains by behaving strategically and therefore will also try to avoid being cheated. In the final analysis, no party will obtain any benefit and as a whole they will have suffered welfare losses. In order to clarify these concepts, a theoretical model was presented to compare the inflation outcome from a binding rule to a discretionary monetary policy. I concluded that the outcome is better under rules than under a discretionary policy. The model was subsequently solved in order to compare the outcome that arises if the government follows rules with that which would ensue if the government were to announce a rule: the public would believe that the government would fulfill its promises and at the end the policymaker could deviate from the rule.

The conclusion is that if the government could afford to "cheat" the public, the results would be much better than under a rule. The model was extended into a stochastic version and thus it was demonstrated that if unexpected shocks arise the outcome provided by discretionary policies will be preferred. A strict binding rule cannot account for unforeseen situations and leave the policymaker without instruments with which to react.

Finally, I discussed some solutions proposed in the literature to overcome the time inconsistency problem, such as the delegation of the monetary policy to an authority which is by nature adverse to inflation, the introduction of punishment, reputation and incentives contracts. The idea behind such proposals is that policymakers deviate from the announced rules because there do not exist effective instruments to punish them. Society as a whole could benefit by forcing the policymaker to respond for their faults. The conclusion that I drew from this section is as follows: important gains can be
achieved by designing policy rules. The fixed exchange rate system acts as a binding rule that eliminates strategic behavior by policymakers. It contains in and of itself a punishment mechanism, whenever the policymaker deviates from the announced monetary policy rule there will be some pressures in exchange rate markets, which can end up as exchange rate collapses.

Additionally, in the case of such high inflationary economies as MERCOSUR countries, these concepts are particularly important. A reputation of being hard-nosed against inflation cannot be acquired as fast as desired. It might take decades until a government can generate the reputation of being against inflation. Credibility can be destroyed extremely quickly, but it takes a very long time to rebuild it again. The fixed exchange rate offers the possibility to borrow credibility from another country that is already well known as being in favor of low inflation.

Summarizing, in this second chapter I discussed in the light of different theories the effect of two extreme cases of exchange rate system: fixed and flexible, which assisted me to draw up some policy recommendations for the MERCOSUR case. Although fixed exchange rates imposed a severe constraint, given by the fact that the follower country must give up completely its monetary policy, losing in this sense an instrument of economic policy, there are some reasons to believe that it nevertheless constitutes a better option. First, because of the reduction on the volatility that it introduces, and second because it increases credibility in the system and helps to coordinate expectations.
Appendix

Stability Condition and Solution of the System

Dornbusch Model

Flexible Exchange Rate

By recalling each difference of two variables as a new variable

\[ x^* = x_1 - x_2. \]

Then, the system is reduced to a simple two equation dynamic system

\[
\begin{align*}
\dot{p}^* &= \varphi/(1-\varphi \sigma) \left[ g^* - \sigma i^* + f y^* + 2\delta e - 2\delta p^* - \bar{q}^* \right] \\
\dot{\varepsilon} &= 1/\lambda [-1(1-2\beta)p^* + 2(1-\beta)e + \phi y^* - m^*].
\end{align*}
\]

In order to analyze the stability conditions the system is linearized \(^{123}\) and can be expressed as follows:

\[
\begin{bmatrix}
\partial p^* / \partial e \\
\partial e / \partial e
\end{bmatrix}
\begin{bmatrix}
p^* - \bar{p}^* \\
e - \bar{e}
\end{bmatrix}
= \begin{bmatrix}
\dot{p} \\
\dot{\varepsilon}
\end{bmatrix}
\]

\[
\begin{bmatrix}
\varphi /(1 - \sigma \varphi)2\delta \\
1/2\lambda(1 - \beta)
\end{bmatrix}
\begin{bmatrix}
p^* - \bar{p}^* \\
e - \bar{e}
\end{bmatrix}
= \begin{bmatrix}
\dot{p} \\
\dot{\varepsilon}
\end{bmatrix};
\]

By recalling the expression in order to simplify the algebra then,

\[ a_1 = \varphi/(1-\varphi \sigma)2\delta \]
\[ a_2 = -\varphi/(1-\varphi \sigma)2\delta \]
\[ a_3 = 1/\lambda 2(1-\beta) \]
\[ a_4 = 1/\lambda (1-2\beta). \]

\[
\begin{bmatrix}
a_1 & a_2 \\
a_3 & a_4
\end{bmatrix}
\begin{bmatrix}
p^* - \bar{p}^* \\
e - \bar{e}
\end{bmatrix}
= \begin{bmatrix}
\dot{p} \\
\dot{\varepsilon}
\end{bmatrix}\text{ and}
\]

\(^{123}\) From a non-linear differential equation system is possible to draw a linear approximation derived from the Taylor expansion of the given system around its equilibrium. For details see Chiang (1984) Turnovsky (1995).
According to the characteristic equation then,

$$[B-\eta I] = \begin{bmatrix} p^* - \bar{p}^* \\ e - \bar{e} \end{bmatrix}$$

The trace of the jacobian B is then, $TrB = a_1 + a_4$
The determinant of the jacobian $Det B = a_1 a_4 - a_2 a_3$
In order the equilibrium to be a saddle path solution the determinant must be negative.

$$Det B = \frac{\varphi}{(1-\varphi \sigma)2\delta} \frac{1}{\lambda} (1-2\beta) - 1/\lambda 2(1-\beta) [-\varphi/(1-\varphi \sigma)2\delta] < 0$$

The characteristic roots will be:

$$\eta_{1/2} = \frac{TrB \pm \sqrt{(TrB)^2 - 4|B|}}{2},$$

and the general solution of the system is:

$$e(t) = \bar{e} + A_1 e^{\eta_1 t} + A_2 e^{\eta_2 t}$$

$$p(t) = \bar{p} + k_1 A_1 e^{\eta_1 t} + k_2 A_2 e^{\eta_2 t}$$

where $A_1$ and $A_2$ are the arbitrary constants. Let $\eta_1 < 0 < \eta_2$ and the saddle path solution is found. $k_1$ and $k_2$ are the Eigenvectors.
Chapter 3

Lessons from the European Experience: The EMS as an Instrument to Achieve Price and Exchange Rate Stability

3.1 Introduction

The analysis of the monetary agreements concluded by the European Union during the last three decades constitutes the natural starting point of any study on monetary integration in other geographical regions. Thus, the European experience establishes an example of a successful economic integration process. It has already been functioning for more than 30 years, trade has significantly increased among member states, and the European countries were able to rapidly rebuild their economies after the Second World War. Although the history of monetary agreements in Europe does not begin with the aftermath of the Second World War, this date constitutes probably the best starting point for the analysis of the long-term developments in European monetary integration. This period is particularly important because it constitutes the beginning of the overall integration process that led to the creation of the European Economic Community (ECC), the European Monetary System (EMS), and finally the present plans for the economic and monetary union (EMU). The European Monetary System (EMS), launched on March 13, 1979, was conceived as another step in the unification of economic policies of the European countries. The EMS constitutes only one element of an important set of agreements (Giavazzi and Giovannini, 1988) among European countries in areas of trade, industrial and agricultural and these agreements rest on exchange rate stability. The EMS was widely perceived, at least until 1992, as a success, and probably the most interesting aspect of it to study is whether it has achieved the goal of providing sufficient stability in European prices and exchange rates. The argument of the European Commission that reaping the full benefits of economic integration requires exchange rates to be firmly fixed, and ultimately a single currency for Europe applies with equal force to the MERCOSUR case.

Although at first view there exist important differences between European and MERCOSUR countries regarding the degree of development, GDP per capita, and the degree of industrialization, there are also relevant similarities between the two groups of countries. Both started the process of integration after a period of destruction, in Europe the world war, in MERCOSUR, a deep debt crisis, an hyperinflationary process and several non-democratic administrations. Both processes were initially based on political elements and attempted to eliminate historic rivalries, Germany-France in Europe, Argentina-Brazil in MERCOSUR. Both established as a basic condition for joining the club the preservation of democracy in the individual countries. Additionally, labor market behavior is identical as between the two groups, in both cases lacking flexibility, which has some consequences for monetary policies as well as for exchange rate policies. In general, the economic structures of the MERCOSUR countries are similar to those of the Southern European countries. Therefore, some lessons can

be drawn from the European experience for other regions such as MERCOSUR that attempt to link economically their economies in order to increase competitiveness and foster trade and growth.

Chapter 3 is organized as follows: first, I will briefly review the monetary agreements that the European Union has introduced over time. I will concentrate especially on the European Monetary System, which has been in operation for 18 years and is probably the most serious attempt to introduce some fixity among European currencies. Second, I will evaluate the performance of the EMS by discussing the contribution of the EMS to the achievement of price stability across Europe and the costs in terms of unemployment that it has incurred. Third, I will perform an econometric analysis in order to study the effect of the EMS on exchange rate stability, particularly; particularly, I will concentrate on the dynamic response of nominal and real exchange rates to monetary and real shocks.

3.2 Review of the European Exchange Rate Agreements:

The Origins

In 1957 the Treaty of Rome was signed, giving birth to the European Common Market. Initially, however, monetary unification was not one of the main objectives, although the Treaty of Rome contains two short chapters on economic policy coordination. The international system established by Bretton-Woods provided a stable framework for the activities of the European Community. In the late 1960s, the European Community had completed the customs union and established the Common Agricultural Policy. The member countries showed their desire to move towards further integration. At the same time, on the international scene the Bretton Wood system showed the first symptoms of weakness, and so the EC countries

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124 I am reviewing only the monetary aspects of the European integration. For surveys concerning the history of the EC, the implementation of the customs unions and other non-monetary aspects of the European integration see Molle (1990), Swann (1990), El Agra (1994), Ohr (1996).

125 Paragraph 103 to 107 explicitly refer to the exchange rate policy by saying that each member country considers its short-term policy and its exchange rate policy as a matter of common concern. See Gros and Thygesen (1992).

126 The Bretton Woods system consisted of a fixed exchange linked to the US dollar and the US dollar to gold. Changes in the parities were allowed only in case of fundamental disequilibria; temporary disequilibria were financed through IMF short-term credits. The IMF rules allowed for a 1 per cent fluctuation band around the central parities against the US dollar. Therefore, two European countries could move by as much as 4% against each other. The countries agreed to limit their European fluctuation vis-à-vis the dollar to 0.75 per cent, therefore reducing the potential margin for intra-European exchange rate fluctuation to 3 per cent. For details see Isard (1994) and Bayoumi and Eichengreen (1994).
agreed upon the need to develop their own monetary individuality. Willy Brandt, at that time German chancellor, proposed that, as a first step, EC member states should jointly formulate medium-term objectives for the participants, and aim to harmonize short-term policies. In a second phase, a monetary union of permanently fixed exchange rate could then be achieved.

In October 1970, Pierre Werner presented a report suggesting the setting-up of a single European currency, which should be implemented in steps by 1980 (Werner, 1970). The Werner Report was extremely explicit regarding the objective of reaching a monetary union as a final step (Willgerodt, Dormsch, Hasse and Marx, 1972). The monetary union should be achieved by permanently fixing all European currencies reaching, thus achieving the elimination of the intra-community exchange rate fluctuations, and the complete liberalization of capital movements. (Werner Report, chapter III, p 10). The Werner report considered two alternative ways of implementing the monetary union, either by establishing a single community currency or by maintaining the national monetary symbols and permanently fixing their parities. A Community central bank in analogy with the US Federal Reserve would be established to conduct the monetary policy and the exchange rate policies with respect to third currencies. These two elements were the only institutional framework that the Werner report suggested for the monetary union. However, it did not describe in detail how this European monetary authority could be constituted. The Werner report emphasized the importance of free movement of goods, services, people and capital, but stressed that factor mobility could be replaced by public financial transfers to eliminate regional and structural disequilibria. However, it did not mention as an important objective to achievement of convergence to low inflation among European countries. Price divergence was not a matter of concern at that time.

In 1971, the EEC Council of Ministers decided to implement a more modest goal than a monetary union by introducing a mechanism that permits the reduction of exchange rate variability. This was the origin of the so-called Snake in the tunnel. The original participants in the agreement were Germany, France, Italy Benelux, UK, Ireland, Norway and Denmark, and in 1973 the European Monetary Cooperation Fund was created. (Table 3.2.1 summarizes the chronology of the Snake). However, the Werner Report could never be implemented. It failed to see the relevance of a common monetary institution. The Bretton Wood system had somehow allowed the Community to attain almost completely fixed exchange rates during the 1960s without constructing any European monetary institution. The Werner Report relied on the Bretton Woods sys-

127 In 1969 in the Hague the wish to move towards an Economic and Monetary Union was reaffirmed, and at the same time it was decided to open the community to new members. See Gros and Thygesen (1992).
128 See Kloten (1980).
131 See Baer and Padoa Schioppa (1989).
132 The tunnel referred to the relation of the EC currencies with respect to the US dollar.
tem, but this system was collapsing exactly when the first stage of EMU (European Monetary Union) had to be implemented.

**TABLE 3.2.1**  
**Chronological History of the Snake**

<table>
<thead>
<tr>
<th>Year</th>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>24 April</td>
<td>Basle Agreement enters into force.</td>
</tr>
<tr>
<td></td>
<td>1 May</td>
<td>Participants: Belgium, France, Germany, Italy, Luxembourg, the Netherlands.</td>
</tr>
<tr>
<td></td>
<td>23 May</td>
<td>The United Kingdom and Denmark join.</td>
</tr>
<tr>
<td></td>
<td>23 June</td>
<td>Norway becomes associated.</td>
</tr>
<tr>
<td></td>
<td>27 June</td>
<td>The United Kingdom withdraws.</td>
</tr>
<tr>
<td></td>
<td>10 October</td>
<td>Denmark withdraws.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denmark returns.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Italy withdraws.</td>
</tr>
<tr>
<td>1973</td>
<td>13 February</td>
<td>Transition to the joint float: Interventions to maintain fixed margins against the dollar ('tunnel') are discontinued. Sweden becomes associated. The DM is revalued by 3 per cent.</td>
</tr>
<tr>
<td></td>
<td>19 March</td>
<td>Establishment of a European Monetary Cooperation Fund is approved.</td>
</tr>
<tr>
<td></td>
<td>3 April</td>
<td>The DM is revalued by 5.5 per cent.</td>
</tr>
<tr>
<td></td>
<td>29 June</td>
<td>The Dutch guilder is revalued by 5 per cent.</td>
</tr>
<tr>
<td></td>
<td>17 September</td>
<td>The Norwegian krone is revalued by 5 per cent.</td>
</tr>
<tr>
<td>1974</td>
<td>19 January</td>
<td>France withdraws.</td>
</tr>
<tr>
<td>1975</td>
<td>10 July</td>
<td>France returns.</td>
</tr>
<tr>
<td></td>
<td>15 March</td>
<td>France withdraws again.</td>
</tr>
<tr>
<td></td>
<td>17 October</td>
<td>Agreement on exchange-rate adjustment ('Frankfurt realignment'): The Danish krone is devalued by 6 per cent, the Dutch guilder and Belgian franc by 2 per cent, and the Norwegian and Swedish krone by 3 per cent.</td>
</tr>
<tr>
<td>1977</td>
<td>1 April</td>
<td>The Swedish krone is devalued by 6 per cent, and the Danish and Norwegian Korea are devalued by 3 per cent.</td>
</tr>
<tr>
<td></td>
<td>28 August</td>
<td>Sweden withdraws; the Danish and Norwegian krone are devalued by 5 per cent.</td>
</tr>
<tr>
<td></td>
<td>13 February</td>
<td>The Norwegian krone is devalued by 8 per cent. The DM is upvalued by 4 per cent, the Dutch guilder and Belgian franc by 2 per cent. Norway announces decision to withdraw.</td>
</tr>
<tr>
<td></td>
<td>12 December</td>
<td>The European Monetary System becomes operational.</td>
</tr>
<tr>
<td></td>
<td>13 March</td>
<td>The European Monetary System becomes operational.</td>
</tr>
</tbody>
</table>

Source: Gros and Thygesen (1992)
The EMS: the Quest for Stability

The snake should have been the first step towards monetary unification, but the international economic and financial volatility in the mid-1970s led to the following steps not being taken. The next attempt to attain exchange rate stability brought about the creation of the EMS in 1979.\(^{133}\)

The EMS\(^ {134}\) was conceived as an intermediate step on the road to a full economic and monetary union\(^ {135}\). The main objective was to avoid violent movements in nominal exchange rates among European currencies. The decision (Coffey, 1993, Giavazzi and Giovannini, 1988) was based on the logical consequence of moving further towards more openness and integration of the member states' economies. Additionally, the management of the Common Agricultural Policy (CAP) required stable exchange rates. The desire to develop an European monetary individuality of one's own as a symbol of one the most important world trading blocs played also an important role toward a closer monetary coordination.

**Table 3.2.2**

Relative openness of countries\(^ {136}\)

<table>
<thead>
<tr>
<th>Imports as share of GDP (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Ireland</td>
</tr>
<tr>
<td>Netherlands</td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>USA</td>
</tr>
<tr>
<td>Japan</td>
</tr>
</tbody>
</table>

Source: Main Economic Indicators, OECD

---

\(^{133}\) Most of the economists were very pessimist about the probability of success of EMS.


\(^{136}\) The best indicator for openness of an economy is (Exports+Imports)/GDP. However, the share of imports on GDP is a good proxy. Giavazzi and Giovannini (1988), among others, use this concept to measure openness.
The Institutional Arrangements

The EMS constitutes an agreement among European central banks to manage intra-Community exchange rates and to finance exchange market interventions. The Exchange rate mechanism (ERM) of the EMS is only one aspect of the system. While only a subset of the EC countries participates in the ERM, all of them belong to the EMS. The European Currency Unit (ECU), which was created with the EMS, is a monetary unit based on a basket of all EC currencies. The EMS constitutes in this sense a fixed exchange rate with a band of fluctuation. The following currencies participate in the arrangement: Belgian franc, Danish crone, French franc, Greek drachma, German mark, Irish pound, Italian lira, Luxembourg franc, the Dutch guilder, the Portuguese escudo, the Spanish peseta, the Finnish marc, the Austrian schilling. The main instruments of the EMS are the intervention rules and the financing facilities. The first works as follows: each community currency has an ECU central rate, expressed as the price of one ECU in terms of that currency. ECU central rates are fixed and are revised only when there is a realignment. Although the members have the obligation to intervene in the foreign market to ensure that the bilateral exchange rates are maintained within the boundaries, changes in the central rates may be introduced previous mutual agreement. The ratio of any two ECU central rates is the bilateral central rate of any pair of currencies which together from the parity grid of the system. By joining the ERM mechanism of the EMS a central bank agrees to keep its market exchange rate vis-à-vis any other currency participating in the mechanism within prearranged margins from the bilateral central parity. The parity grid is in this sense the heart of the exchange rate mechanism of the EMS, and in this mechanism the ECU is only a numeraire. Initially, the bilateral margin was set at 2.25 per cent on either side of the central parity, so that the width of the band for any bilateral rate was 4.5 per cent. The currencies were allowed to fluctuate within the band, but when they reached the margin interventions were compulsory. However, there are two kinds of interventions, the so called "marginal intervention" and "intramarginal intervention". The first is compulsory and takes place when two currencies reach their bilateral margin, meaning when the bilateral exchange rate diverges by 2.25 per cent from the central parity. This marginal intervention must be carried out by both central banks involved in the currency at the opposite bilateral limit. Moreover, financing for bilateral intervention is unlimited: the central bank of the strong currency undertakes to grant its weaker partner an unlimited credit line.

139 For details see Giavazzi and Giovannini (1988), Gros and Thygesen (1992), Ungerer (1986).
141 The EMS introduced the divergence indicator, which is a formula that allows to determine which currency is approaching its outwards limit. See Argy (1994), Gros and Thygesen (1992).
142 Italy was allowed to remain in a +-6 percentage band.
The other kind of intervention, the intramarginal, allows the central bank to intervene before the currency has reached the limit of the bilateral band. However, this kind of intervention is subject to the approval of the central bank whose currency is being bought or sold. Nevertheless, there are no borrowing credit lines for these kinds of intervention.

The second interesting element of the EMS are the financing facilities, which constitute concession of mutual credits so that central banks are able to defend the agreed parity. Moreover, there are three kinds of financing facilities: the very short-term financing facility, the short-term monetary support and the medium-term financial assistance. While the first two are administrated by central banks, the third is administrated by the European Council of Ministers.

The very short-term financing facilities, which have been mentioned before, are designed to provide credibility to bilateral EMS parities by securing unlimited financing for marginal intervention. They consists of mutual credit lines between central banks of the system. The short-term monetary support is implemented to provide short-term financing for balance of payments problems and the medium-term financial assistance is designed to provide longer-term financing.

At the time of joining the EMS, the countries were obliged to deposit 20 per cent of their gross reserves in US dollar in exchange for ECUs. Interest was paid (earned) when their holdings fell below (above) the amounts received against their deposits. Although the ECU plays an important role within the EMS, it serves only as a unit of account, it never became, as it was initially expected, a popular reserve asset or a means of debt settlements. Initially, some member countries were allowed to maintain capital controls; in fact France, Italy, Ireland, Portugal and Spain made use of this right. They were phased out over time.

From the implementation of the EMS until the crisis of 1992, twelve realignments of central rates involving two or more currencies took place. Given the fact that the rules of the game in the EMS were changing over time, in order to analyze its performance, it is convenient to divide the whole period of analysis in three well-defined subperiods: from 1979 to 1987, EMS with frequent realignments; from 1987 to 1992, the EMS without realignments; and after the 1992 crisis, the EMS with wide bands.

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143 The reason of the existence of these credit lines is that while the stronger currency has no limits to purchase the weak currency, the central bank of the weak currency faces the problem of having to sell the strong currency.

144 The European Commission uses the ECU as a means of account and at government level some credit lines are settled in ECU. However, in the private sector the ECU is not widely used.

145 This is the division mostly adopted among authors Gros and Thygesen (1992), Goodhart (1990), Ungerer (1990).
The Turbulent EMS: 1979-1987

As mentioned above the main objective of the EMS was to avoid violent movements in nominal exchange rates among the European countries. Therefore, the simplest criterion to use in evaluating the past performance of the EMS consists of observing the frequency of realignments. In this sense, the beginning of the EMS was not very successful: central rates were modified at the rate of an average once every eight months. The experience raised the question of whether the EMS had any effect on the nominal exchange rate fluctuation, or whether it was simply a veil over the system of the facto floating rates. The strong political support for the EMS was based on the belief that, by stabilizing nominal exchange rates, it would be possible to stabilize relative prices across Europe. Between 1979 and 1987, 11 realignments took place (see table 3.2.3). The early phase of the EMS can be interpreted as a discretionary collective management. As the period ended, officials were disillusioned with the EMS performance, with very little convergence having been achieved. Nevertheless, this first period is not homogenous and it can be divided in two subperiods. In the first subperiod, realignments were frequent and convergence very limited. The EMS participants could succeed only in maintaining the mechanism they had constructed. No reforms were introduced, and policy divergence was ultimately corrected in France, Belgium and Denmark in 1982-1983, but Germany remained skeptical about the survival prospects for the EMS. The second subperiod from 1983 to 1987 revealed a better performance in terms of discipline and disinflation. Realignment became less necessary as national inflation rates began to converge, and they were implemented even less frequently than price divergence itself justified. The capital liberalization process started and was confirmed as one of the main objectives in the Single European Act of 1986.

149 See Ungerer, Jouko, López-Claros, Mayer (1986) for details.
Table 3.2.3
Realignments

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 1979</td>
<td>DM was revalued 2%. Danish crone was devalued 3%.</td>
</tr>
<tr>
<td>November 1979</td>
<td>Danish crone was devalued 5%.</td>
</tr>
<tr>
<td>March 1981</td>
<td>Italian lira was devalued 6%.</td>
</tr>
<tr>
<td>September 1981</td>
<td>DM was revalued 3%. French franc was devalued 5.5%.</td>
</tr>
<tr>
<td>February 1982</td>
<td>Belgian franc was devaluated 8.5%. Danish crone was devaluated 3%.</td>
</tr>
<tr>
<td>June 1982</td>
<td>DM was revalued 4.5%. Guilder was revalued 4.5%. Franc was devalued 5.75%.</td>
</tr>
<tr>
<td>March 1983</td>
<td>DM was devalued 5.5%.</td>
</tr>
<tr>
<td>June 1985</td>
<td>French franc was revalued 2.5%.</td>
</tr>
<tr>
<td>April 1986</td>
<td>Italian lira was devalued 8.5%.</td>
</tr>
<tr>
<td>August 1986</td>
<td>French franc was devalued 6%.</td>
</tr>
<tr>
<td>January 1987</td>
<td>Irish pound was devaluated 8%.</td>
</tr>
<tr>
<td>January 1989</td>
<td>DM was revalued 3%. Guilder was revalued 3%. Belgium franc was revalued 2%.</td>
</tr>
<tr>
<td>June 1989</td>
<td>Spanish peseta enters the EMS under the wide band of +/−6%.</td>
</tr>
<tr>
<td>January 1990</td>
<td>Italian lira moves to the narrow band of +/−2.25%.</td>
</tr>
<tr>
<td>October 1990</td>
<td>British pound enters the EMS under the wide band of +/−6%.</td>
</tr>
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</table>

Source: Deutsche Bundesbank, several issues.

The speculative attacks in 1986/1987 and a general realignment induced the commissioners to emphasize the need of reaching exchange rate stability and new solutions were discussed in order to achieve it.

The EMS without Realignments 1987-1992

After the last realignment on January 1987 there was a general agreement that the monetary authorities within the EMS countries should not be again in such a situation that they were unable to cope with speculative pressures. During this period, although countries reached a considerable convergence in national inflation rates at a low level (see table 3.2.4 and 3.2.5), national budgetary policies persisted on divergent paths (see table 3.2.7, 3.2.8).

---

### Table 3.2.4
**Consumer Price Index**

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Source: Main Economics Indicators, OECD

### Table 3.2.5
**CPI average EMS countries**

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<th>Standard deviation</th>
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<td>1994</td>
<td>3.74</td>
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</table>

Source: Main Economic Indicators OECD

<sup>151</sup> Although since August 1993 the band has been widened for practical purposes, here in the narrow band are considered those countries which initially allowed their currencies to fluctuate. +/−2.25.
In 1987 the European countries signed the Basle-Nyborg agreement, which introduced a new version of the EMS. Under this new EMS, the elimination of realignments was achieved. The credibility of exchange rate commitments improved and interest rate differentials declined. From 1987 until the crisis of 1992, no further realignment occurred. The critical factors that explain why it was possible to avoid additional realignments, at least until 1992, were on the one hand, the achievement of a reasonable degree of convergence, monetary coordination was strengthened and exchange rates were defended with a wider range of instruments than during the earlier period. On the other hand, some reforms were introduced into the EMS such as the removal of capital controls, and the discussion about the timetable for reaching EMU by stages made participants keen to demonstrate that they were indeed ready to move towards further integration. Although the average EMS inflation picked up from the artificially low level reached in 1986, 1.5%, to nearly 3.5% in 1990, the dispersion around it as measured by standard deviation was stable or declined slightly further, at least among the initial members of the narrow band (see table 3.2.5). This fact reveals, however, clearly improved convergence in the group of seven countries that had from the start of the EMS observed narrow margins, and some divergence between this group and Italy plus the two new members Spain and the United Kingdom. For the group of seven the range of national inflation rates had narrowed to 1%. Convergence in nominal interest rates was slower, but also unmistakable: by 1990 the differential in short-term rates was down to less than 2% in this group except for Ireland. With both inflation and interest rates converging, long-term real interest rates had become much more uniform across the first group. With respect to the external balances, at least the 7 original participants were moving closer to a sustainable external position. With the exception of the German surplus up to 1989, external imbalances proved to be transitory. The deficits of Denmark and Ireland were sharply reduced relative to earlier phases in the 1980s, switching even into surplus at the end of the decade. Belgian and Dutch surpluses diminished while French accounts did not move far from balance. Italy moved into a modest deficit from 1989. (See table 3.2.6).

Table 3.2.6
Current Account Balance as % of GDP

<table>
<thead>
<tr>
<th>Year</th>
<th>G</th>
<th>F</th>
<th>I</th>
<th>NL</th>
<th>B/L</th>
<th>DK</th>
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<td>-6.8</td>
<td>-2.4</td>
<td>-1.0</td>
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</table>

Source: International Financial Statistics, IMF

As far as regards fiscal policy, it becomes less clear that the EMS has introduced some contribution to improve the fiscal deficits and debt ratios. Probably, the main danger signal for the functioning of the EMS as a whole has remained the persistence of the public sector deficit of over 10% of GDP in Italy, and very high levels of debt in Belgium and Ireland (see tables 3.2.7, 3.2.8).

Table 3.2.7
Public Debt % of GDP

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Source: Main Economic Indicators, OECD
Table 3.2.8
Fiscal Deficit
% GDP

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</table>

Source: Main Economic Indicators, OECD

1992 The Crisis

The achievement of the EMS without realignments from January 1987 to August 1992 induced the belief that moving towards a monetary union would not necessarily involve substantially high costs, and instead would allow further benefits to be gained, as for example, the reduction of transaction costs. Capital controls in every form\textsuperscript{153} were eliminated, as a corollary of the 1992 program to complete the internal market\textsuperscript{154}, and in fact most of EMS countries had removed their capital controls by the beginning of 1990, while Spain and Portugal had significantly reduced them before the crisis started.

For a period, the EMS without realignments was working even in the face of persistent inflation differentials. Therefore, there were some doubts about how to correct real exchange rates without affecting nominal exchanges rates in a world of structural rigidities in labor markets. The lack of feasible answers induced markets to threaten the new EMS system. The first currency to show some weakness was the Italian lira. The Bank of Italy intervened extensively over the summer, but it could not avoid the suspension of the Italian lira from the ERM. The British pound showed also disturbing symptoms, and despite extensive intervention from the Bank of England, the British Pound was forced to abandon the system. The facts are summarized in table 3.2.9. The

\textsuperscript{153} Capital controls could be achieved either introducing taxes on foreign currency asset holdings, or by introducing restrictions on the ability of banks to lending abroad. See Gros and Tyghesen (1992)

\textsuperscript{154} In the Single European Act (1986) was agreed the elimination of capital controls by July 1990 in all countries except Spain and Ireland who would be exempted until December 1992 and Portugal and Greece would be exempted until December 1995.
persistent instability in financial markets and the crisis during the summer of 1993 led the European countries to agree in August 1993 to the implementation of a wide band +-15. Since then, financial markets have been calmer and most currencies moved "de facto" inside a much smaller band.

### Table 3.2.9
The 1992 crisis

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<th>Event</th>
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<tbody>
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<td>April 1992</td>
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<tr>
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<tr>
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<td>Italian lira membership is suspended.</td>
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<tr>
<td></td>
<td>British pound membership is suspended.</td>
</tr>
<tr>
<td></td>
<td>Spanish peseta devalued 5%</td>
</tr>
<tr>
<td>January 1993</td>
<td>Irish pound devalued 10 %.</td>
</tr>
<tr>
<td>August 1993</td>
<td>Wide band in the ERM +-15</td>
</tr>
</tbody>
</table>

Source: Deutsche Bundesbank (several issues)

### Some Explanations of the Crisis of 1992

Different economists attributed the responsibility of the crisis to diverse factors such as: competitiveness losses, inconsistent monetary policies combined with perfect capital mobility, and the external shock implied by the German unification. Probably all of them contributed partially to foster the crisis of 1992. The Commission of the European Community (1993) based the explanation on the competitiveness problems originated from significant distortions between prices of tradable and non-tradable goods from some countries that showed internal divergent policies.

Viñals (1994) and Ungerer (1993) also argue also along these lines. Thus in their opinion, the causes of the crisis of 1992 can be found in the combination of two main elements: first, the inability to sufficiently coordinate monetary and especially fiscal policies among member countries led to competitiveness problems. Additionally, the fact that real exchange rate appreciation could not be corrected by itself plus the lack of mechanisms to defend the exchange rate parities agreed upon increased the probability of speculative attacks.

However, Eichengreen and Wyplosz (1993) found by analyzing all the countries which were affected by the September crisis that not all of them showed important competitiveness problems. They classify the countries, whose currencies were under specula-

---


157 Actually the instruments provided by the EMS to avoid currency crisis were the financing facilities. They did not optimally work because the individual countries were sterilizing the monetary effects.
tive pressures during the crisis of 1992 into three categories: the first case: Italy, where there were clear competitive problems due to price distortion, the second group: United Kingdom, Spain and two non EMS countries (Sweden and Finland), the competitiveness problem was quite ambiguous. The third group, constituted by France, Belgium and Ireland, did not show significant competitiveness problems.

While internal imbalances resulting from losses in competitiveness have in some cases played an important role in prompting market pressures, there have been other factors behind the crisis. One of the most stylized explanations was based on the concepts already made popular by Padoa-Schioppa (1987), and extensively developed by Wyplosz (1989) and known as the "impossibility theorem". It is in fact the logical consequence of the N-1 problem that each fixed exchange rate faces, and which has been extensively developed in Section 2.4 of Chapter 2. This proposition suggests that there are three conditions- free trade, free capital movements and exchange rate stability-that can only coexist together if they are followed by an excellent coordination of national economic policies (monetary and fiscal), otherwise there would be serious risk of exchange rate instability. 158 The 1992 crisis would fit into this reasoning in the sense that the countries were enjoying free trade and free capital mobility without having achieved a perfect coordination of their internal policies. The attempt to pursue independent monetary policies under a quasi-fixed exchange rate system like the EMS induced the crisis as the natural consequence.

The external factor, as the shock implied by the German unification, was also responsible for the collapse, by inducing a coexistence of excess demand pressures in Germany linked to unification, and a weak demand pressures in other European countries. This situation made extremely costly for the authorities of the latter countries to maintain the exchange rate stability. As market participants became aware of these costs, foreign exchange pressures tended to intensify. Moreover, all these factors, competitiveness problems, and capital inflows had been undermining the system for a long time and speculative attacks did not arise until September 1992.

The question to be asked is why the crisis began in September 1992 and not before. Interest differentials between weak and strong currencies were persistent without any threat of the market. Probably, the stability of currencies until the crisis was based not so much in the contemporaneous policies being pursued, but rather on the expectations that future policies would be changed to achieve the convergence conditions required in the Maastricht treaty. The doubts as to whether the European countries would really implement the monetary union, as agreed in the Maastricht Treaty, 159 induced the mistrust in the financial markets and capital flowed out of the weak currency countries, making it very difficult for the governments to defend the agreed parity.

158 This condition is also known as the "impossibility triangle". Only a combination of two conditions can work.

159 The rejection of the monetary union in the Danish Referendum and the 51 % vote against EMU in France. See Eichengreen and Wyplosz (1993).
3.3 Effect of the EMS on Price Stability

The previous analysis has, concerning the functioning of the EMS, clearly shown two things: during the time period from 1983 until 1992, and particularly after 1987 (Basle-Nyborg agreement), the behavior of the exchange was relatively stable. Additionally, the Bundesbank played, at least to some degree, a special role (as an anchor currency) in determining monetary policies for the community. As for the well-known anti-inflationary policy of the German Bundesbank, this constellation suggests that the EMS served as a means towards price stability for the other member countries.

This section concentrates on two aspects: on the one hand, I will analyze the contribution of the EMS to the achievement of price stability; and on the other hand, I will discuss the costs in terms of unemployment rates that it has involved.

Credibility and Inertia Inflation

In this section, firstly, I will review the relevant empirical literature concerning the effect of the EMS on price stabilization among member countries and, secondly, provide further empirical evidence regarding this argument using some descriptive statistics.

Review of the Empirical Literature

The theoretical analysis that supports the idea that there are some benefits of pegging the exchange rates to a harder currency is based on the Barro and Gordon (1983) argumentation.\(^{160}\) The reasoning is as follows: central banks are not able to commit themselves to reduce inflation because there is no punishment suffered by them if they deviate from the rules. As long as wages are rigid and markets understand policy maker's incentives the economy will have a bias towards inflation, then the equilibrium inflation rate will be positive and there will be no gains at all in output and employment at all. Therefore, the society will benefit from an enforceable precommitment. The EMS fits in this way of thinking: thus, high inflation countries (France, Belgium, Italy) would have benefited from the EMS by delegating their monetary policy to the Bundesbank, who enjoys high credibility against inflation. There is a wide agreement that inflation differentials within the EMS have narrowed during the 1980s. Inflation in the member countries has converged to German standards. However, there is no consensus as to whether the mere presence of EMS itself has played the main role in the disinflationary process and whether it has reduced the costs of disinflation. Although some analysts point out that the benefits of EMS membership came from the enforcement of deflationary policies through exchange rate

\(^{160}\) This theoretical approach as well as the relevant references were presented in the previous chapter in section 2.5.
constraints, which would allow inflation to be reduced at lower cost in terms of output and unemployment, others support the thesis that the disinflation process has been not only an European phenomenon but a generalized one and that the cost of disinflation in Europe has been even higher than in other part of the world. The view of the EMS as a disciplinary instrument was initially stressed by Giavazzi and Pagano (1988), Giavazzi and Giovannini (1989), Metz (1985) who empirically demonstrated that, by "tying" the exchange rate to a hard currency such as the DM, member countries have increased the credibility of their announced anti-inflation policies, thereby lowering inflation expectations and thus the cost of disinflation.

Kremers (1989) and Dornbusch (1989) analyzed the disinflation process in Ireland during the 1980s. They argued that the EMS increased the credibility of the Irish monetary policy and helped to reduce inflation expectations by moderating wage demands and contributed, in this way, to a disinflationary process in Ireland. In this sense the fixed exchange rate would have helped to discipline labor markets, even when they were not perfectly flexible, by allowing the coordination of expectations with respect to the future inflation rate.

Christensen (1987) reached a similar conclusion by analyzing the disinflation process in Denmark during the 1980s. He argued that the EMS contributed to the disinflation process by reducing inflationary expectations, making disinflationary policy in Denmark more credible.

Barrell (1990), analyzes the impact of the EMS on disinflation by examining its impact on wage policies in the European countries. He tested for structural breaks caused by the EMS in a Phillips-curve wage equation, concluding that the EMS contributed positively to disinflation in some European countries.

Giavazzi and Giovannini (1989) Robertson and Symon (1992) found evidence that membership in the EMS has lowered the cost of disinflation for high inflation countries, but has increased it for low inflation members.

Weber (1992) estimated credibility and reputation for the whole EMS. He found that borrowing credibility from the Bundesbank has worked for some countries (Denmark, Ireland, Netherlands, Belgium) but not for others (France, Italy). Giavazzi and Giovannini (1989) take a more skeptical view of the effect of the EMS on inflation. Using a VAR approach they found for the non-German countries an improvement in price stability in the 80's. However, due to the long lag in the effect, it remains doubtful, whether this has been caused by the entry into the EMS or by other exogenous factors. Artis and Nachane (1990) examined the price-stabilizing effect of the EMS based on causality and cointegration tests of wage and inflation differentials in France, Belgium, Italy and the Netherlands. Although they found evidence that wages and prices were reduced after 1979, they argued that this had not necessarily been caused by the membership in the EMS, because similar evidence was obtained for the United Kingdom as well, which was not a member country during the observation period.

Considering a measure of reputation using a Kalman-Filter approach, Weber (1992) analyzed the price-stabilizing effect of the EMS. He found that, in small member countries, the reputation of the monetary authorities has improved. However, for Italy and France he could not confirm a similar effect. Although an overview of the inflation performance of the member countries of the EMS tends to support the discipline argument, Fratianni and von Hagen (1992) showed that inflation rate has been reduced
during the EMS experience, but it does not seem to be only a phenomenon of having membership in the EMS because countries outside the EMS have also reduced inflation. Moreover, even the disinflation processes have brought important losses in output and employment in the EMS countries, which were higher than in non-EMS countries.

Some economists support the idea that EMS has introduced an artificial stabilization by linking nominal exchange rates and has imposed high costs in terms of output losses and unemployment upon the domestic economies, especially those which used to have high inflation. De Grauwe (1989c, 1994) analyzed the trade-off between inflation and unemployment in the 80s, reaching the conclusion that, compared to those countries relying on domestic policies, the effect of the EMS on disinflationary processes has been relatively less important. He argued that in those countries that have used domestic policies (budget policies, "own house in order"), inflation was reduced more forcefully because of the use of "shock-therapy-type of policies avoiding overvaluation of the home currency and thereby signaling a greater willingness for price stability. Schäfer (1990), Schiemann (1992) also argue in this direction. Summarizing, the empirical evidence regarding the credibility effects of EMS membership is quite mixed and the analyses provide a rather ambiguous picture of the price stabilization effect of the EMS, depending on the method applied and the countries observed.

**Stylized Facts**

The simplest criterion to analyze the EMS performance with respect to price stability consists in observing the row data. Concerning the monetary stability achieved by the EMS member countries, as depicted in Fig 3.3.1, the performance seems to be quite satisfactory. At first sight, inflation rates have tended to fall in all cases and in some cases to converge. Countries with high inflationary traditions like Belgium, France and Italy have undertaken strong measures to control inflation using their membership of the EMS.  

Whenever rates of inflation have diverged too sharply and too widely, pressures have built up on the weak currencies in the exchange rate markets. However, parity adjustments have taken place within rather than outside the system. Arrangement within the EMS, at least until 1992, was smooth and in all cases appropriate, since speculative attacks stopped.

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161 The countries have to some extent coordinated their monetary policies. See table 3.3.2, both the average of growth rate of monetary aggregate and its standard deviation declined.

162 At least until the crisis of 1992 currencies could adjust their parity without leaving the EMS.

However, there are two very different group of countries, which I will call group 1 (Belgium, Denmark, Germany, Luxembourg and Netherlands) and the group 2 by France, Italy, Portugal, United Kingdom, Spain). Concerning group 1, one observes that inflation rates developed remarkably similarly (see Figure 3.3.2.). Only Denmark in the mid 70s and early 80s maintained a higher rate of inflation than the other countries. In all of those countries, the impact of the oil-shocks in 1973 and 1979 is clearly observable. In the early 80s the inflation rate dropped significantly so that in the mid 1980s a de facto state of price stability could be observed, which was supported by the fall in energy prices then. At the beginning of the 1990s a remarkable convergence of inflation rates is to be noted, lying between 2% and 4% at a relatively low level. Until 1986, Germany maintained a position of being the country with the lowest inflation rate, this situation was achieved, thereafter by the Netherlands and France.
Figure 3.3.2

CPI Group 1

Source: International Financial Statistics, IMF

Figure 3.3.3

CPI Group 2

Source: International Financial Statistics, IMF
Concerning the second group of countries, the behavior of inflation rates is remarkably similar to the one described above, particularly after the introduction of the EMS until 1986-1987. (see Fig. 3.3.3). The behavior parallels that of the countries of group 1, however to a higher level of inflation. After 1987, the behavior of domestic prices shows a significant convergence to the German inflation rate.

By comparing the pre-EMS period (1971-1978) and post-EMS (1979-1992) behavior, the Netherlands, which is probably the country following German's monetary policy most closely, apparently achieved the largest success in price stabilization. However, looking only at the EMS-period in comparison to the subperiod 1979-1982, those countries in the EMS not having been participating in the Snake seem to have achieved the greatest progress in their disinflation processes.

Regarding the interest rates and money growth, the EMS has introduced some convergence (See Fig. 3.3.4). The growth rate of the monetary aggregates has declined from 12.8 in 1979 to 7.4 in 1987 and the standard deviation from 8.16 to 1.96 in 1987 (See table 3.3.1). In this sense, the fact of fixing the exchange rates has contributed to the achievement of some convergence among the nominal indicators.

---

Figure 3.3.4

Interest rates 1973-1979

Interest rates 1979-1992

Source: International Financial Statistics, IMF
Table 3.3.1
Money Market rates

<table>
<thead>
<tr>
<th>Year</th>
<th>EMS Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>10.2</td>
<td>3.26</td>
</tr>
<tr>
<td>1980</td>
<td>13.8</td>
<td>2.98</td>
</tr>
<tr>
<td>1981</td>
<td>14.4</td>
<td>2.74</td>
</tr>
<tr>
<td>1982</td>
<td>14</td>
<td>4.01</td>
</tr>
<tr>
<td>1983</td>
<td>11.6</td>
<td>4.87</td>
</tr>
<tr>
<td>1984</td>
<td>10.5</td>
<td>3.58</td>
</tr>
<tr>
<td>1985</td>
<td>9.9</td>
<td>2.87</td>
</tr>
<tr>
<td>1986</td>
<td>9.1</td>
<td>2.90</td>
</tr>
<tr>
<td>1987</td>
<td>8.9</td>
<td>3.59</td>
</tr>
<tr>
<td>1988</td>
<td>7.8</td>
<td>2.57</td>
</tr>
<tr>
<td>1989</td>
<td>10</td>
<td>2.67</td>
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<tr>
<td>1990</td>
<td>10.9</td>
<td>2.47</td>
</tr>
<tr>
<td>1991</td>
<td>10.5</td>
<td>1.47</td>
</tr>
<tr>
<td>1992</td>
<td>10.5</td>
<td>1.14</td>
</tr>
<tr>
<td>1993</td>
<td>8.14</td>
<td>1.75</td>
</tr>
<tr>
<td>1994</td>
<td>6.14</td>
<td>1.44</td>
</tr>
<tr>
<td>1995</td>
<td>6.19</td>
<td>2.09</td>
</tr>
</tbody>
</table>

Source: International Financial Statistics, IMF

Table 3.3.2
Monetary aggregates

<table>
<thead>
<tr>
<th>Year</th>
<th>AV. Rate of Growth</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>12.8</td>
<td>8.16</td>
</tr>
<tr>
<td>1980</td>
<td>5.8</td>
<td>4.72</td>
</tr>
<tr>
<td>1981</td>
<td>8</td>
<td>4.97</td>
</tr>
<tr>
<td>1982</td>
<td>7.6</td>
<td>3.55</td>
</tr>
<tr>
<td>1983</td>
<td>11.9</td>
<td>5.01</td>
</tr>
<tr>
<td>1984</td>
<td>9.8</td>
<td>5.77</td>
</tr>
<tr>
<td>1985</td>
<td>8.9</td>
<td>5.61</td>
</tr>
<tr>
<td>1986</td>
<td>9.5</td>
<td>5.19</td>
</tr>
<tr>
<td>1987</td>
<td>7.4</td>
<td>1.96</td>
</tr>
<tr>
<td>1988</td>
<td>7.7</td>
<td>3.40</td>
</tr>
<tr>
<td>1989</td>
<td>7.9</td>
<td>4.09</td>
</tr>
<tr>
<td>1990</td>
<td>8.6</td>
<td>4.78</td>
</tr>
<tr>
<td>1991</td>
<td>9</td>
<td>5.99</td>
</tr>
</tbody>
</table>

Source: International Financial Statistics, IMF

On the contrary, the behavior of fiscal indicators such as public debt and fiscal deficit show a quite divergent pattern. While some countries like Luxembourg show a very low indebtedness coefficient\(^{165}\) 6.4 in 1992, others show extremely large debt ratios such as Belgium, 129.6; Ireland 100.4; and Italy 103.9 for the same year (See table 3.3.3). Additionally, the performance has tended to worsen over time rather than improve. Observing the behavior of public deficits as share of GDP, they show

\(^{165}\) Measured as percentage of GDP.
especially high values in the case of Italy (over 10 per cent) and no sign of reduction over time is observed (See Fig 3.3.5). Only Ireland shows a significant improvement in its fiscal account by reducing the percentage from 9.8 in 1984 to 3.5 in 1989.

Figure 3.3.5

Source: International Financial Statistics, IMF

Table 3.3.3
Public Debt as percentage of GDP

<table>
<thead>
<tr>
<th></th>
<th>G</th>
<th>F</th>
<th>Ir</th>
<th>NL</th>
<th>B</th>
<th>L</th>
<th>DK</th>
<th>IRL</th>
<th>S</th>
<th>UK</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>41.6</td>
<td>43.8</td>
<td>75.1</td>
<td>66.1</td>
<td>112.6</td>
<td>15</td>
<td>78.9</td>
<td>104.8</td>
<td>39.9</td>
<td>60.3</td>
<td>62.4</td>
</tr>
<tr>
<td>1985</td>
<td>42.3</td>
<td>45.5</td>
<td>82</td>
<td>69.7</td>
<td>119.8</td>
<td>14</td>
<td>76.8</td>
<td>108.5</td>
<td>45.2</td>
<td>58.9</td>
<td>70.9</td>
</tr>
<tr>
<td>1986</td>
<td>42.4</td>
<td>54.7</td>
<td>86.5</td>
<td>71.6</td>
<td>124</td>
<td>13.4</td>
<td>69</td>
<td>120.8</td>
<td>46.2</td>
<td>57.7</td>
<td>69.5</td>
</tr>
<tr>
<td>1987</td>
<td>43.5</td>
<td>47.3</td>
<td>90.5</td>
<td>75.4</td>
<td>131</td>
<td>11.8</td>
<td>65.8</td>
<td>122</td>
<td>46.6</td>
<td>55.7</td>
<td>72.9</td>
</tr>
<tr>
<td>1988</td>
<td>44.1</td>
<td>47.2</td>
<td>93.3</td>
<td>77.7</td>
<td>132.4</td>
<td>9.9</td>
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<tr>
<td>1989</td>
<td>43</td>
<td>47.4</td>
<td>96</td>
<td>77.9</td>
<td>128.4</td>
<td>8.5</td>
<td>65.6</td>
<td>110.1</td>
<td>44.2</td>
<td>45.1</td>
<td>72</td>
</tr>
<tr>
<td>1990</td>
<td>43.6</td>
<td>46.6</td>
<td>98.6</td>
<td>78.3</td>
<td>127.3</td>
<td>7.3</td>
<td>66.4</td>
<td>103</td>
<td>44.5</td>
<td>42.8</td>
<td>68.2</td>
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<tr>
<td>1991</td>
<td>46.2</td>
<td>47.2</td>
<td>101.2</td>
<td>78.4</td>
<td>129.4</td>
<td>6.9</td>
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<td>102.8</td>
<td>45.6</td>
<td>43.8</td>
<td>64.7</td>
</tr>
<tr>
<td>1992</td>
<td>48.7</td>
<td>47.5</td>
<td>103.9</td>
<td>79.5</td>
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<td>6.4</td>
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<td>100.4</td>
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</tr>
<tr>
<td>1993</td>
<td>48.2</td>
<td>45.4</td>
<td>119.4</td>
<td>81.1</td>
<td>137.9</td>
<td>7.6</td>
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<td>97.5</td>
<td>60.5</td>
<td>48.3</td>
<td>67.2</td>
</tr>
<tr>
<td>1994</td>
<td>50.4</td>
<td>48.3</td>
<td>125.4</td>
<td>77.6</td>
<td>136</td>
<td>7.37</td>
<td>76</td>
<td>91.5</td>
<td>63.1</td>
<td>50.2</td>
<td>69.5</td>
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<tr>
<td>1995</td>
<td>58.1</td>
<td>52.4</td>
<td>124.7</td>
<td>79.1</td>
<td>133.5</td>
<td>-</td>
<td>72</td>
<td>86.3</td>
<td>65.7</td>
<td>54</td>
<td>70.7</td>
</tr>
</tbody>
</table>

Source: Main Economic Indicators, OECD

Summarizing, the descriptive statistics support the thesis that the EMS has helped to reduce inflation and a considerable improvement has been observed in the convergence of monetary variables. On the contrary, the behavior of the fiscal sector variables has not shown convergence but rather divergence.
The data presented in the previous section showed that the EMS has been followed by a disinflationary process. Nevertheless, the movement towards lower inflation rates along the 1980s seems to be a general process and not necessarily a particularly phenomenon of the European countries, and even more the costs of disinflation seem to have been significantly higher than in non-EMS countries. In general, disinflation policies lead to temporary increases in unemployment. However, the most puzzly feature is the fact that EMS and non-EMS countries have experienced both: during the 1980's, a very sharp reduction of inflation rates, but a very different behavior of rates of unemployment. While the non-EMS countries were able to bring about a reduction in unemployment rates from 1986 onwards, the EMS countries were not.

**Figure 3.3.6**

![Figure 3.3.6](image)

Source: Main Economics Indicators, OECD.\(^{165}\)

Figure 3.3.6 depicts inflation and unemployment in Germany. Between 1980 and 1983 there was a trade-off between inflation and unemployment. From 1983 to 1987 less unemployment goes together with lower inflation, and finally from 1987 to 1993 the Phillips curve appears again. Denmark shows a similar. (See figure 3.3.9). The curve of France (Fig. 3.3.10) shows from 1980 to 1986 a clear Phillips curve, then from 1987 to 1990 lower inflation and lower unemployment, and finally from 1990 to 1993 the typical Phillips curve behavior again. The figure 3.3.7 (United Kingdom) shows a Phillips curve with two breaks along the whole period.\(^{166}\) Belgium (Fig- 3.3.8) shows a sharp decrease in inflation from 1980 to 1986 at relatively lower cost in terms of

\(^{165}\) It considers only West Germany.

\(^{166}\) The United Kingdom is probably the European country that presents the most deregulated labor market.
unemployment, from 1987 to 1991 lower inflation is accompanied by high unemployment.

**Figure 3.3.7**

![UK Unemployment and Inflation Graph](image)

Source: Main Economics Indicators, OECD.

**Figure 3.3.8**

![Belgium Unemployment and Inflation Graph](image)

Source: Main Economics Indicators, OECD.
Figure 3.3.9

Source: Main Economics Indicators, OECD.

Figure 3.3.10

Source: Main Economics Indicators, OECD.
Figure 3.3.11

Source: Main Economics Indicators, OECD.

Figure 3.3.12

Source: Main Economics Indicators, OECD.
Italy (figure 3.3.11) shows a vertical Phillips curve from 1980 to 1995. From 1987 the reduction in inflation was not followed by a reduction in unemployment. A quite different pattern is presented by the USA (figure 3.3.13); the reduction of inflation during the 1980s was associated with a sharp increase in unemployment. From 1983, however, there was a large reduction in unemployment without an increase in inflation. Canada (figure 3.3.12) shows a similar pattern than USA. Therefore, from the observation of the Phillips curve of the respective countries, it does not seem that the EMS helped to reduce the costs of disinflation, as most authors argued. De Grauwe (1989a, 1989b) provides some explanations for this puzzle. At the first stage, EMS would have provided little disciplining effect because there was a lack of credibility. Countries like France and Italy devalued very often during the first phase of the EMS, and so they could import very few inflationary discipline from Germany. In the second part of the 1980s France and (to a less degree Italy) made it clear that they were committed to maintaining more rigid exchange rates with the low inflation country in the system. At this time, unemployment remained very high. The change in behavior helped to improve the credibility in the fixity of the exchange rate within the system. The governments demonstrated that they were giving priority to the inflation target even when unemployment was high.

The second explanation is due to supply-side effects. Labor rigidities play a more important role among European countries than among non-European countries (USA, Canada)\textsuperscript{167}. Therefore, the supply shocks during the early 1980s induced an increase in

\begin{footnotesize}
\textsuperscript{167} The European countries showed important rigidities in their labors markets due to a higher degree of labor unionization. In contrast, labor markets in USA and Canada are much more flexible.
\end{footnotesize}
the natural level of unemployment and labor market rigidities did not permit the inflation-unemployment trade-off to move inwards.

Summarizing, the EMS showed a relatively good performance in achieving price stability during more than 15 years, at least until the crisis of 1992. Although the first years were relatively turbulent, the situation was progressively improving and during the 80s the European countries reached a reasonable degree of inflation convergence that led the countries to attempt to go towards greater integration by eliminating capital controls and agreeing upon the way to achieve the single European currency. The fact that the EMS was working better than expected induced many to think that the transition to monetary union would be smoothly and costless. The elimination of capital controls without having achieved monetary, and especially fiscal co-ordination, plus the doubts about the degree of political support for the single currency, led to financial and monetary instability, accelerating the crisis in 1992 that induced the commissioners to adopt the decision to move towards an EMS with wider bands. Nevertheless, it becomes less clear that the EMS had helped to improve the fiscal parameters. Even more, it seems that not only has not induced a convergent behavior on the fiscal side, but a divergent one worsening over time. In the same way, it is not clear that the EMS has contributed to lowering the costs of disinflation. Unemployment rates have increased across European countries since the 1980s while other non-European countries were able to reduce both inflation and unemployment rates.
3.4 The Effect of the EMS on the Dynamic Exchange Rate

Responses to Nominal and Real Shocks: An Econometric Analysis

Although many economists have been interested in the real effect of alternative nominal exchange rate regimes, there exists no agreement among them about how the way in which exchange rate variations affect macroeconomic variables such as output and inflation. The controversy as to whether nominal disturbances have real effects has not been resolved, facing in the theoretical world of open-macroeconomics market-clearing approaches against models with inertia and nominal rigidities. Baxter and Stockman (1989) for example, investigated the behavior of real macroeconomic variables across alternative nominal exchange rate regimes. The evidence from the comparison of the Bretton Woods system with the flexible exchange rate regime suggested that a nominal exchange rate regime might be associated with significant real effects. Mussa (1986) analyzed the behavior of different price indexes in different time periods in several countries. He found relative prices to be more stable during periods of relatively fixed exchange rate regimes, and his evidence supported a sticky price model in the tradition of Dornbusch (1976). Stockman (1987) developed a general equilibrium model and pointed out that the collapse of Bretton Woods could reflect not the importance of sluggish price adjustment, but rather the influence of real shocks with large permanent components. The inability of economists to converge on a common model that allows the explanation of short run variability led to the development of atheoretic research, focusing directly on correlations in the data through time series methods. Examples of this style of work are provided by Baxter and Stockman (1989), Bordo (1992), and Eichengreen (1992). In the previous section, the EMS performance with respect to price stability and unemployment was analyzed; in contrast in this part 3.4, I will focus on other aspects that are relevant in any exchange rate regime. By means of econometric instruments, I will attempt to identify the sources of nominal and real exchange rate fluctuations among seven European countries (Belgium, Denmark, France, Germany, Italy, Netherlands and United Kingdom) under different exchange rate arrangements. The main objective is to study whether the movement towards a more fixed exchange rate agreement, such as the EMS, has induced some changes in the dynamic response to nominal and real shocks. The methodology adopted is as follows, first, I estimate the two equation Mundell-Fleming-Dornbusch model under rational expectations, which was presented in chapter 2, on nominal and real exchange rates. I contrast the theoretical results predicted by the model with those provided by the data, and analyze whether the results are consistent with the model. I then inquire into the relative importance of nominal and real disturbances in periods of relatively fixed and relatively flexible exchange rate regimes. I examine not only the impact ef-


169 The selection of these countries is based on the fact that they are representative of the different behaviors and that most of the time they have belonged to both exchange rate agreements (Snake and EMS).
fect of disturbances, but also whether the economy's subsequent adjustment to shocks differs depending on the exchange rate regime. In the following analysis, I will focus on the Snake as a proxy of a flexible exchange rate regime and on the hard-EMS as a proxy of a fixed exchange rate regime. This part should thus be interpreted as a direct extension and application of the theoretical model presented in Chapter 2.

Stylized Facts

There is an extensive literature analyzing the effect of EMS on member countries on the basis of different criteria, among others Giavazzi and Giovannini (1989), Gros and Thygesen (1992), Giavazzi (1989), Fratianni and von Hagen (1990). There seems to be considerable evidence that the EMS has reduced the variability of real and nominal exchange rates among member countries; at least nominal variables seem to have reached some convergence. Basically, inflation rates have approached to the German level. Although by simply observing the raw data it is already possible to derive some conclusions, that is not sufficient to enable us to analyze whether the introduction of the EMS has affected the response to different shocks impacting upon the domestic economies.

I will present first some descriptive statistics that allow the variability of nominal and real exchange rates of European economies along different exchange rate arrangements to be compared. The analysis covers the Bretton Wood period (1960-1972), the Snake (1971-1979) and the introduction of the EMS in 1979.

As it was shown in section 3.2, the EMS has not been an homogenous system over the years. In the early period the realignments occurred so often that it was not so very different from the Snake. The system evolved towards a more fixed regime along the years. Therefore, I will consider three periods according to the degree of flexibility: the flexible EMS (1979-1987), the hard EMS or EMS without realignments (1987-1992) and EMS post-crisis or EMS with wide bands (1992-1994). The monthly data covers the period from 1960.05 to 1994.05 and was obtained from the CD Rom International Statistics Yearbook and corresponds to the variables nominal exchange rates and CPI (consumer price index) from OECD sources. The countries considered are: Belgium,

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170 As it has been described in the previous section, neither of the two systems has been either absolute fixed or absolutely flexible. The EMS also constitutes a floating system but the variability is much more limited. Because empirically there has never existed an absolute flexible nor an absolutely fixed exchange rate regime, the author believes that Snake and EMS can be interpreted as a good proxy of a floating and fixed exchange rate regime. Bayoumi (1989) adopts the same interpretation.

171 For a survey see Haldane (1991).

172 The evidence on effective exchange rate indices is more mixed. See Artis and Taylor (1988).

173 Compare with section 3.
Denmark, France, Italy, Netherlands, and United Kingdom, whose exchange rates have been calculated with respect to the DM.

E = domestic currency/DM and θ = EP*/P, being E the nominal exchange rate, θ the real exchange rate, P* German CPI, P domestic CPI.

Variability of Nominal and Real Exchange Rates

The most straightforward way to measure the impact of the EMS on exchange rate variability is to compare the short-run intra-EMS exchange rates before and after the introduction of the EMS.

Fig. 3.4.1 depicts nominal and real exchange rates from 1960.05 to 1994.04 for the EMS countries. From the simple visual observation, it is possible to conclude that the variability of both nominal and real exchange rates was much greater during the Snake than under the EMS.
Figure 3.4.1
Nominal and Real Exchange rates
1960.05-1994.04

Bex: Nominal exchange rate Belgium
Dkex: Nominal exchange rate Denmark
Fex: Nominal exchange rate France

Bexr: Real exchange rate Belgium
Dkexr: Real exchange rate Denmark
Fexr: Real exchange rate France
Itex: Nominal exchange rate Italy
Itexr: Real exchange rate Italy

Nethex: Nominal exchange rate Netherlands
Nethexr: Real exchange rate Netherlands

Ukex: Nominal exchange rate United Kingdom
Ukexr: Real exchange rate United Kingdom

Note: All exchange rates have been calculated with respect to the DM.

Source: International Financial Statistics, IMF
I applied the standard deviation of monthly percentages changes as a measure of the exchange rate variability. Table 3.4.1 depicts the variability of nominal exchange rates for the whole period and for the subperiods 1960-1972, 1972-1979, 1979-1992 and 1992-1994; table 3.4.2 shows the same issues in the case of real exchange rates. In most cases, the variability in the first stage of EMS was not significantly smaller than during the Snake. Italy and the UK showed the highest nominal (2.5 and 2.4 %) and real (2.8 and 2.5 %) exchange rate variability during the Snake. Nevertheless, there is a considerable reduction after the Basle-Nyborg agreement, in the period 1987.03-1992.09, until the September crisis, when the variability again increased and was even larger than during the Snake period for some countries (Belgium, Denmark, Italy and United Kingdom). Indeed, and in the last two cases was remarkably high (Italy 3.2 and United Kingdom 3.1) for nominal and real exchange rate respectively. In table 3.4.3 the correlation coefficients between the nominal and the real exchange rate are shown for the period 1973.03-1979.03 and 1979.03-1994.04. The coefficient is high in all cases and reaches a value larger than 0.85, except for Netherlands, where it is 0.68 and 0.58 for the Snake and EMS respectively. A high correlation coefficient indicates a symmetrical behavior of nominal and real exchange rate as signal of absence of significant overvaluation/undervaluation. In most cases the coefficient is even higher during the EMS except for Italy, Denmark, and the United Kingdom.\textsuperscript{175}

\textsuperscript{174}The empirical literature considered several measures of exchange rate variability. Gros and Thygesen (1992) consider that the ideal measure would be the variability (standard deviation of variance) of unexpected exchange rate changes. But as Gros himself recognizes, the measure of unexpected changes requires exchange rate predictions, which are extremely difficult to form. Meese and Rogoff (1983) argue that most changes in exchange rates cannot be predicted; in this sense the standard deviation of monthly percentage changes represents a good proxy and for this reason is widely applied. See, among others, Ungerer (1986), Emerson (1991) and Weber (1990).

\textsuperscript{175} In this sense, this empirical evidence supports the thesis that the EMS has not artificially reduced the exchange rate variability.
3.4.1 Model Specification Analysis

Univariate and Bivariate Analysis

In order to investigate the behavior of the series under analysis, previous to the construction of the VAR (Vector Autoregression) model, I will perform the following statistical analyses, unit root test, test for cointegration, and Granger Causality test.

Unit Root Tests

The unit root tests, which were developed in the 1980s, have attracted most econometricians' attention, becoming very popular in the last decade. The test attempts to identify the order of integration of each variable (assuming that each variable can be transformed into a stationary one). The unit root test was developed in response to the findings of Granger and Newbold (1976), who demonstrated, by carrying Monte Carlo simulation experiments, that two independent random walk series might show a very high R² and highly significant t statistics, though there is no economic relation between them. In this way, they coined the concept of "spurious regressions" to explain this phenomenon.

Nelson and Plosser (1982) found that most of the economic series are trended and therefore contain an unit root. The unit root concept can be explained as follows:

Given the model:

\begin{equation}
(3.4.1.1) \quad y_t = \alpha y_{t-1} + \varepsilon_t
\end{equation}

with \( \varepsilon_t \) white noise, and \( \alpha = 1 \), the estimation of (3.4.1.1) by Ordinary Least Square (OLS) is biased towards zero and the time series \( y_t \), represents a random walk and can be expressed as follows:

\begin{equation}
(3.4.1.2) \quad \Delta y_t = \varepsilon_t
\end{equation}

However, if \( |\alpha| < 1 \) the process generating \( y_t \) is integrated of order zero and therefore, stationary, but the estimation is also biased if \( \alpha \) not being one is close to one.

This is the reason why equation (3.4.1.1) cannot be estimated by OLS and the hypothesis \( \alpha = 1 \) cannot be tested by a Student t. Dickey and Fuller (1979) proposed the so-called DF (Dickey Fuller) test or unit root test, which tests whether \( \alpha = 1 \). The test is based on following estimation:

\begin{equation}
(3.4.1.3) \quad y_t = (1+\delta)y_{t-1} + \varepsilon_t
\end{equation}

\footnote{See Diebold and Nerlove (1990) for a survey.}

\footnote{See Maddala (1992) and Charemza (1992).}
If $\delta$ is negative then $\alpha<1$, the DF test consists of testing the negativity of $\delta$ within an OLS regression such as (3.4.1.4). The null hypothesis is $\delta=0$ and the alternative $\delta<0$. A rejection of the null hypothesis in favor of the alternative implies $\alpha<1$ and the time series $y_t$ is considered integrated of order zero and therefore stationary. Because equation (3.4.1.4) represents a regression of stationary time series $I(0)$ on a non-stationary time series $I(1)$ the $t$ Statistic has not a limiting normal distribution, therefore Fuller (1976) constructed a new table of limit values. There are also other tables like Guilkey and Schmidt (1989), and MacKinnon (1991), though all of them are simulated and not derived analytically. The Dickey-Fuller test can also be used for testing the order of integration for a variable generated as a stochastic process with a drift and/or a stochastic trend.\footnote{\textsuperscript{178}The weakness of the original Dickey-Fuller test is that it does not take into account the possibility of autocorrelation in the error term $\varepsilon_t$. If the error term is not white noise, then the OLS applied to equation (3.4.1.4) are not efficient. Dickey and Fuller (1981) developed the so-called Augmented Dickey-Fuller test (ADF), which is widely regarded as being the most efficient test from among the simple tests for integration and is the one most frequently employed.\footnote{\textsuperscript{179}Recently Phillips (1986) suggested two other test statistics the $Z_a$ and $Z_t$ which are based in non-parametric modifications of the Dickey Fuller test.}}

The test consists in running a regression of the first difference of each series against the other series lagged $k$ times. The method analyzes if the coefficient $y_{t-1}$ in the regression is significantly different from zero. If this is the case, then the null hypothesis is rejected and the alternative hypothesis ($y_t$ is stationary) is accepted. On the contrary, if the null hypothesis is accepted the series is considered to be a unit root. The critical values are the same as for the DF test.

\begin{equation}
\Delta y_t = \delta y_{t-1} + \sum \delta_t \Delta y_{t-1} + \varepsilon_t
\end{equation}

Tables 3.4.4, 3.4.5 and 3.4.6 report the values corresponding to the ADF test for all the countries for the periods 1973.03-1994.04, 1973.01-1979.03 and 1983.01-1992.09 for the nominal and real exchange rate respectively.

By considering the whole period 1973.03-1994.04, all nominal exchange rates are non-stationary at 1% significance except for Italy and United Kingdom. The real exchange rates are stationary for Denmark, France, Italy, Netherlands and United Kingdom (see table 3.4.4). For the snake period 1973.03-1979.03 all nominal and real exchange rates behave as unit root. (see table 3.4.5). For the hard-EMS all nominal exchange rates have an unit root except for Netherlands, and all the real exchange rates are stationary at 10% except for Belgium.

\footnote{In this case the equation would look like: $\Delta y_t = \mu + \delta y_{t-1} + \varepsilon_t$ and $\Delta y_t = \mu + \eta t + \delta y_{t-1} + \varepsilon_t$.}
Test for Cointegration

Granger (1986) and Engle and Granger (1987) developed the concept of Cointegration, which addresses the possibility of integrating short-run dynamic with long-run dynamic. They found that two non-stationary series would be cointegrated if a stable relationship between them in the long-run exits. This concept became very important for the modeling of time series, because if two series are cointegrated, they can be represented as an error correction model (ECM) and vice versa.\footnote{ECM models and therefore, the cointegration concept are very useful in economics because they allow for a good adjustment if a long-run stable relationship exists together with sluggish adjustments in the short-run. This concept is really appealing to economists given the fact that it seems to be a very commonly assumed behavior in economic theory (sticky prices assumption, etc).} Two non-stationary series, integrated of order one I(1) $x_t$ and $y_t$ are cointegrated if there exists a $\beta$ such that $y_t-\beta x_t$ is I(0) (stationary) and then $x_t$ and $y_t$ are CI(1,1) which means that the regression equation:

\begin{equation}
(3.4.1.6) \quad y_t= \beta x_t+u_t
\end{equation}

makes economic sense because both variables do not drift too far apart from each other over time; and there is a long-run equilibrium relationship between them; and thus the regression is not spurious. Initially, in order to test for cointegration the ADF test was applied to the residuals of the cointegrated equation. This method, however, did not allow for the existence of more than two cointegrated variables to be tested. Johansen (1988) and Johansen and Juselius (1990) developed a method that allows the number of cointegrating equations, which is called the cointegrated rank, to be determined. The method applies the maximum-likelihood procedure to determine the presence of cointegrating vectors and allows for tests of hypotheses regarding elements of the cointegrating vector. The test is known as LR (Likelihood Ratio) test for cointegration. According to Dickey (1991) and Choudhry (1996) cointegrating vectors are obtained from the reduced form of a system in which all the variables are assumed to be jointly endogenous. Thus cointegrating vectors cannot be interpreted as representing structural equations. However, cointegrating vectors may be due to constraints that an economic structure imposes on the long-run relationship among the jointly endogenous variables. Osterwald-Lenum (1992) provides the appropriate critical values required for these cointegration tests.

The results of the LR cointegration tests are reported in table 3.4.7. The test rejects the hypothesis of no cointegration vector in all cases, and for Denmark, France, and Netherlands, the test shows that there exist two cointegration vectors. However, by partitioning the sample into the Snake period 1973.03-1979.03, the EMS period 1982.03-1992.09, the hard EMS 1987.03-1992.09 and EMS wide-bands 1993.08-1994.04 both variables are not cointegrated.\footnote{This is reasonable because the cointegration concept always applies in the long run. When partitioning the series into sub-periods, the series is then not long enough for the cointegration relation can apply.} Note that this finding implies that there exists a long-
run relationship between nominal and real exchange rate over the whole period although different exchange rate agreements were in force.  

**Granger Causality Test**

Granger (1986) and Engle and Granger (1987) developed the concept known as "Granger causality" that takes into consideration the information provided by the cointegrated properties of variables. This test considers the possibility that the past level of a variable \( e_t \) explains the current changes in the other variable or variables \( r_t \) even though the past changes in \( e_t \) do not. Given a VAR representation of a stationary bivariate series \( e_t \) and \( r_t \) then;

\[
\pi(L)z_t = \epsilon_t \text{ and } z_t = (e_t, r_t)
\]

where \( \pi_i \) is a matrix nxn, \( z_t \) is a vector lxn \( \epsilon_t \) is a vector lxn and \( L \) represents the lag operator. then, \( \pi(L) = I + \pi L + \pi L^2 + ... \) can be expressed as:

\[
(3.4.1.7) \quad \left[ \begin{array}{c} \pi_{11}(L) \\ \pi_{12}(L) \\ \pi_{21}(L) \\ \pi_{22}(L) \end{array} \right] \left[ \begin{array}{c} \epsilon_{1t} \\ \epsilon_{2t} \\ r_{1t} \\ r_{2t} \end{array} \right] = \left[ \begin{array}{c} \xi_{1t} \\ \xi_{2t} \\ z_{1t} \\ z_{2t} \end{array} \right], \quad \text{and } \epsilon_t = \left[ \begin{array}{c} \xi_{1t} \\ \xi_{2t} \end{array} \right].
\]

If \( \pi_{11}(L) = 0 \), \( \epsilon_t \) cause \( r_t \) and if \( \pi_{21}(L) = 0 \), \( r_t \) cause \( \epsilon_t \).

I performed the Granger causality test, which consists in regressing \( \epsilon_t \) on two lags of itself and two lags of \( r_t \), and by regressing \( r_t \) on two lags of itself and two lags of \( \epsilon_t \). An \( F \) statistic is performed to establish the validity of the hypothesis. As table 3.4.8. shows, it is not possible to conclude which variable Granger causes the other. There seems to be a feedback relationship between nominal and real exchange rate.

\[182\] Lastrapes (1992) analyzes the nominal and real exchange rates with respect to the dollar over the flexible post-Bretton Woods period. He found that in all cases nominal and real exchange rates were not cointegrated. It is possible to interpret this finding so as that somehow the underlying exchange rate agreement induce a coordination of nominal and real exchange rates, even when not perfect, at least in the long run.

\[183\] \( L^nx_t = x_{t-n} \)
3.4.2 VAR Analysis

The Methodology

In order to analyze the relative magnitude and sources of exchange rate fluctuations under different exchange rate arrangements, I will study the relative importance of nominal and real shocks, and the dynamic response of nominal and real exchange rates to the shocks impacting upon the economies by estimating a VAR model.184

I will follow to some extent the methodology applied by Lastrapes (1992), Clarida and Gali (1994), Mark (1990), and Jordan and Lenz (1995), which facilitates the empirical analysis of sources of fluctuations of time series. In contrast to the papers mentioned above, I will study the sources of fluctuation in real and nominal exchange rates by concentrating on the comparison between the Snake and the EMS period. As usually assumed in the literature, I will consider that the economies, and consequently the exchange rates, are affected by two kinds of shocks: real and nominal. Typical real shocks are changes in resource endowments, technological shocks or fiscal policies. An example of a nominal shock is a change in money growth.

Both variables, nominal and real exchange rates, present a joint stochastic behavior that can be represented by a two variables VAR process.

The VAR methodology was originally developed by Sims (1980) and has become a popular tool in empirical macroeconomics. A VAR system may be thought of as a specific reduced form of a set of dynamic simultaneous equations describing the economy185. Initially, interest in VAR methodology arose because of the inability of economists to agree on the economy's true model. VAR users thought that important dynamic characteristics of the economy could be revealed by these models without imposing structural restrictions stemming from a particular economic theory. In its most unrestricted form, such a system expresses each variable of interest as a function of all variables, believed to be interacting, lagged t times.186 187

184 Other authors have performed the analyses taking into account real variables. See Bayoumi and Eichengeen (1994): they considered consumer prices indexes and output. Blanchard and Quah (1989) considered unemployment rates and a consumer prices index.


186 In practice the selected variables are those that the economist believes concentrate most information about other variables.

187 The Akaike information criterion (AIC) constitutes a guide to the selection of a number of terms in an equation. It places a penalty on extra coefficients. Therefore, the length of a lag distribution can be determined by choosing the specification with the lowest value of AIC. It can be applied to any model that can be estimated by the method of maximum-likelihood. It consists in minimizing the following expression: -2log L/n +2k/n where k is the number of parameters in L. The Schwarz criterion is an alternative to the AIC based on the same interpretation. See Maddala (1992), Griffiths, Hill and Judge (1993).
No a priori restrictions have been imposed which would prevent a specific variable from influencing others directly. Therefore, the data are allowed maximum freedom to determine the dynamic relationships between the variables in the model.

A two-variables VAR system lagged twice can be expressed as follows:

\[(3.4.2.1)\] 
\[e_t = a_{11}e_{t-1} + a_{12}r_{t-2} + b_{11}r_{t-1} + b_{12}r_{t-2} + u_{et}\]

\[(3.4.2.2)\] 
\[r_t = a_{21}e_{t-1} + a_{22}e_{t-2} + b_{21}r_{t-1} + b_{22}r_{t-2} + u_{rt}\]

where \(e_t\) is the nominal exchange rate and \(r_t\) is the real exchange rate.

In the equational system presented above, each variable of interest depends on its own lagged value as well as on the lagged value of the other ones. An error term \(u_t\) is also present and represents those influences that cannot be accounted otherwise than by the model. Thus, \(u_{et}\) is thought as the current innovation of \(e_t\) and constitutes the part of \(e_t\) that could not have been predicted from the history of all variables of the system. Equation (3.4.2.1) and (3.4.2.2) form the so-called autoregressive representation of the system of order \(p\), AR(\(p\)) \(^{188}\) and can be applied to test hypotheses about the dynamic relationships between the variables.

Equations (3.4.2.1) and (3.4.2.2) can also be represented in a compact way as a vector, where \(z_t = (e_t, r_t)\) is a \(n \times 1\) vector, \(A\) is the matrix of coefficients \(n \times n\), \(L\) represents the lag operator and \(v_t = (u_{et}, u_{rt})\) \(n \times 1\) represents the vector of innovations.

\[(3.4.2.3)\] 
\[z_t = A(L)z_t + v_t\]
\[A(L) = A_0 + A_1L + A_2L^2 + ... + A_pL^p\]

The equation (3.4.2.3) also constitutes an AR(\(p\)) and can be interpreted as determining the joint reaction of each of the endogenous variables of the matrix \(z_t\) to the vector of shocks \(v_t\) affecting the economy.

To study this reaction it is convenient to transform the system as a VMA(\(q\)) (vector moving average) representation, which implies expressing the matrix of variables \(x_t\) as a function of the vector of residuals \(v_t\) \(^{189}\).

A VMA(\(q\)) structure implies that the solution of each dependent variable will depend on the past values of all innovations. For example, the solution of \(e_t\) will be:

\[(3.4.2.4)\] 
\[e_t = h_0u_{et} + h_1u_{et-1} + h_2u_{et-2} + ... + h_qu_{et-q} + c_0u_{rt} + ... + c_1u_{rt-1} + c_2u_{rt-2} + ... + c_qu_{rt-q}\]

By operating on (3.4.2.3)

\[(3.4.2.5)\] 
\[[I - A(L)]z_t = v_t\]
\[and\] 
\[[I - A(L)] = B(L)\]

then,

\[(3.4.2.6)\] 
\[B(L) z_t = v_t\]

\(^{188}\) In this case \(p = 2\).

\(^{189}\) It is always possible to transform an AR(\(p\)) in a MA(\(q\)) whenever the system is invertible. See Harvey (1992).
with \( \text{Cov}(u_t, u_{t-1}) = 0 \).

By inverting the expression (3.4.2.6) the MA(q) (moving average of order q) is obtained.

\[
(3.4.2.7) \quad z_t = C(L)v_t
\]

with

\[
(3.4.2.8) \quad B^{-1} = C(L).
\]

Both variables \( e_t \) and \( r_t \) are assumed to be serially and mutually uncorrelated in lags and leads. As is usual in this kind of models, the variances are normalized to unity.

The identification assumption consists on \( \text{C}_{12}(0) = 0 \) that restricts shocks to the nominal exchange rate equation \( e_t \) not to have a contemporaneous effect on the real exchange rate equation. However, shocks to the real exchange rate equation by definition affect the real exchange rate contemporaneously. The restriction allows for a permanent effect of both types of shocks on the level of real exchange rate, as well as on the equilibrium of the nominal exchange rate. Because of the unit root assumption \( r_t \) and \( e_t \), at least one of both shocks must have a permanent effect on the level of each variable.

The empirical work presented in this section concentrates on two aspects, the computation of response patterns over time in a variable due to an innovation in itself or in the other variable, and the determination of the relative importance of each of the innovations in accounting for the variations in the dependent variables.

The first effect is known as impulse-response function: if there is an increase in \( u_{et} \) in period \( t \) and no changes in the other innovations, the response of \( e_t \) values will be as follows:

\[
(3.4.2.9) \quad e_t = d_0
e_{t+1} = d_1
e_{t+2} = d_2
\]

\[ ... \]

The sequence of values \( d_0, d_1, d_2 \ldots \) is the so-called impulse-response function of the system, and it shows the response of a variable over time to a specific disturbance. In the following section, the impulse-response functions are estimated to describe the way in which the nominal and the real exchange rates respond to shocks in the nominal and in the real exchange rate equations.

In order to measure the relative importance of one variable in accounting for movements in another, the expression for the forecast of the variable is needed. Notice this implies the prediction of one period in advance of equation (3.4.2.4).

\[
(3.4.2.10) \quad e_{t+1} = b_0 u_{et+1} + b_1 u_{et} + b_2 u_{et-1} + \ldots
\]

\[ c_0 u_{rt+1} + c_1 u_{rt} + c_2 u_{rt-1} + \ldots \]

Using (3.4.2.10) it is possible on the basis of knowledge of all current (period \( t \)) and past shocks to the economy to forecast the most likely value of \( e \) in period \( t+1 \). Since no information about disturbances during the next period \( (u_{et+1}) \) is available, their expected value is set to zero. Then, I obtain:
(3.4.2.11) \[ e_{t+1}^e = b_1 u_{et} + b_2 u_{et-1} + \ldots + c_1 u_{rt} + c_2 u_{rt-1} + \ldots \]

Combining (3.4.2.4), (3.4.2.10) and (3.4.2.12) the forecast error is:

(3.4.2.12) \[ e_{t+1} - e_{t+1}^e = b_0 u_{et+1} + c_0 u_{rt+1} \]

The size of the forecast error depends on the impulse-response coefficients (b_s and c_s) as well as on the sizes of the innovations to each of the variables. This property can be used to define a measure of the relative size of the forecast error variance that can be attributed to each of the innovations.

**Empirical Results**

In this section the empirical results provided by the two-equations VAR(2) model are presented. The lag was established in two because the Akaike and Schwarz criteria indicated that it was the optimal in most countries, and an uniform lag of two was chosen to preserve the uniformity of the model across countries.

**Impulse Response Analysis**

An impulse response analysis was performed in order to study the effect of the introduction of the EMS on the response to different shocks affecting the economies. I consider the following periods: the Snake 1973.03 -1979.03, the EMS without realignments 1987.03-1992.09, and the EMS wide bands 1993.08-1994.04.

**Snake 1973.03-1979.03**

In chart 3.4.1 the impulse-response functions for the levels of real and nominal exchange rate of six European countries are displayed. Each panel plots the dynamic response of the nominal/real exchange rate to a standard deviation of either a shocks in the nominal exchange rate equation \( (u_{et}) \) or the shock in the real exchange rate equation \( (u_{rt}) \) over a forecast horizons from 1 to 35 months. Because the real exchange rate is a relative price between domestic and foreign goods, it seems reasonable to interpret the shock to the nominal exchange rate equation as a nominal shock and a shock to the real exchange rate equation as a real shock.¹⁹⁰

For most of the countries, the response of the nominal exchange rate to a shock to the nominal exchange rate equation shows a hump-shaped form which peaks within approximately two or three months and afterwards decreases smoothly. Nevertheless, ¹⁹⁰ Monetary shock was interpreted in the theoretical model as an expansionary/contractive monetary policy and a real shock can be interpreted as an expansionary/contractive fiscal policy. (See Chapter 2).
there is a small permanent effect in the long run. In the case of Belgium, as the panel shows, the nominal shock induces an immediate response in the nominal exchange rate of about 0.05% of its initial level; but this effect increases to 0.06% and afterwards decreases slowly over the next 10 months, reaching the steady state after approximately 24 periods. The panel shows an overshooting response to a nominal shock. Nominal shocks seem to be absorbed in the short-run by the nominal exchange rate instead by the prices. This result is consistent with a sticky-price behavior.\textsuperscript{191}

The response of the nominal exchange rate to a shock in the nominal exchange rate equation for the others countries is depicted in the following panels. All of them show a similar behavior, though the degree of response differs from country to country. In Denmark the response reaches 0.5% at the peak, in France 1.2%, Italy 0.01%, Netherlands 0.85%, in the UK the response is unusually large, 15%, but after the impact effect the nominal exchange rate seems to move back to the initial level.

The response of the nominal exchange rate to a shock in the nominal exchange rate equation shows also a hump-shaped form which is very similar to the previous case, but the impact seems to have a transitory effect, which disappears over time. For Belgium, the immediate response to a nominal shock is about 0.07%, increasing to 0.083% and reaching the peak after 3 months. It then declines relatively quickly over the next 10 months, and finally the rate of decrease appears to be slowly, disappearing over the next 3 years, with some statistical confidence, almost completely. For the other countries, the pattern of response turns out to be similar. In France the responses reaches a peak 2.5%, Italy 0.03%, Netherlands 1% and Denmark 0.9%. The U.K. is again unusually high, 32%.

The response of nominal exchange rate to a shock in the real exchange rate equation reacts with a negative correlation, showing in most of the cases a mirror image to the response of the nominal exchange rate to a nominal shock. The result seems to be consistent with the prediction of the theoretical model in response to a fiscal shock (appreciation of the domestic currency in response to a positive fiscal shock). For Belgium it peaks at -0.015% after 3 months, afterwards increases slowly over the next 10 months and remains a persistent effect. For all the other countries, the panels show similar pattern. Only the degree of impact of shocks differs from country to country. For example, in the United Kingdom the impact is much larger. Finally, the effect of a real shock to a real exchange rate reaches a peak after 4 or 5 periods the effect. In most cases, remains at this level, which is the new steady state. The results seems to show the permanent effect predicted by the Mundell-Fleming-Dornbusch theoretical model presented in Chapter 2.

Summing up, though differing in magnitude, the response seems to show a relatively similar behavior in most of the countries. In general, the empirical results seem to be consistent with the predictions delivered by the Mundell-Fleming-Dornbusch theoretical model. Nominal shocks induce a permanent effect on nominal exchange rates; however, the impact overshoots the new equilibrium level. Nominal exchange rates absorb the nominal shock fully. Once prices react, the nominal exchange rates approach to the new equilibrium level. The impact of the nominal shock on the real exchange rate is transitory. Real shocks to both nominal and real exchange rate equations

\textsuperscript{191} See Dornbusch (1976).
show a permanent impact, and in general, they are inversely correlated to the shocks.\textsuperscript{192}

**Hard EMS 1987.03-1992.09**

In this section by applying the same procedure as before for the period corresponding to the hard EMS, the response behavior of nominal and real exchange rates to shocks in the nominal and real exchange rate equation are presented. See chart 3.4.2. The second graph on the left side (continuous line) shows the response of the nominal exchange rate to a shock in the nominal exchange rate equation for Denmark. The response shows a hump-shaped form, and peaks after 3 periods. The effect disappears completely after 9 or 10 periods. Denmark, 0.12%; France, 0.22%; Italy, 0.0014%; Netherlands, 0.2%. The highest impact is observed in the case of Belgium, 12% and U.K., 8%. The response of the nominal exchange rate to a shock in the real exchange rate equation is depicted in the same panel (discontinuous line). The impact peaks after approximately 3 months and tends to disappear over time. The impact reaches 3.8% in Belgium, -0.02% in Denmark, 0.02% in France, 0.0002% Italy, 0.001% in the Netherlands, 2% in the U.K.

The response of the real exchange rate to a shock in the nominal exchange rate equation is depicted in the chart on the right side (continuous line). It also shows a hump-shaped form peaking after 3 or 4 periods, 80% of the effect; declines over the next 6 periods and become even negative; afterwards it declines slowly, but persists for some time. This real exchange rate volatility can be attributed to the sluggish prices behavior: once prices react to the shock, there is some real exchange rate appreciation. In Belgium the peak is reached at 12%; in Denmark, 0.1%; in France, 0.8%; Italy, 0.00012%; Netherlands, 1%; UK, 8%. Finally, the response of the real exchange rate to a shock in the real exchange rate equation peaks after 4 or 5 periods and the effect, in most cases, shows a persistence in the long run. However, in the Netherlands the effect disappears completely. Nominal exchange rates seem to show a much lower and a more similar response to nominal shocks during the EMS than during the Snake. The result seems to be consistent with the limited flexibility imposed by the EMS. However, the larger impact of nominal shocks is observed on real exchange rates which after the first positive impact tend to react negatively. This behavior is consistent with a sluggish response of prices. An expansionary monetary will induce a small improvement in real exchange rate, and once prices react, the effect is more than compensated for and finally the real exchange rate appreciates. By comparing the magnitude of the response to nominal shocks between the EMS and the Snake, the first is much lower and more similar across countries. Nevertheless, the responses to fiscal shocks seem to be very different across countries. In general, by analyzing the responses of the EU countries, the EMS seems to have reduced exchange rate volatility. In addition, it has also lowered the speed at which member countries respond to shocks. The results imply that by introducing a greater degree of fixity in the exchange rate regime, the response to shocks seems to be more prolonged and much more correlated across coun-

\textsuperscript{192} A positive fiscal shock will induce a nominal and real exchange rate appreciation.
tries, which is the direct consequence of the co-ordination to some extent of the monetary policies

**EMS Wide Bands 1993.07-1994.04**

Chart 3.4.3 shows the impulse response function for the post-crisis period. The response of the nominal and real exchange rate to a shock in the nominal exchange rate equation shows a greater volatility than under the previous arrangements. The form of the response function shows a zigzag form: the peak is reached in most of the cases after 3 or 4 periods, but this is followed by a negative response. The effects disappear completely converging to zero after 15 periods. The only countries that show a relatively stable pattern after the shock in the nominal exchange rate equation are UK and Italy, which are exactly those countries that left the ERM after the crisis of September 1992.

The response of the nominal and real exchange rate to a shock in the real exchange rate equation shows a relative less volatile pattern and the effect disappear completely after approximately 10 periods.

**Forecast Error Variance Decomposition**

Tables 3.4.9, 3.4.10 and 3.4.11 depict the variance decomposition (VCD) for the Snake, hard EMS and the EMS-wide bands respectively. The variance decomposition shows the proportion of variance of n-quarter ahead forecast errors for the nominal and real exchange rate attributable to nominal shocks innovation and to the real shocks innovation according to the VAR(2) model. While the impulse-response function shows the dynamic effect of a one-time shock, the VDC is a convenient measure of the relative importance of such a shock to the system.

According to table 3.4.9, nominal shocks are the primary contributors to the variance forecast error. In the case of Belgium, when forecasting the level of nominal exchange rate, 92.5 % of the forecast error variance is attributed to nominal shocks for horizons up to 16 months; in Denmark, 96.44 %; in France, 98.31 %; Italy, 86.29 %; in the Netherlands, 95.08 %; United Kingdom, 86.01 %. In the long run, over 35 months the contribution of output declines very little and remains over 70 % for all the countries.

For the hard-EMS period, in most of the countries nominal shocks also explain over 90% of the forecast error; and for longer horizon over 35 months, nominal shocks still explain over 80 % of the forecast errors, except for the case of Belgium.

During the EMS-wide bands the nominal shocks also explain over 90 % of the forecast error; only in the case of Italy is the figure extremely low at 59.23 %. Real shocks seem to have a relative lower effect in explaining nominal exchange rate fluctuations in all the periods. During the Snake, when forecasting real exchange rates, nominal shocks seem to have a less uniform effect across countries: 52.78 % in Belgium; 74.22 % in Denmark; 89.68 % in France; 65.18 % in Italy; 30.75 %; in the Netherlands, and 48.68 % in the United Kingdom. In all cases, the effect decreases when forecasting for

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193 This period is not long enough, so that the result must be interpreted very carefully.
longer horizons. During the hard-EMS, the effect is very irregular across countries: 32.23% in Denmark; 19.23% in France, 28.85% in Italy, 31.20% in Netherlands; and 52.19% in the United Kingdom. Finally, during the EMS-wide bands, nominal shocks seem to explain an even larger proportion of the real exchange rate fluctuations: 98.81% in Belgium; 96.74% Denmark; 93.63% France; 54.30% Italy; 68.75% Netherlands; 96.77% United Kingdom. The decrease of the effect over time is not very significant.

Summing up, the results obtained in these two sections are as follows: in all the countries there is an interdependent relationship between nominal and real exchange rates. The results are to some extent consistent with the predictions of a two-country Mundell-Fleming-Dornbusch model under rational expectations. Nominal shocks seem to be mainly responsible for exchange rate fluctuations in all periods. However, nominal shocks tended to have a transitory effect on real exchange rates during the Snake but a permanent one during the EMS. Real shocks tended to have a permanent effect in both nominal and real exchange rates; and in general the response was negatively correlated with the shocks. Nevertheless, while nominal shocks seem to show a more similar pattern during the EMS, real shocks seem to show a less uniform pattern. Finally, the forecast-error-variance-decomposition shows that nominal shocks seem to be the main contributors of exchange rate fluctuations in both periods Snake and EMS, while the exchange rate fluctuations attributed to real shocks seems to be less important.

**Concluding Remarks**

In this section 3.4. I estimated a VAR model in nominal and real exchange rates for six European countries. I investigated the dynamic behavior in response to nominal and real shocks during the Snake and the EMS periods. I found that the dynamic behavior seems to be consistent to some extent with the prediction of a two-country Mundell-Fleming-Dornbusch model under rational expectations. During the more flexible exchange rate period, the Snake, nominal shocks seem to have had permanent effect on nominal exchange rate, but a transitory effect on real exchange rates. On the contrary, during the EMS the effect on real exchange rates is not significant. Real shocks showed a permanent effect in both nominal and real exchange rates in both periods. Second, the result of the variance-decomposition-analysis suggests that nominal shocks explain the larger proportion of exchange rate volatility. Real shocks appear to be less important in explaining exchange rate fluctuations. The evidence provided in this part is consistent with the finding reported by Dornbusch and Giovannini (1988) and Giavazzi and Giovannini (1989), and with the theoretical model presented in chapter 2. It indicates that members of the EMS have enjoyed, to some extent, a reduction in exchange rate volatility. This is a direct consequence of the fact that nominal shocks were mainly responsible for exchange rate fluctuations. Therefore, a movement towards a more fixed exchange rate agreement induces the coordination among monetary policies, reducing in this way the source of exchange rate volatility. Nevertheless, a fixed exchange rate regime has no power to coordinate either fiscal policies or other kind of real shocks, and therefore the variability due to real shocks cannot be moderated.
3.5 Summary and Conclusions

In this third chapter, I analyzed the European experience with exchange rate agreements in order to be able to draw some lessons for the MERCOSUR case. In the European Union, the single market program has created growing momentum for deeper integration and thus the movement towards a single European currency was regarded as an additional component of this integration. The European Union constitutes an excellent example of a successful integration process, and therefore, it becomes interesting to analyze how the discussion on exchange rates agreements developed over time. In contrast with the European case, within MERCOSUR countries the debate about exchange rate agreements has been barely touched on altering current monetary arrangements, although the arguments as to the advantages of fixing exchange rates in order to obtain the full benefits of economic integration apply in the same way as in the European case.

I reviewed, first, the historical experience since the founding of the European Union towards monetary agreements. In the early period, when the European Community was founded, the stability of intra-European currencies did not constitute a problem by then, with the Bretton Woods system providing sufficient nominal and real stability among currencies. After the breakdown of Bretton Woods, the European states were concerned about developing their own monetary agreements to allow them to maintain stability among their currencies. Actually, some of the arrangements that the EC had introduced, such as the CAP, relied on relatively stable exchange rates. In this context, a number of exchange rate agreements developed through the years, first the Snake and later on the EMS. The EMS, which constitutes a quasi-fixed exchange rate system with escape clauses, has been widely perceived as a success, at least until the crisis of September 1992. Therefore, it becomes interesting to analyze the extent to which it has contributed to the reduction of exchange rate variability and inflation across European countries. The EMS has not been an homogenous system over eighteen years, since a learning- by-doing process has been present, and the system has been adjusted through the years. Thus, although initially designed as a symmetric system, it has worked "de facto" in an asymmetric way. Additionally, the frequency of realignments also has changed dramatically from its beginnings until the aftermath of the Basle-Nyborg agreement.

Second, I concentrated on the EMS performance towards the achievement of price and exchange rate stability. I found that convergence has been observed in monetary variables such as inflation rates, interest rates and monetary growth rates. Fiscal indicators, however, like the debt ratios and fiscal deficits did show divergence rather than convergence. In addition, I analyzed the costs in rates of unemployment the EMS has introduced. It does not seem that the EMS has significantly reduced the costs of disinflation. On the contrary, in comparison to non-European countries, the cost has been significantly higher: at least, unemployment rates have increased over 10 percent across Europe. This fact can be explained through the rigidities in European labor markets. Thus, the sluggish adjustment of nominal wages contributed to increase unemployment rates.

Third, I introduced an econometric analysis in order to discuss the performance of the EMS regarding nominal and real exchange rate variability. I estimated the two- equations Mundell-Fleming-Dornbusch model under rational expectations presented in
chapter 2. I analyzed the dynamic behavior of nominal and real exchange rates in response to nominal and real shocks. I found the results to be consistent with the theoretical model previously presented. The Snake, which was considered as a proxy for a flexible exchange rate, seems to have induced more variability in both real and nominal exchange rates. Additionally, the variance-decomposition analysis suggests that monetary shocks explain a larger proportion of exchange rate variability. In this sense, by coordinating monetary policies some stability was introduced. Nevertheless, the EMS had no influence on fiscal policies. Summarizing, the adoption of a relative fixed exchange rate agreement among members of an economic area seems to be a desirable target, even when it is difficult to achieve. At least the European experience has shown that after the breakdown of Bretton Woods quite significant efforts have been invested in designing a feasible monetary arrangement that could reduce exchange rate variability and could help to achieve price stability. However, the collapse of the EMS in 1992-93 and the movement toward wide bands (+-15 %) showed the fragility of the system.

A fixed exchange rate system helps to coordinate monetary policies among its members. However, it does not eliminate the necessary adjustment in domestic policies. A fixed exchange rate regime can only help to coordinate expectations, but cannot replace the introduction of austerity measures and has no power at all to coordinate fiscal policies. To fix artificially the exchange rates in order to pursue price stability only delays the adjustment, and in the end the market threatens the domestic currencies, accelerating exchange rate collapses. Because nominal shocks explain a larger proportion of exchange rate fluctuations, a movement towards a more fixed exchange rate arrangement represents a partial solution, even when it cannot solve all the problems. In order to avoid speculative attacks, additionally rules to coordinate macroeconomic policies among the countries should be introduced, especially some measures that allow the incorporation of fiscal
### Table 3.4.1

Nominal Exchange Rates

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.7</td>
<td>0.08</td>
<td>0.8</td>
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<td>0.09</td>
<td>0.9</td>
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<td>1.7</td>
<td>0.4</td>
<td>1.3</td>
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<td>0.9</td>
<td>3.2</td>
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<tr>
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<td>0.9</td>
<td>0.9</td>
<td>0.08</td>
<td>0.1</td>
</tr>
<tr>
<td>UK</td>
<td>1.1</td>
<td>2.4</td>
<td>2.4</td>
<td>1.6</td>
<td>2.0</td>
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</table>

Source: Main Economic Indicators. OECD Own calculation. Standard deviation*(100). All exchange rates has been calculated in relation to the DM.

### Table 3.4.2

Real Exchange Rates

<table>
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<tbody>
<tr>
<td>Belgium</td>
<td>1.0</td>
<td>0.8</td>
<td>0.9</td>
<td>0.3</td>
<td>1.1</td>
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<tr>
<td>Den.</td>
<td>1.4</td>
<td>1.3</td>
<td>0.8</td>
<td>0.6</td>
<td>1.5</td>
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<tr>
<td>France</td>
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<td>1.8</td>
<td>0.9</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Italy</td>
<td>0.9</td>
<td>2.8</td>
<td>1.1</td>
<td>0.9</td>
<td>3.1</td>
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<tr>
<td>Neth.</td>
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<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>UK</td>
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<td>2.5</td>
<td>2.3</td>
<td>1.6</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Source: OECD. Own calculation. Standard deviation*100
### Table 3.4.3

**Correlation Coefficients**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Belgium</td>
<td>0.85</td>
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<tr>
<td>Denmark</td>
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<tr>
<td>Italy</td>
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<tr>
<td>Netherlands</td>
<td>0.68</td>
<td>0.58</td>
</tr>
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<td>United Kingdom</td>
<td>0.98</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Source: Main Economic Indicators. OECD. (own calculation)

### Table 3.4.4

**Unit Root Tests 1973.03 1994.04**

**ADF tests**

<table>
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<tr>
<th>Country</th>
<th>Nominal exchange rate</th>
<th>Real exchange rate</th>
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</thead>
<tbody>
<tr>
<td>Belgium</td>
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<td>Italy</td>
<td>-5.108968</td>
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<td>Neth.</td>
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<td>-4.081215</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-3.4794</td>
<td>-6.343717</td>
</tr>
</tbody>
</table>

Mc Kinnon critical values for rejection of a unit root are: -3.4575 (1%), -2.8729 (5%), 2.5728 (10%).