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DECLARATION

Chapter 1 is a substantial extension of the M.Sc. dissertation *'New Evidence for the Imported Credibility Model of the EMS*, by the same author, University of Southampton (1991). In particular, most of sections 1.3 and 1.4 and part of section 1.2 refer to the dissertation. The rest of the material, however, has not been submitted previously. As for chapters 2, 3, 4 and 5, no portion has been submitted in support of an application for another degree or qualification from this University or any other Institute of Learning.

ABSTRACT

The aim of the thesis is to contribute to the debate over the past experience of the ERM and the prospect of the creation of EMU, both by throwing new light on issues where no agreement has been reached in the literature and by investigating important areas so far overlooked. Methodologically, we will consider existing theories and test for their empirical implications by applying time series econometric techniques; and for the ERM crisis of 1992 we develop our own theoretical model and provide preliminary empirical results on its implications.

In the first chapter we consider the process of disinflation which Europe and the US experienced in the 1980s and adopt the Hamilton filter for the analysis of inflation differentials for the ERM countries against Germany. The results are supportive of the view that the ERM membership helped inflation-prone countries to reduce inflation in the first phase of their commitment to stable exchange rates, but they also show that a sizeable positive differential persisted for Italy.

In the second chapter we test for the validity of the empirical implication for expected realignments of the model of target zones, proposed by Bertola and Svensson, and show that these are not corroborated by our results.

In the third chapter we propose a theoretical model of the ERM crisis of 1992, which focuses on how the attitude of the Bundesbank towards the defence of the weak currencies in the system feeds into market expectations of the sustainability of the System and of future exchange rates.

The empirical implication of our theoretical model, as for expected devaluations, is considered in details and tested in chapter four; the results seem to be consistent with the model.

In chapter five we investigate whether the EU as a whole has the characteristics necessary for a successful currency union and in particular focus on how employment shocks spread in Europe; the results seem to support the call for a two-speed Europe.

Introduction

1.1: Historical background

Both the past experience of the ERM, for the 1980s and the first part of the 1990s, and the future prospect of the formation of a currency union in Europe, have been at the centre of attention of academic analysis and the broad economic policy debate in recent years.

The origins of the idea of a European currency union go back at least as far as the years following the end of the second world war, when the Organization for European Economic Cooperation and the European Payment Union were founded, the first in 1948, the second in 1950 (Eichengreen, 1993). A first attempt to establish a monetary union in Europe was made in 1962 when the Commission of European Communities drafted a plan suggesting the completion of the union within ten years. However, the late 1960s brought currency turmoil not only in Europe, but in the whole of the Western World; and the Bretton Woods System, which has guaranteed currency stability for over twenty years, finally collapsed in the early 1970s. In order to revive the program of a currency union, a committee was formed, chaired by Pierre Werner, with the objective of drawing up a new plan. The report was finalised by the end of 1970; like the plan drawn in 1962, it suggested full monetary union within a decade with a gradual transition to reach it. The first practical step towards it was the formation in 1972 of a scheme of limited exchange rate fluctuations within Europe, the so-called 'Snake'. However, due to the effects of the first oil shock in 1973 on the European economies , some of the countries who joined the Snake were forced to leave the system, either on a temporary basis or permanently.

A new milestone in the effort to limit exchange rate fluctuations among the countries belonging to the European Community was the summit held in Bremen in 1978, which led to the creation of the European Monetary System (EMS) and its core, the Exchange Rate Mechanism (ERM); all the countries belonging to the EC at the time

joined the EMS in March 1979, except the United Kingdom, which joined the ERM only in October 1990.

The ERM was designed as a system of limited fluctuations among the currencies of the member countries. The band of fluctuations was established to be of +/- 2.25 around a central parity, with the exception of Italy, which was granted a band of +/- 6%. Realignments of the central parities were allowed, subject to previous agreement with the monetary authorities of the member countries.

According to the Act of Foundation of the ERM, it was established that once two currencies hit the limit of their band of fluctuation, the central banks of both the countries involved were obliged to intervene in defence of the weak currency. 'These interventions shall be unlimited at the compulsory intervention rates' (document 8, section 1, article 2.2 as reported in Eichengreen and Wyploz 1994); credit facilities (Very Short Term Facilities, VSTF) were made available to ease the process of defence of the central parity.

According to Gros and Thygesen (1992), the history of the ERM until 1992 can be seen as evolving in three periods, if we use as a criterion the change in attitude towards realignments. In the years between 1979 and 1983 the system looked like a crawling peg and experienced eight realignments overall. Between 1983 and 1987 there was a tighter commitment to exchange rate stability; after 1987, and until the currency crisis of 1992, great emphasis was put on the objective of the exchange rate fixity; the goal of exchange rate stability within the System acquired more credibility, although full credibility was never achieved and it proved to be quite fragile, after all. Clearly, 1987 was an important date also because it marked a substantial change in the way central parities were going to be defended: the member countries decided to rely more on interest rate changes and on exchange rate flexibility inside the band, rather than primarily on interventions. This shift in approach found its formalization in the Basle-Nyborg Agreement signed in September 1987.

The change in attitudes towards realignments reflected a change in attitude towards the ERM itself: while in the early years its membership was interpreted in a fairly loose

way, the last period was marked by the resumption of the formation process of the Monetary Union. In 1988 the European Council appointed a committee, chaired by Jacques Delors, president of the European Commission at the time, whose task was to study the feasibility of a Monetary Union. This step followed the agreement over the Single European Act in 1986, according to which the EC countries committed themselves to create by the end of 1992 a fully integrated European market, where commodities, capital and labour could move freely; restrictions to capital movements were completely lifted in all the EC countries, with the exception of Greece, Portugal and Spain, by 1990.

The committee chaired by Delors produced a report which later became the basis of the treaty signed in Maastricht at the end of 1991. The Treaty envisages the formation of the European Union to be achieved in three stages and establishes four criteria which needed to be met for a country to become a member of the Monetary Union (see Eichengreen 1993 for details). The earliest date set for the inception of the Union is 1997, if a majority of countries has met the four criteria by that time; if not, the Treaty states that the Monetary Union should be implemented by the 1st of January 1999, even if only a limited number of countries will have met the conditions by that time and, hence, will be able to participate. Recently, it was publicly announced that the only date feasible for the formal creation of the EMU will be 1999. Cancelling the option for beginning earlier reflects the evident difficulties which the member countries are facing and have faced for the past few years. The ERM was plunged into crises both in September 1992, which led to the exit of the Italian Lira and the British Pound from the System and the fluctuation of their currency, and again in July 1993, when it was decided to enlarge the fluctuation bands for the remaining members from +/- 2.25 to +/- 15%. Despite these currency crises, however, the proviso of the Maastricht Treaty for the formation of the Monetary Union is still valid, subject to the delay of two years, at least at the time of writing.

The attention devoted by the academic research to all the issues related to the creation and the working of a Monetary Union and of a system of limited exchange rate

flexibility, like the ERM Considerable has been considerable (see Masson and Taylor 1993 for an extensive survey).

I.2: Topics to be considered

The goal of the thesis is to make a contribution to the current debate by shedding light on some of the most controversial issues. We aim to analyse the past experience of the ERM, with an eye to the lessons which can be learnt for the formation of the Monetary Union. Methodologically, we will consider existing theories and test for their empirical implications by applying time series econometric techniques; and, for the ERM crisis of 1992, we develop our own theoretical model and provide preliminary empirical results on its implications.

I.2.i: Disinflation and the ERM

In the first chapter we investigate the process of disinflation in Europe in the 1980s and the possibility that ERM membership had a role to play in it. To clarify the ERM role is extremely important as the 'discipline effect' is often viewed as one of the main benefits of the EMU membership. According to *The Economist* (2nd September 1995, page 15), for example, the Italian government believes that the re-entry of the Italian Lira in the ERM would help cut the budget deficit and restrain inflation.

The approach followed in the empirical literature on the subject has been to look for any significant change in pattern in inflation or any parameter non-constancy in relationship between inflation, output growth and wage inflation, usually by analysing the pre and post-ERM periods or by dividing the ERM period in two subperiods: 1979-1983 and post-1983. As a consequence, all the results of the analysis are conditional on a given choice of a break date. In chapter 1 we propose, as an alternative, to analyse the time series behaviour of inflation differentials with Germany by adopting a recent econometric technique suggested by James Hamilton (1989). This allows one to test for the presence of a regime shift in the series and to find the timing of the switch in an <u>endogenous</u> fashion. The results, then, do not depend on any prior choice of a break date by the researcher.

I.2.ii: Devaluations expectations in the ERM

The question on the role of the ERM in the disinflation process is closely linked with the issue of credibility of the commitment to exchange rate stability. In the model of 'imported credibility' (Giavazzi and Pagano 1988, Giavazzi and Giovanninni 1989), which is the main theoretical reference to support the idea of an effective role of the ERM membership in bringing down inflation in inflation-prone countries (Italy), the crucial aspect for achieving a lower level of inflation by pegging the exchange rate with a strongly inflation-averse country (Germany) instead of by targeting money supply growth, is the credibility of the commitment of the exchange rate target.

The literature on the effect of the presence of currency bands on the behaviour of exchange rates mushroomed in the first part of the 1990s, following the seminal paper by Krugman (1991a) on 'Target Zones and Exchange Rate Dynamics'. While the original paper assumed fully credibility of the bands, most of the subsequent literature focused on models which allowed for the presence of realignments of the central parity, the so called 'second generation target zone models' (see Bertola 1993 for a broad survey of this literature); among these models, the one which has received the strongest support, on the grounds of favourable empirical evidence, has been proposed by Bertola and Svensson (1994), which is why it is subjected to further testing in chapter two.

The major difference from the Krugman model is the inclusion, among the determinants of the exchange rate, of an expected rate of devaluation, which is assumed to follow a Brownian motion process (or, in discrete time, a random walk). Although the authors point out that the assumption of uncorrelated innovations is made for tractability and analytical convenience, they do not question the more general assumption that devaluation expectations follow an integrated process of the first order, I(1). The assumption that expectations of a realignment follow an I(1) process does not seem very appealing on economic grounds and, given that the strength of the model seems to be the fact that it fits the data better than its alternative, in chapter two we test directly for the validity of their assumption. We do this by analysing the time

series behaviour of interest rate differentials; it will be shown how the interest rate differential can be seen as the sum of three components: expected devaluations, expected change of the exchange rate inside the band and a risk premium; as it can be assumed that the last two components follow stationary processes, it follows that if the expected devaluation actually behaves as an I(1), the same will be true for interest rate differentials.

I.2.iii: A Model of the 1992 ERM crisis

The framework of the target zone literature will also be adopted to analyse the currency crisis which the ERM experienced in 1992 and led to the exit of the Italian Lira and the British Pound from the System. It is clear by now that the crisis can be attributed to several causes. The victory of the 'no' vote in the Danish referendum on the ratification of the Maastricht Treaty in June 1992, for example, weakened the conviction that the Treaty would be ratified after all, given that the approval of all the 12 countries was needed for it to become operative. Then there are the consequences of the German unification, either higher inflation in Germany, or a general realignment implying the revaluation of the Deutschmark, or disinflation in the other ERM countries were needed if tight monetary policies throughout Europe were to be avoided. But as for the first of these options, the Bundesbank was strongly against any increase in inflation in Germany. As for the second, the German partners, and France in particular, opposed a general revaluation of the Mark, and as for the third the disinflation process in the ERM countries was not sufficient to balance the effects of the German reunification.

In the absence of fiscal measures to finance the cost of unification and to check the excess deficit in Germany, it followed that tight money emanating from Germany was inevitable. But the high level of interest rates in Germany, coupled with the need for the other ERM countries to maintain positive interest rate differentials with Germany in order to keep exchange rate parity with the Mark provoked pressure on their domestic markets, which were going through a recession period. This aspect of the

crisis has found detailed analysis in the models proposed by Masson (1994), Obstfeld (1994) and Ozkan and Sutherland (1994).

One aspect of the crisis widely recognised in the institutional literature (Eichengreen and Wyploz 1994, Kenen 1994), but not in the theoretical literature, is the attitude of the Bundesbank towards defending the currencies of the System under attack. Despite the fact pointed out earlier that the Act of Foundation of the ERM calls for intervention of 'possibly unlimited amount' in order to defend currencies under pressure, it became patently clear in September 1992 that the German central bank had no intention of doing so. Indeed, this was clear both to the Bundesbank and to the German Government from the beginning of the ERM experience: in a speech to the Bundestag in December 1978, the Finance Minister of the time said that '...the Bundesbank has the responsibility to intervene, <u>and the option not to intervene if it is its opinion that it is not able to do so</u>..'.

The two-country model contained in chapter three includes a facility for borrowing reserves to see how it affects expectations of future exchange rates and the behaviour of exchange rate inside the band. It considers a situation where the domestic country (Italy or the UK) has run out of reserves in order to defend its currency and, in order to maintain the sustainability of the system, the central bank of the foreign country (Germany) agrees to provide a loan. The foreign central bank, however, has the right to call back the loan at any time and the probability of the loan being called back is modelled as a Poisson process with constant probability. If the loan is called back, the target zone becomes unsustainable and the exchange rate will float. The possibility of the switch affects market expectations ahead of time and influences the way the exchange rate behaves inside the band.

Unlike the standard case of a 'peso problem' where there is a stochastic devaluation component, the possibility of a switch between a target zone and a free float (where the loan has been called back and has to be repaid in full) implies that the future exchange rate will contain a random walk component. This will be the focus of chapter four and the empirical results provided in the chapter seem to be consistent

with the model detailed in chapter three, although the test adopted for the analysis is affected by low power and further empirical testing is required.

I.2.iv: Employment and Unemployment: EU vs EMU

Despite the exit of the Italian Lira and the British Pound from the ERM and the broadening of the bands for the remaining ERM currencies to a substantial +/- 15%, the prospect of the creation of the Monetary Union by 1999 is still on place. One question that has grown in importance in recent years is how suited are the EU economies for EMU; this issue has revived interest in the literature on optimum currency areas, first proposed by Mundell (1961). According to this theory, the cost of relinquishing monetary autonomy is small if the incidence of disturbances affecting the members of the currency area is mainly symmetric and if there is high factor mobility to adjust quickly to asymmetric shocks. One strand of the recent literature to date has focused on the comparison between the states of the USA and the EU countries as far as the evolution of prices and output (Bayoumi and Eichengreen 1993, Bayoumi and Thomas 1995); another has focused on the comparison between the states of the US and European regions with reference to the response to shocks of labour markets. There is no analysis to date, however, of the relative performance of national European labour markets, the type and size of shocks faced by them and the kind of response. This will be the focus of the fifth chapter of the thesis.

To consider the analysis at national and not at regional level appears important, as the EMU will be first among countries, although regional issues will doubtless dominate once the process of economic and monetary unification will be completed, in the meantime it seems inevitable that national issues will predominate. In the chapter we will analyse the evolution of employment, unemployment and participation rates for the EU members in the past twenty years and the relative performance of each country vis-a-vis the EU as a whole. We consider the time-series dimension of the data by focusing on the long-run relationship among the national and the EU-wide variables; we also exploit the time-series dimension coupled with the cross-section one, by adopting panel data analysis. We study the nature of employment shocks in Europe

and analyse the response to shocks of all the variables just mentioned. Furthermore we see whether our results of our analysis allow us to divide the EU members in two groups, the 'core' and the 'periphery' and, if so, which countries belong to which group. In the conclusions we will draw together the results of the analysis contained in the thesis and the lessons which can be learnt from them.

Chapter 1:

The process of disinflation of the 1980s: Is there an ERM effect?

1.1: Introduction

The process of disinflation has been a major aspect of the performance of the US and the European economies in the 1980s and one that has attracted considerable attention in the academic arena. In particular, a large debate has been raised, both at theoretical and empirical level, relative to the role of the ERM membership and the commitment to stable exchange rates within the System in the process of disinflation.

This issue has relevance for the analysis of the past experience: among the ERM countries, the most significant cases are represented by France and Italy; both these countries, which in the early 1980s were known for being inflation-prone countries, adopted a very restrictive monetary policy in order to bring down inflation, which in Italy reached, at its peak in 1982, a value of 20% per annum. If their success in reducing inflation was made easier by maintaining stable exchange rates against the DM is the question we will try to solve in this chapter. One aspect of the past experience of the ERM which needs to be borne in mind in trying to evaluate its role in the disinflation process, is the changing attitude towards realignments. This, as pointed out by Gros and Thygesen (1992), can be seen as developing in three stages: between 1979 and the realignment of 1983 the System was quite similar to a crawling peg; in this case, in the definition of the ERM as a system of 'fixed but adjustable exchange rates', the stress was on the term 'adjustable'. After that date, and until 1987, realignments were less frequent and smaller in size than previously and after 1987 there were no realignments at all, with the exception of the realignment for the Italian lira in January 1990 that coincided with the reduction of its allowed band of fluctuations to +/- 2.25% (1).

The question on the role of the ERM is also important once we take into account that the belief that ERM membership means sharing its counter-inflationary benefits is one of the factors at the base of the UK decision to join the ERM in October 1990 (Artis and Omerod 1994).

The relevance of the topic is not confined to the evaluation of the past experience; it also affects the discussion on the perspective membership in the Monetary Union, which should be established by 1999. During the summer of 1995 the Italian government expressed the intention to rejoin the ERM by the end of the same year, in order to fulfil the requirement relative to exchange rate stability against the other currencies in the System. The same governments stressed that one of the incentives of joining EMU would be the gain in terms of price stability (as reported in *The Economist* September 2nd 1995).

The question on the role of the ERM membership in the process of disinflation has not found in the literature to date, either theoretical or empirical, a definitive answer. The goal of this chapter is to provide an empirical contribution, able to shed new light on the issue at stake: we do this by applying a new econometric technique proposed in recent years by Hamilton (1988, 1989, 1990) to the inflation differential between each of the countries belonging to the ERM since the start and Germany. The UK will be also considered, as control case.

Section two will review the existing literature; section three will be devoted to the description of Hamilton's econometric methodology and its extension by Garcia and Perron (1990). In section four we present and comment the results of implementing the Hamilton filter for the series of inflation differentials for the ERM countries against Germany. Section five provides further analysis of the French and Italian cases. Final remarks will be contained in section seven.

1.2: A survey of the literature

The main theoretical model on the role of the ERM in the process of disinflation has been proposed by Giavazzi and Giovannini (1989) and has been labelled the 'imported

credibility' model, as , in this setting, the inflation-prone country, Italy or France, imports the credibility of the inflation-averse country, Germany, through the commitment to stable exchange rates with it.

The model is based on the framework proposed by Canzoneri and Henderson (1988), which is an open-economy extension of the model by Barro and Gordon (1983). It considers the government of a high inflation country, trying to reduce the level of inflation. We refer the reader to the original paper for the details of the model; what we are going to do here is to highlight its major characteristics. It is a two-country model which focuses on the interactions, within each country, between the public and the monetary authorities and between monetary authorities of the two countries. Consider first the characteristics of the game between each government and the private sector: as in the Barro and Gordon model, the policy maker has an inflation and an employment target; the second is such that it is higher than the natural level employment level; the instrument that the government has at its disposal to reach its targets is given by the money growth rate. Two crucial assumptions of the model are that, first, wages, set by the private sector, cannot react instantaneously to current information and, second, the private sector forms expectations rationally. Due to the fact that wages are sluggish, the government has an incentive to create surprise inflation in order to reach a higher level of employment than the natural one. However the private sector takes into account the government's incentive of creating surprise inflation when they form their expectations. These assumptions lead to an inflationary bias in the Nash equilibrium , time consistent outcome of the game among government and private sector: the level of employment equals the natural rate and there is a positive level of inflation.

Suppose now that the employment target in the domestic country, Italy, is higher than in the foreign country, Germany; this implies that also the inflation rate in Italy is higher than in Germany. In case of flexible exchange rates, then the game is such that each government sets monetary policy taking as given price expectations in the domestic labour market, thus generating a time-consistent equilibrium, and the foreign

country's money supply, thus generating a Nash equilibrium in the interaction with the foreign country. In case of flexible exchange rates there will be two different levels of inflation, with the domestic one being higher; both the levels of inflation, however, are lower than the one generated in the closed economy, due to the effect of the game between the two governments.

Things are different once we consider a fixed exchange rate regime: suppose that the inflation-prone country commits itself to peg its exchange rate with the foreign, low inflation country; by doing this, the domestic government loses any power to conduct monetary policy and adopts the one existing in the foreign country, as for a fixed exchange rate to be sustainable (and given the assumptions of the model), domestic money growth has to equal money growth abroad. Given that the stance of monetary policy abroad is more restrictive that the domestic one, and the level of inflation lower, it then follows that the domestic country imports the credibility of the foreign monetary authorities. In other words, the Italian government can lower the expectations of inflation of the private sector, and hence the equilibrium level of inflation, by pegging the exchange rate against the Deutsche Mark and allowing monetary policy to be set by the German authorities. In order for this to happen, however, it is necessary that the commitment to fixed exchange rate is a credible one; why should an exchange rate commitment be more credible than a money growth target is an obvious question to raise. There could be two reasons for this: first, exchange rate changes are costly for the monetary authorities, second, the reasons to change the exchange rate can be monitored more easily, and 'cheating' on the side of the government becomes more difficult, than in presence of a money target. Giavazzi and Giovannini themselves, however, note that the reasons why a commitment to fixed exchange rates should be more credible than a monetary target are fairly weak and conclude that 'the absence of a strong theoretical argument makes the empirical evidence even more important' (Giavazzi and Giovannini 1989, page 104).

As pointed out in the introduction of this chapter, the experience of disinflation in the 1980s is common to all the Western European countries, as well as the US and not

only to the ERM members: if there is any role in this process played by the ERM membership is the focus of the empirical analysis.

In order to test for any change in the price expectation formation by the private sector, Giavazzi and Giovannini (1989) estimate, for France, Germany, Italy and the UK and for the period 1960-1987, the following system for the dynamics of prices, wages and income

1.1) $$Y_t = A(L)\, Y_{t-1} + B(L)\, Z_{t-1} + u_t$$

where A(L) and B(L) are polynomials in the lag operator, $Y_t = [p_t, w_t, y_t]'$ is the vector of endogenous variables: inflation, change in wages (i.e. wage inflation) and income, and Z is the vector including a time trend, dummies and the exogenous variables, among which the change in the money supply.

According to the Lucas critique, a change in the stance of economic policy, such as the participation to the ERM or the turnaround in France and Italy in 1983, should generate a change in the statistical relationship among the variables of the system. Giavazzi and Giovannini exploit this, by testing for a structural break at the beginning of 1979 and in 1983. The results do not seem to support the implications of their theoretical model, as the null hypothesis of no structural break cannot be rejected in any of the cases considered, with the exception of France in 1979. More favourable results are obtained if the model is estimated for the pre-ERM period and then the parameters are used to build the endogenous variables: it turns out that the forecasts for inflation and wage inflation are higher than the actual level. This result is, according to Giavazzi and Giovannini, supportive of the hypothesis of a shift in expectations, but one that took place well after the inception of the ERM.

Another study that has found an ERM effect in the disinflation process has been pursued by Artis and Omerod (1994). Their goal is first to look for evidence of credibility in inflation-expectations' generators; second, if there is an extra effect in the

formation of wages, by testing for parameter non-constancy. The countries considered include Belgium, France, Italy and the Netherlands.

In order to answer the first question, they model price inflation as an AR(4) process and add in the specification lagged German inflation and institutional dummies. Given their belief that, if there was any 'ERM effect', this had an effect well after the inception of the System, they test for the above specification for the period 1979-1982 and 1983-1989. Their results indicate that, for Italy (2) and France, the German inflation term is significant for the ERM period, but not for the pre-ERM one; in the case of Belgium and the Netherlands the German inflation is significant in both the subsamples; at the same time inflation in Germany was remarkably stable. They then conclude that the results are in support for the 'German dominance hypothesis', which is strongly linked to the model of imported credibility.

The second part of the analysis involves the estimation of a wage equation, written in the error-correction form, which includes among the regressors the expected rate of inflation, i.e. the fitted values of the regression estimated in the first part of their study. The goal here is to test for any structural change in the wage equation process. For France and Italy there does not seem to be a substantial change in the structure of the wage equation, although the periods pre and post-ERM are separated by a transition period not included in the estimation; on the contrary, for Belgium it appears that there is a substantial downward shift on the parameter attached to inflation expectations, i.e. in this case, in the period post-ERM there would be a smaller increase in wage inflation, given a 1% increase in expected inflation.

Overall, the result supports, according to the authors, the view that German inflation is a significant component of inflation expectations' formation and, through this channel, it influences the labour market behaviour, thus sustaining the argument of an added gain in deflating within the ERM.

Evidence that there was no specific ERM effect in the experience of disinflation has also been provided in the literature. Collins (1988) estimates an equation for the determinants of inflation, change in real money supply, change in income and inflation

expectations (proxied by actual inflation) by applying a panel for ERM and non-ERM countries for the period 1974-1985. In order to test for the existence of an ERM effect, she adds three dummies: first, a dummy for all the countries, which allows for inflation to differ for the periods pre and post the ERM; second a dummy for the ERM countries only for the period 1979-1985, which, like the first, allows for inflation to differ for the two periods, but in this case only for the ERM members; third a dummy that allows the ERM countries to have a different constant term in the pre-ERM period. The results of the estimation (see Collins table 5.4) indicate that the ERM-specific dummy is not significant, even more so when expected inflation is proxied by lagged instead of current inflation. The author herself, however, points out that the results are not very robust, given than the regression appears to be highly misspecified.

As Eichengreen (1992a) points out, the result obtained by Collins might be due to the fact that the sample size is limited to 1985 and, thus, the analysis cannot pick up any 'ERM effect' which, if exists, took place in the mid 1980s. He extends the analysis by Collins, by considering a sample up to 1989 and a dummy for the period 1986-1990 and finds that the EMS effect is still not significant; the result does not seem to change if Germany is excluded from the panel . Eichengreen seems convinced that it is more the determination of ERM countries to reduce inflation that allowed for the ERM to be successful in the 1980s, more than the ERM had a causal role in bringing inflation down.

The papers reviewed in this section test for the ERM effect by establishing ex-ante a break period; the results are then conditional on the choice of the break date. The approach contained in this chapter is substantially different: we will look for a break in the series of inflation rate differentials with Germany by means of the Hamilton filter, which allows for a structural break to be determined endogenously. In this way the results do not depend on a particular choice of break and it is possible to determine if and when a break in the series has occurred.

1.3: Methodology: A brief description of the Hamilton filter and its extension

The technique used in the empirical analysis is due to Hamilton (1988, 1989, 1990) and is a particularly useful device for detecting shifts in regime.

The filter can be applied when the series under scrutiny follows a non-linear, stationary autoregressive process and the switch between regimes is governed by a Markov process.

The non-linear nature of the filter is due to the assumption of discrete shifts in regime which radically alter the dynamic behaviour of the series.

Formally, it is assumed that the series y_t follows a stochastic process which can be expressed as:

1.1) $$y_t - \mu(S_t) = \phi_1(y_{t-1} - \mu(S_{t-1})) + \ldots + \phi_m (y_{t-m} - \mu(S_{t-m})) + \sigma(S_t)u_t$$

The mean μ and the variance σ^2 are functions of the regime in place at a given time, u is assumed to be distributed as N(0,1). The regime, or state, is denoted by S_t; it is modelled as an unobserved, discrete time, two-state first-order Markov process, taking a value of either 0 or 1. Given the Markov property, S_{t-1}, if known, summarises all the information available at time t-1 which can be used to forecast the state at time t:

1.2) $$p(S_t=s_t|S_{t-1}=s_{t-1}) = p(S_t=s_t|S_{t-1}=s_{t-1},\ldots, S_{t-m}=s_{t-m})$$

It is possible to parameterize the mean and the standard deviation of the process as follows:

1.3) $$\mu(S_t) = \alpha_0 + \alpha_1 S_t$$

with

$\alpha_0 = \mu(S=0)$ mean in state 0

$\alpha_0 + \alpha_1 = \mu(S=1)$ mean in state 1

and

1.4) $$\sigma(S_t) = w_0 + w_1 S_t$$

with

$w_0 = \sigma(S=0)$ standard deviation in state 0

$w_0 + w_1 = \sigma(S=1)$ standard deviation in state 1

The states, however, are not directly observable and their historical sequence has to be inferred from the observable series y_t.

The procedure proposed by Hamilton consists of drawing inferences on the state at time t, S_t, based on inferences about the state at time t-1, S_{t-1}, and on data on y observed up to time t.

The transition matrix that governs the transition between states is:

1.5) $$\mathbf{P} = \begin{bmatrix} q & 1-q \\ 1-p & p \end{bmatrix}$$

where

$p = p(S_t=1|S_{t-1}=1)$

$q = p(S_t=0|S_t=0)$

The filter contains five steps:

<u>Step 1</u>:

from the output of the filter at time t-1 and the conditional probability $p(S_t=s_t|S_{t-1}=s_{t-1})$, the joint probability of the sequence S_t, S_{t-1},.... S_{t-m} is obtained:

1.6) $$p(S_{t-1}=s_{t-1},\ldots, S_{t-m}=s_{t-m}| y_{t-1},\ldots,y_0)\, p(S_t=s_t \mid S_{t-1}=s_{t-1}) =$$
$$= p(S_t=s_t, S_{t-1}=s_{t-1},\ldots, S_{t-m}=s_{t-m}| y_{t-1},\ldots,y_0)$$

in deriving 1.6 the assumption that the transition between states follows a first order Markov process has been used

Step 2:

from the output of the first step and the density of y_t conditional on past valued of S_t and y_t, the joint density of y_t and the sequence of states is obtained:

1.7) $$p(S_t=s_t, S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m} \mid y_{t-1},\dots,y_0)\, f(y_t \mid S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m}) =$$
$$= f(y_t, S_t=s_t, S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m} \mid y_{t-1},\dots,y_0)$$

$f(y_t, S_t=s_t, S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m} \mid y_{t-1},\dots,y_0)$ is a normal distribution with mean $\mu(S_t)$ and variance $\sigma^2(S_t)$.

Step 3:

the joint conditional distribution $f(y_t, S_t=s_t, S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m} \mid y_{t-1},\dots,y_0)$ is then marginalized with respect to the sequence of states and the distribution of y_t conditional on its own history is thus obtained:

1.8) $$\sum_{S_t=0}^{1} \dots \sum_{S_{t-m}=0}^{1} f(y_t, S_t=s_t, S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m} \mid y_{t-1},\dots,y_0) = f(y_t \mid y_{t-1},\dots,y_0)$$

a by-product of the filter at this stage is the estimation of the unknown parameters (α_1, α_0, p, q, $\phi_1,\dots,\phi_m$, w_0, w_1) via the maximisation of the conditional log likelihood

1.9) $$\log f(y_T,\dots,y_m \mid y_{m-1},\dots,y_0) = \sum_{t=m}^{T} \log f(y_t \mid y_{t-1},\dots,y_0)$$

Step 4:

from the output of the second and third steps the conditional probability of the states is obtained:

1.10) $$f(y_t, S_t=s_t, S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m} | y_{t-1},\dots,y_0)/f(y_t | y_{t-1},\dots,y_0) =$$
$$= p(S_t=s_t,\dots, S_{t-m}=s_{t-m} | y_t,\dots,y_0)$$

Step 5:

finally, the conditional probability obtained in stage four is marginalized with respect to S_{t-m} to obtain the final output:

1.11) $$\sum_{S_{t-m}=0}^{1} p(S_t=s_t,\dots, S_{t-m}=s_{t-m}|y_t,\dots,y_0) = p(S_t=s_t,\dots, S_{t-m+1}=s_{t-m+1}|y_t,\dots,y_0)$$

which is then the input for the filter at time t+1.

To start the first iteration, as $p(S_{t-1}=s_{t-1},\dots, S_{t-m}=s_{t-m}|y_{t-1},\dots,y_0)$ is not available, the procedure followed by Hamilton (1989) considers the unconditional distribution of the states , $p(S_{m-1}=s_{m-1},S_{m-2}=s_{m-2},\dots,S_0=s_0)$, which is evaluated as:

1.12) $$p(S_{m-1}=s_{m-1},S_{m-2}=s_{m-2},\dots,S_0=s_0) = p(S_{m-1}=s_{m-1}|S_{m-2}=s_{m-2})\dots p(S_0=s_0)$$

where for the generic time index n,

$p(S_n=s_n|S_{n-1}=s_{n-1}) = \mathbf{P}$

where **P** is the transition matrix

and $p(S_0=s_0) = \Pi = (\Pi_0, \Pi_1)$

where Π is the equilibrium probability distribution and Π_0 and Π_1 are the unconditional probabilities of being respectively in state 0 and in state 1.

In case the states are found to be highly persistent, it is possible to check for the presence of three states, according to what suggested by Garcia and Perron (1990). The procedure consists of splitting the sample into two overlapping subsamples and applying the Hamilton filter with two states in both subsamples. If the filter clearly

identifies two states in both subsamples, it is likely that the model with three states applies to the full sample. The authors note, however, that the procedure is not totally free of the intervention by the researcher, as the choice of how to split the sample implicitly determines the end and the beginning of the period.

1.4: The results of the implementation of the Hamilton filter for inflation differentials

In this section we analyse the evolution of inflation differentials between Germany and the other ERM countries for the period 1979-1990 (4). The technique proposed by Hamilton and described in the previous section allows one to detect precisely any shift in regime where the alternatives are a state of high mean-high variance and one with low mean-low variance (5). It does this by assigning to each observation an appropriate distribution with constant mean and variance and with endogenous sample separation. As we pointed out in section two of this chapter, this characteristic of the technique is very important as it allows one to discover any distinctive phases in the evolution of inflation differentials in the first ten years of the ERM and to detect the precise timing of the turning points when these are found.

Differently to the mixed nature of the results found in the empirical literature surveyed in section two of this chapter, our results seem to be consistent with the model of imported credibility. The inflation differentials for France and Italy show a totally different stochastic behaviour from those of the other countries considered here, including the UK. In the first case, (see figures 1.3 and 1.4 and table 1.1) there is a clear-cut separation of the overall period into two subperiods: indeed, the filter assigns state 1 to all of the observations up to 1984 and state 0 to all of the observations thereafter. In contrast to this, the inflation differential between the UK and Germany does not show any change in pattern during the period considered in the analysis (see figure 1.6 and table 1.1). The different stochastic properties of the series between France and Italy, on the one hand, and the UK, on the other hand, seem to be consistent with the model of 'imported credibility' and the hypothesis of an ERM effect

in the disinflation process for the member countries. Although the aim of reducing inflation was a goal shared by most European countries, membership of the ERM made the achievement more successful.

The timing of the shift in regime, which both for France and for Italy took place in 1984-1985, adds further support to the hypothesis. The French and Italian tightening of economic policy around 1984 can be attributed, according to Giavazzi and Giovannini (1989, chapter 4), both to the desire of the governments to remain in the ERM and to their willingness to appeal to the ERM rules as an external justification for unpopular domestic policies.

A pattern similar to the one found for France and Italy is not observed for the smaller countries of the ERM, except possibly for Belgium (see figures 1.1, 1.2, 1.5 and table 1.1). This does not conflict with our interpretation of the results. Countries such as Belgium, Denmark and the Netherlands, together with Germany, were already part of the exchange rate agreement which preceded the ERM, the 'Snake'. For these countries, therefore, the onset of the ERM did not represent a fundamental policy regime shift.

1.5: More on the French and Italian cases

In the previous section we observed that a clear change in regime in the series of inflation differentials is present for France and Italy in 1984, when we consider the sample 1979-1990. Given the importance of their experience, we decided to check for the robustness of the results and extended the analysis in two directions. First we considered a larger sample period and run the filter for the inflation differential between 1975 and 1990 (see figures 1.7 and 1.8); it could be possible that the filter is unable to detect a shift in regime at the beginning of the ERM experience for lack of enough observations on the 'high inflation regime'; the results strongly refute this hypothesis for both the countries considered (see table 1.2). In other words, once the sample includes the pre-ERM period, as well as the first ten years of the ERM, it appears that still the break takes place in 1984 for the 'inflation-prone' countries (6).

These results are consistent with the ones obtained by Artis and Omerod, surveyed in section 1 of this chapter.

Note that, for both France and Italy, by extending the sample period to 1975-1990, not only the timing of the shift in regime remains unaltered with respect to the one detected for the period 1979-1990 remains unaltered, but the values found for average inflation in the two regimes are very similar to the ones obtained for the shorter sample period.

There is also another line of research that is worth pursuing. Gros and Thygesen (1992) note that the main criterion for describing the evolution of the ERM is the changing attitude towards realignments; this implies a division in three periods: between 1979 and 1983, 1984 and 1987 and after 1987. The regime shift in 1984 corresponds closely with the above mentioned change in attitude towards realignments. It could be that also the further commitment to stable exchange rates corresponds to a second break in the inflation differential. If this is the case, the series would be characterised by three different states, corresponding to the three periods indicated above. The way to test for the presence of three states has been suggested by Garcia and Perron (1990), as we pointed out in section three. The overlapping samples have been chosen as follows: for Italy the first subsample goes from February 1979 to December 1984 and from August 1983 to December 1990; for France the first subsample spans from February 1979 to June 1986, the second from June 1984 to December 1990; the overlapping period for France has been chosen to be longer than for Italy, given that it appears that the switch was somewhat more gradual for the first country. The results, shown in table 1.3 and 1.4 and in figures 1.9 to 1.12 do not support the hypothesis of the existence of a third state for either France or Italy: whilst a clear regime shift is found for the first period, the second subsample is not characterised by any shift in the process followed by the inflation differential. This result might reflect the fact that the meaning itself of belonging to ERM changed radically for the inflation-prone countries in 1983-1984, while the stronger commitment to stable exchange rates was a reinforcement of the same policy stance.

As a consequence the inflation differential might have changed subsequent to the change in policy, while it did not vary in a significant way for the post-1987 period.

Another relevant aspect that needs to be pointed out is the size of the inflation differential. In the case of France not only the degree of inflation convergence to the German level was quite substantial, but also the mean difference was only about 1% in the period after 1984. On the contrary, in the case of Italy although the convergence of its inflation level towards the German one was a very important aspect of the performance of its economy in the mid 1980s, the differential remained quite high, in the region of 4%; our result shows that such a differential did not tend to decline significantly after 1987.

The results shown in this section strengthen, in our opinion, the ones that we commented upon in the previous section: there was a clear change in regime in the process followed by the inflation differential with Germany for France and Italy in 1983-1984. No sign of a break at the beginning of the ERM experience was found even when we extended the sample to include four years of the pre-ERM period. The fact that there was no break in 1987 can be explained by noticing that in that year there was no change in policy, but a strengthening of the same economic stance.

1.6: Conclusion

In this chapter we examined the experience of the European disinflation in the 1980s. The purpose is mainly to contribute to the debate on the role of ERM membership on the process of disinflation itself, but also to shed some light on the consequences of the disinflation process for the EU in the 1990s.

We noted that all the empirical literature which tackles the question of the role of the ERM in the disinflation experience establishes date breaks exogenously: the usual procedure for testing for an 'ERM effect' is to test for a structural break either in 1979 or in 1983, with the break dates set before the implementation of the testing procedure. The advantage of the methodology adopted in this paper, proposed by Hamilton, is that the determination of the break date in the pattern followed by inflation

differentials with Germany is not dependent on the choice of the econometrician; on the contrary it is an output of the filter the precise finding of the break date, if any is found; in other words the filter allows for an endogenous assessment of the likely break in the series.

The results obtained by adopting this technique are consistent with the view that the ERM helped the inflation-prone countries, such as France and Italy, in their objective of reducing their level of inflation; a clear-cut break in the series given by the inflation is found for these two countries. The same is not true for Denmark, the Netherlands and, possibly, Belgium: this result can be explained by recalling that these countries were part of the 'Snake', the exchange rate arrangement that tried to limit exchange rate fluctuations in some of the European countries in the 1970s, and that their participation to the ERM did not represent a fundamental policy regime shift. In our analysis we also considered the case of the UK, which experienced disinflation outside the ERM: the filter is unable, in this case, to find any shift in regime. The observation that the disinflation process was not specific to the ERM members is one of the leading argument of those who deny the presence of an 'ERM effect': in this chapter we are able to show that actually there is a substantial difference between the disinflation experience for France and Italy, on one hand, and the UK on the other. Another argument that has been raised against the thesis of the 'ERM effect' is related to the performance of unemployment in the 1980s in Europe (see De Grauwe 1989): not only unemployment increased substantially after the shocks that hit the Western economies in the 1970s, but, for the European countries, it stayed persistently high in the following decade. According to this thesis, hence, the disinflation was 'paid' by an increase in unemployment. Also in this case, the experience of the UK vis-à-vis the one of the other European countries is illuminating and allows us to refute the argument just outlined: the UK experienced high and persistent inflation in the 1980s as well as the ERM countries (see chapter 5 of this thesis).

Also the timing of the shift in regime for France and Italy, around 1984, seems in accordance with the implications of the model of 'imported credibility'; as Giavazzi

and Giovannini (1989) note, the actions taken in order to reduce inflation could be attributed both to the desire of the government to remain in the ERM and to their willingness to appeal to the ERM rules as an external justification for unpopular domestic policies. The results relative to the timing are strengthened once a long sample size, spanning from 1975 to 1990 is considered: no break appears to have taken place in 1979, while a clear one is obtained for 1984, for both countries.

Finally, once we test for the presence of a further regime shift for France and Italy, we do not find any evidence of it: it seems that the tightening of the commitment to stable exchange rates in 1987 was not reflected in a further reduction in the average inflation differential with Germany. This does not seem surprising for France, given that from 1984 onwards the average differential with France was of 1%; for Italy, however, the differential remained of considerable size, about 4%. The persistence of a positive inflation differential, coupled with the absence of realignments (with the exception of the one in January 1990), thus generating a cumulative loss in competitiveness, is commonly agreed to be one of the causes of the crisis of the Italian lira in September 1992 (see Eichengreen and Wyploz 1993). This leads us to conclude that there is enough evidence to suggest that the ERM made easier a certain degree of convergence for the inflation-prone countries; however, in the case of Italy the convergence was far from being complete and the lack of full convergence, is understood by the literature, was subsequently one of the causes of the collapse of the lira in the currency crisis of 1992.

Footnotes

(1) For a detailed survey on the history and the evolution of the ERM see Gros and Thygesen (1992)

(2) for Italy, the regression has been estimated over the period 1972-1979 and 1982-1989; the period 1979-1982 has been left out as its inclusion would have created sever problems in the econometric estimation; the authors take this as a sign that the breakpoint in the inflation process occupied that period

(3) in chapter 3 we will provide a theoretical model of the ERM crisis which led to the exit from the ERM of the Italian lira and the British pound

(4) All the data have been collected through DATASTREAM; the source of CPI (Consumer Price Index) is OECD. In the majority of cases we have considered annual inflation rates, built by compounding the monthly inflation rates, instead of calculating the rate of change of CPI on an annual basis. We have done this in order to preserve the variability in the series, which is needed to implement the Hamilton filter.

(5) The words 'high mean-high variance' and 'low mean-low variance' do not have to be interpreted in absolute, but in relative terms. It is perfectly possible that the mean inflation differential of the 'low mean' state in one country is actually higher than the mean in the 'high mean' state in another country. What we want to test for in section 4 of this chapter, is the presence of two different states in the process of inflation differentials with Germany, characterised by two different means and variances.

(6) For the extended period 1975-1990 we used monthly inflation differentials, in order to check that the results do not depend on our choice of modelling inflation; the choice of monthly inflation is given by the fact that in this way we are able to have as large a frequency as possible and that, at the same time, the data are not overlapping, which might interfere with the way the filter works.

Figure 1.1a: Annual inflation differential Belgium-Germany 1979-1990

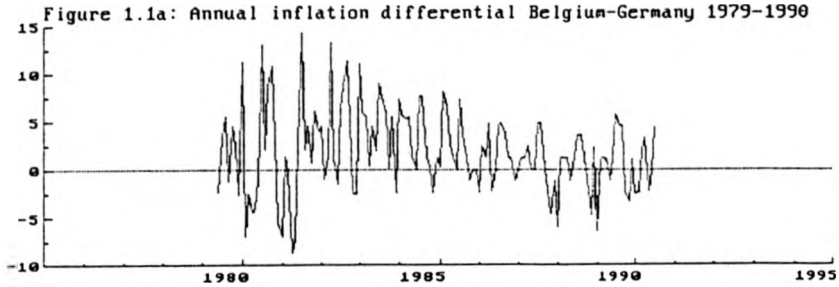


Figure 1.1b: Hamilton probabilities

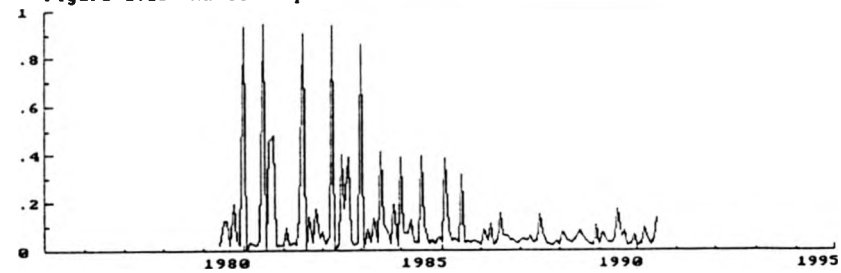


Figure 1.2a: Annual inflation differential Denmark-Germany 1979-1990

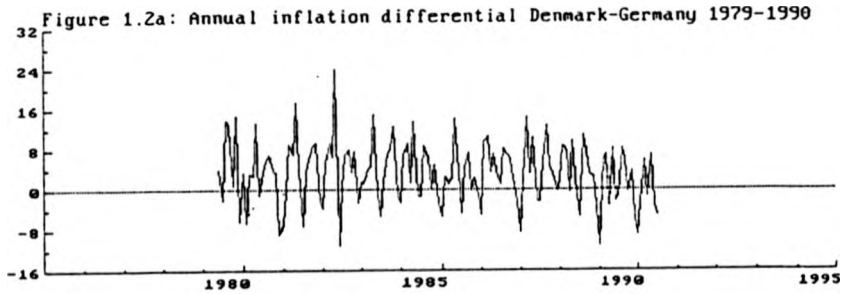


Figure 1.2b: Hamilton probabilities

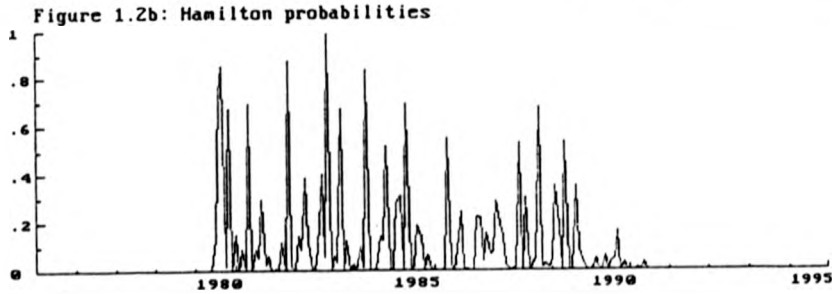


Figure 1.3a: Annual inflation differential France-Germany 1979-1990

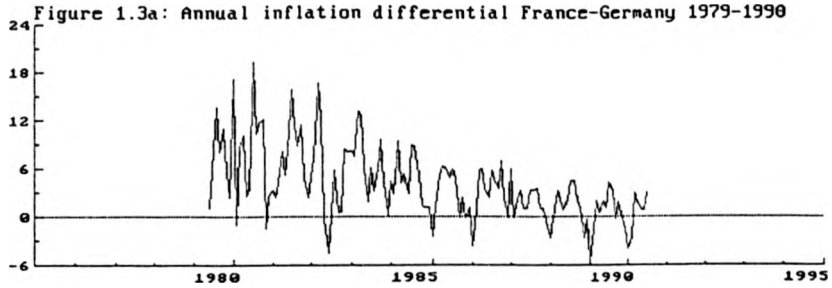


Figure 1.3b: Hamilton probabilities

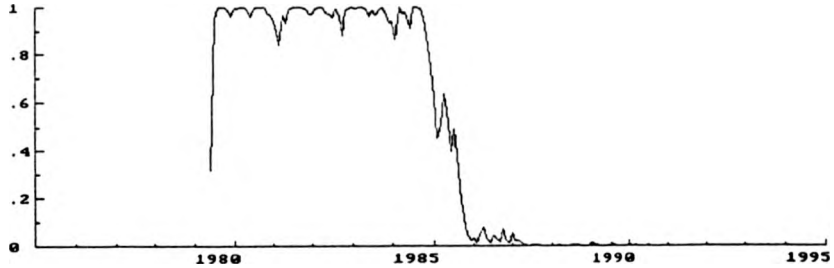


Figure 1.4a: Annual inflation differential Italy-Germany 1979-1990

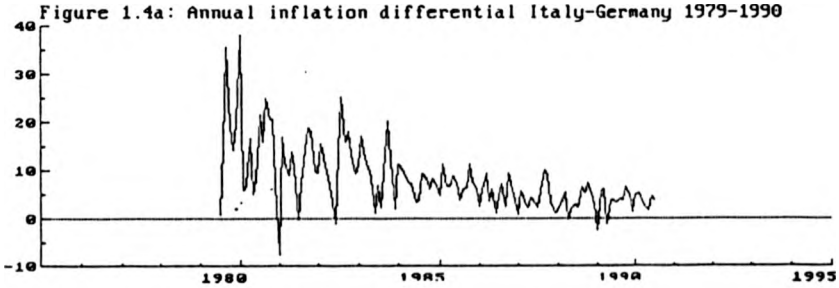


Figure 1.4b: Hamilton probabilities

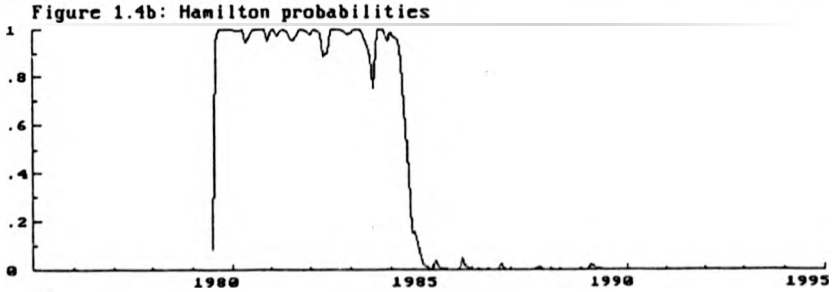


Figure 1.5a: Annual inflation differential Meth.-Germany 1979-1990

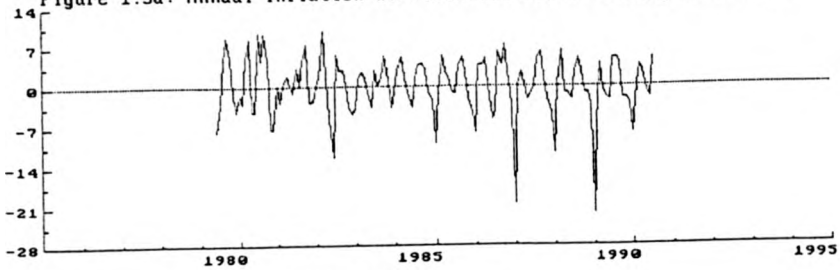


Figure 1.5b: Hamilton probabilities

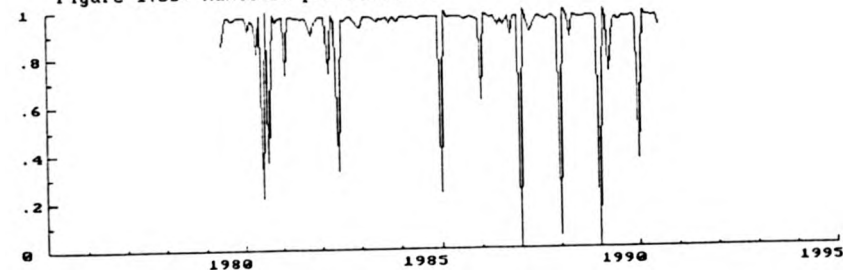


Figure 1.6a: Annual inflation differential UK-Germany 1979-1990

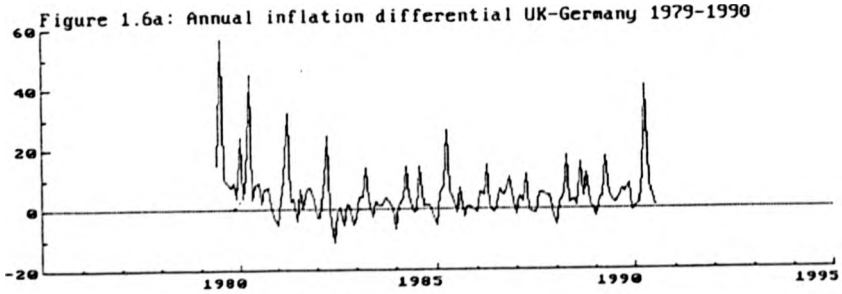


Figure 1.6b: Hamilton probabilities

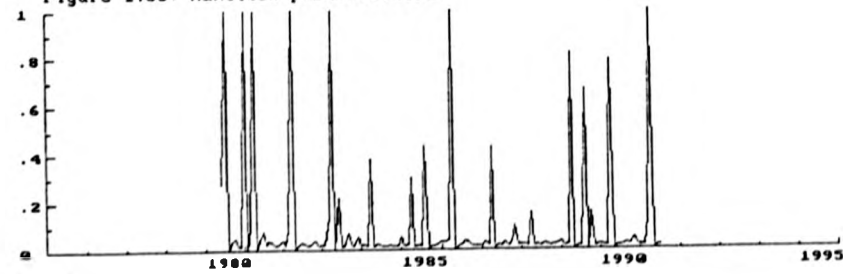


Figure 1.7a: Monthly inflation differential France-Germany 1975-1990

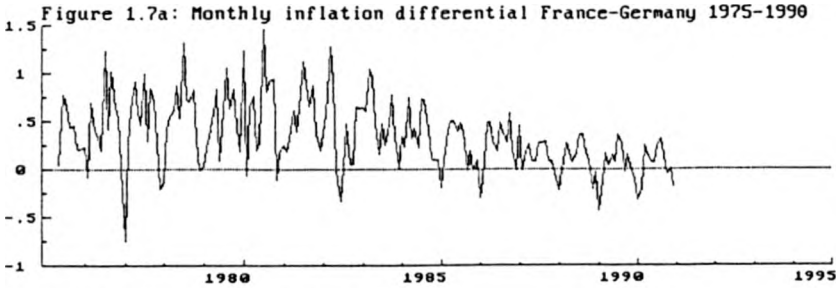


Figure 1.7b: Hamilton probabilities

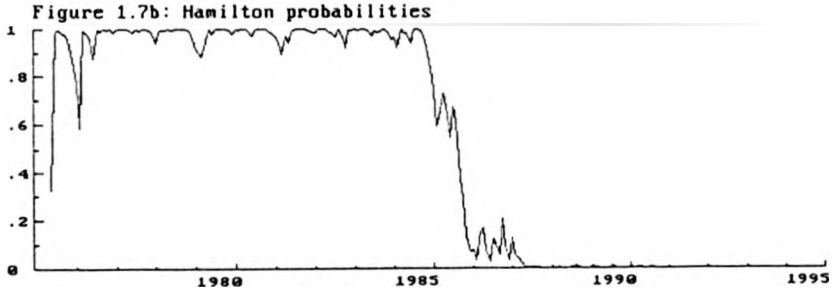


Figure 1.8a: Monthly inflation differential Italy-Germany 1975-1990

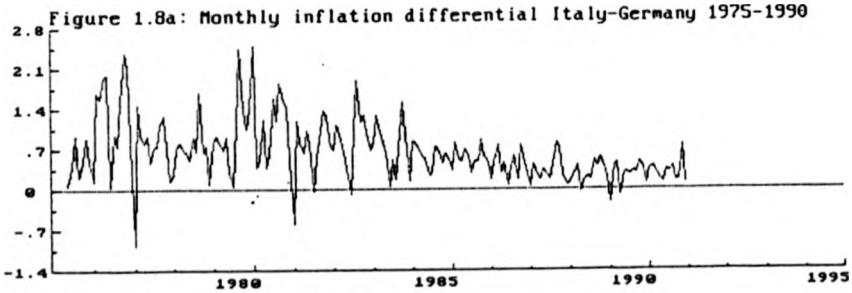


Figure 1.8b: Hamilton probabilities

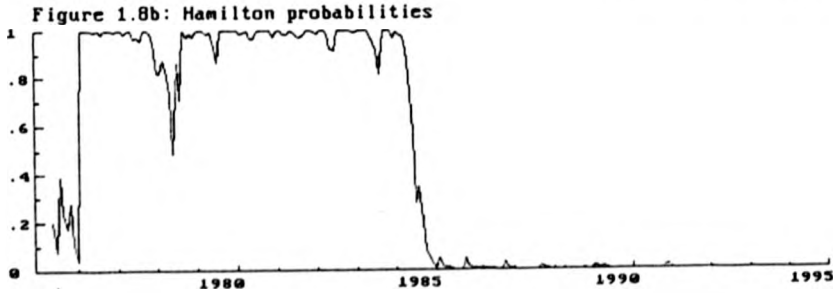


Figure 1.9a: Annual inflation differential France-Germany 1979-1986

Figure 1.9b: Hamilton probabilities

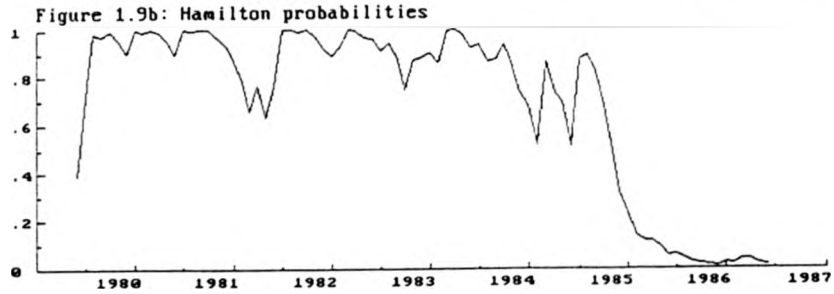


Figure 1.10a: Annual inflation differential Italy-Germany 1979-1984

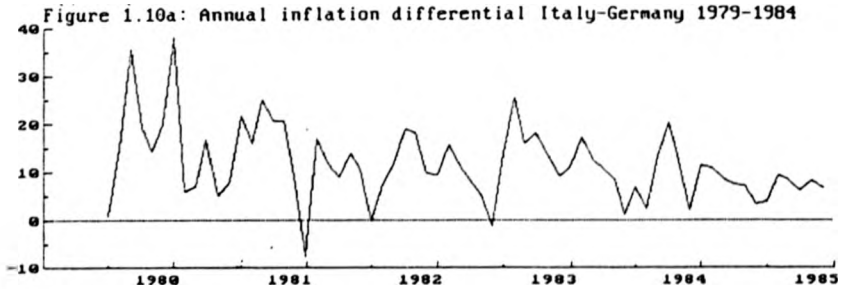


Figure 1.10b: Hamilton probabilities

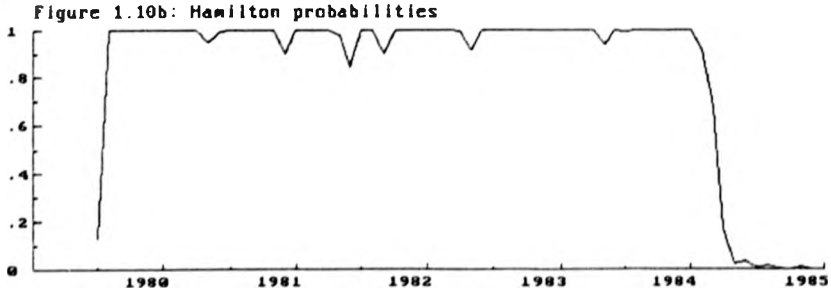


Figure 1.11a: Annual inflation differential France-Germany 1984-1990

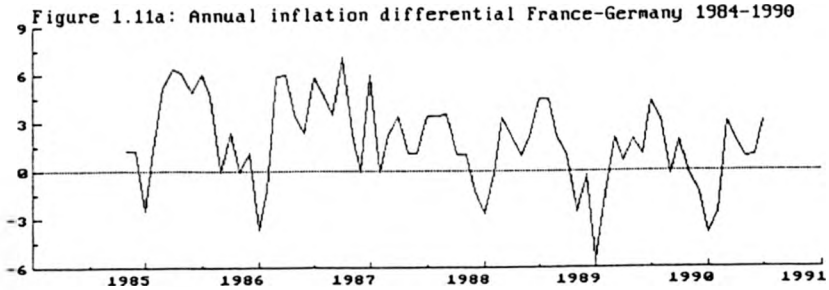


Figure 1.11b: Hamilton probabilities

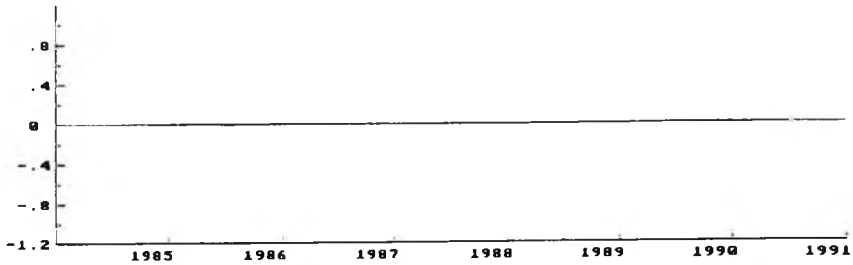


Figure 1.12a: Annual inflation differential Italy-Germany 1984-1990

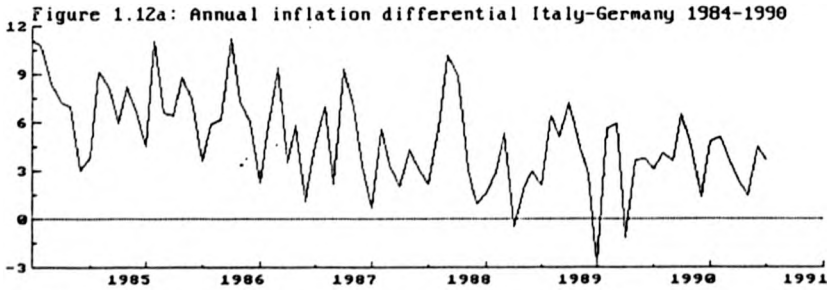


Figure 1.12b: Hamilton probabilities

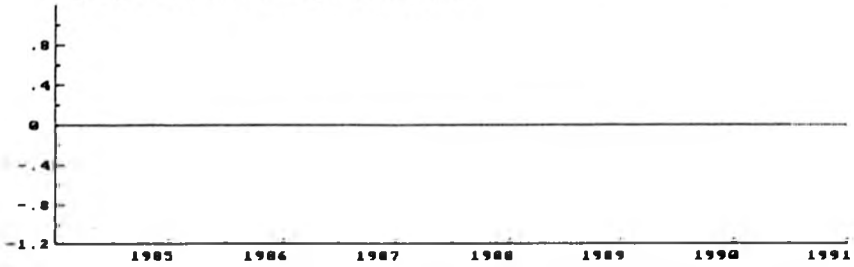


Table 1.1: Inflation differentials 1979-1990

	Belgium	Denmark	France	Italy	Neth.	UK
α_1	5.609659	9.818929	4.838052	7.324158	5.086215	17.17391
α_0	1.179244	2.008626	1.743562	4.829122	-4.659323	3.198914
p	0.009911	0.003608	0.992603	0.988421	0.901	0.000001
q	0.879783	0.838392	0.993538	0.993004	0.000585	0.883677
w_0	3.516340	4.685227	2.398444	2.75669	9.466588	4.493030
ϕ_1	0.364356	0.020842	0.396181	0.323986	0.212504	0.196236
ϕ_2	-0.00189	-0.39214	-0.08957	-0.18859	-0.296378	0.039731
ϕ_3	-0.12638	-0.00127	0.1402	0.174625	-0.206147	-0.108511
ϕ_4	0.090918	-0.4256	-0.18862	-0.00883	-0.106657	0.11588
w_0+w_1	5.005350	4.106627	4.7025	7.873861	3.09835	1.645278
logL	-264.787	-300.587	-237.788	-272.05	-258.4875	-224.6134

Annual inflation rates expressed as percentages
logL is the value of the log likelihood

Table 1.2: Monthly inflation differentials 1975-1990

	France	Italy
α_1	0.347731	0.501188
α_0	0.145412	0.388414
p	0.99495	0.9916
q	0.993992	0.992832
w_0	0.192647	0.22031
ϕ_1	0.376533	0.28821
ϕ_2	-0.0341474	-0.159374
ϕ_3	0.0527615	0.098411
ϕ_4	-0.165284	-0.0305924
w_0+w_1	0.35881	0.563318
logL	140.398321	87.50073

Monthly inflation rates expressed as percentages
log L is the log likelihood

Table 1.3: Inflation differentials 1979-1986 (France) and 1979-1984 (Italy)

	France	Italy
α_1	3.58355	6.31163
α_0	3.28438	6.54852
p	0.98598	0.9861723
q	0.985134	0.968724
w_0	2.98311	1.17159
ϕ_1	0.328974	0.385091
ϕ_2	-0.0740907	-0.550005
ϕ_3	0.100327	0.163312
ϕ_4	-0.167796	-0.263895
w_0+w_1	4.81758	7.88093
logL	-164.524739	-156.40384

Annual inflation rates expressed as percentages
log L is the log likelihood

Table 1.4: Inflation differentials 1984-1990 (France) and 1983-1990 (Italy)

	France	Italy
α_1	1.59601	3.99874
α_0	1.75692	4.63728
p	0.936858	0.9319873
q	0.999999	0.999999
w_0	2.31355	2.6785
ϕ_1	0.52471	0.201984
ϕ_2	-0.108	-0.112598
ϕ_3	0.132837	0.205559
ϕ_4	-0.16792	0.143968
w_0+w_1	3.26163	5.19874
logL	-100.599	

Annual inflation rates expressed as percentages
logL is the log likelihood

Chapter 2:

Expected Devaluation and Integration Accounting

2.1 Introduction

Following the seminal paper by Krugman (1991a), considerable attention has been devoted to the study of the behaviour of exchange rates within a target zone. As a result, ironically enough, the original Krugman model has been now widely dismissed, finding little empirical support either from the currencies of the European Exchange Rate Mechanism or from the unilateral target zone adopted by the Swedish Krona (see, among others, Flood, Rose and Mathieson (1991) and Lindberg and Soderlind (1994a)).

Two of the specific implications of the original model that have been rejected empirically are the deterministic and negative relationship it predicted between the exchange rate and the interest rate differential and the U-shaped distribution of the exchange rate within the band.

As for the first implication, a new model has been formulated by Bertola and Svensson (1993), hereafter BS, which seeks to fit the data better by relaxing the strong assumption of full credibility.

Formally their proposal is to augment the target zone model by introducing a second stochastic process in addition to the traditional fundamentals (such as liquidity and activity levels) driving the exchange rate within the band. This additional fundamental is also modelled as following a Brownian motion (a sketch of the BS model is presented in the appendix to this chapter).

Given the presence of this second driving force, possibly correlated with the other economic fundamentals, the relationship between the latter and the exchange rate may not resemble that suggested by the Krugman model, the 'S-shaped curve', as Krugman and Miller (1993) note. Moreover, the crucial feature of the basic target zone model,

namely the stabilising effect of the presence of the band, is blurred if not overwhelmed by the variations in the expected rate of devaluation.

If the BS model explains the lack of a negative deterministic relationship between the exchange rate and the interest rate differential, on the other hand it cannot explain the hump-shaped distribution of the exchange rate within the band. A model that explains both the lack of a deterministic relationship between the exchange rate and the interest rate differential and the hump-shaped exchange rate density has been proposed by Lindberg and Soderlind (1994b) (LS henceforth).

Contrary to BS, LS assume that the central banks intervene not only when the exchange rate hits the band, but also when it is inside the band, i.e. they resort to intramarginal intervention. Subject to an appropriate intervention rule, LS show that the composite fundamental, given by a linear combination of the traditional fundamental and the expected rate of devaluation, does not follow a Brownian motion, as in the BS model, but a Ornstein-Uhlenbeck process (see the appendix to this chapter for details). Similarly to BS, however, the expected rate of devaluation is still modelled as a Brownian motion process.

As the main purpose of both BS and LS is to offer a well-fitting model of target zones, it is important to submit their models to empirical testing and see if they achieve their goal. To do this, we note first that introducing a stochastic expected rate of devaluation has important implications for the time series behaviour of the interest rate differential. In particular, the specification advanced by both BS and LS implies that the interest rate differential is an integrated process. In the case where the alternative is between either maintaining the central parity or realigning, this assumption is, clearly, far from being realistic.

In this chapter we exploit the implication of their models to test whether the particular behaviour assumed for the rate of expected devaluation is consistent with the data.

2.2 Expected rate of devaluation and the interest rate differential

In the BS and LS model, it is assumed that agents form their expectations rationally, that capital is perfectly mobile and that if any risk premium exists, it is negligible. Given these assumptions, the interest rate differential equals the expected change in the exchange rate

2.1) $$i - i^* = E_t (ds) / dt$$

that is Uncovered Interest Parity holds.

However, as it is assumed that the target zone is not fully credible, the expected change of the exchange rate, E_t (ds) / dt, is the sum of two terms: first, the expected change of the exchange rate within the band, E_t (dx) / dt, where x = s - c and c is the central parity, and second the expected rate of realignment, E_t (dc) / dt. So

2.2) $$E_t (ds) / dt \equiv E_t (dx) / dt + E_t (dc) / dt$$

and, given the assumption that UIP holds

2.3) $$i - i^* = E_t (dx) / dt + E_t (dc) / dt$$

BS observe that equation 2.3) implies that in order to get an estimate of the expected realignment, it is sufficient to get an estimate of the change of the exchange rate within the band, and then subtract it from the interest rate differential. Svensson (1991), however, observes that such estimation is made difficult by the fact that usually the exchange rate within the band, x, jumps at the time of a realignment. This difficulty is overcome by conditioning the expected exchange rate within the band upon no realignment and hence rewriting 2.3) as follows:

2.3') $$i - i^* = E_t (dx \mid nr) / dt + g_t$$

where g_t, the expected rate of devaluation, is the product of the probability of a realignment per unit of time, v_t , and the expected devaluation size conditional upon realignment, $E_t (dc \mid r) + E_t (dx \mid r) - E_t (dx \mid nr)$

such that

2.4) $$g_t = v_t [E_t (dc \mid r) + E_t (dx \mid r) - E_t (dx \mid nr)]$$

(for details see Svensson (1993)).

Even before testing the hypothesis that the expected devaluation follows a random walk, it is possible to argue against it. The argument which follows, as well as our empirical analysis, is conducted in a discrete time framework, while the theoretical analysis is developed in a continuous time framework. The approximation is acceptable, however, if one uses high frequency data, as we do in this paper.

Given that the Brownian motion process has its counterpart in discrete time in the random walk (with or without drift), it is our purpose to show that, on the basis of the assumptions made in the BS and LS models, the expected rate of devaluation, defined in equation 2.4), cannot follow such a process.

The argument can be divided into three steps:

i) Unless the exchange rate follows an integrated process of order greater than one, the first difference is a stationary process. The empirical literature usually shows that the exchange rate, both spot and forward, follows an integrated process of the first order (see Meese and Singleton 1982, Meese and Rogoff 1983, Baillie and Bollerslev 1989, Baillie and McMahon 1989, De Vries 1994) and hence, by definition, its first difference is a stationary process.

ii) If the realised changes of the exchange rate (both total and inside the band) are stationary, also their expected counterparts are, if we assume, as BS and LS do, that the market is efficient. Indeed, according to the hypothesis of rational expectations

2.5) $$s_{t+j} = E(s_{t+j} \mid I_t) + u_{t+j}$$

(where I_t is the information set available at time t), i.e. the realised value of the exchange rate at time t+j, s_{t+j}, differs from its expected value for an error, u_{t+j}, which follows a white noise process if the horizon of the expectations j matches the sampling frequency of the data; however, if the frequency of the data is finer than the expectation horizon, then u_{t+j} is autocorrelated and follows a moving average process, which is, by definition stationary. Given this, the order of integration of the realised series has to match the order of integration of the expected series. If this is true, then, as the exchange rate follows at most an I(1) process, also the expected future exchange rate does and the first difference is a stationary process.

It is then possible to state that both $E_t(Ds)$ and $E_t(Dx)$ follow an I(0) process:

2.6) $$E_t(Ds) \sim I(0),\ E_t(Dx|nr) \sim I(0)$$

where $Ds = s_{t+1} - s_t$ and $Dx = x_{t+1} - x_t$

iii) From the discrete time counterpart of equations 2.2), 2.3) and 2.3') it also follows that:

2.7) $$E_t(Dx|nr) + g_t \sim I(0)$$

This is possible only if either $E_t(Dx|nr)$ and g_t are both I(1) and cointegrated or if they are both I(0). But we have shown above that $E_t(Dx|nr) \sim I(0)$, hence g_t cannot be an integrated process of the first order.

We show empirically that g_t is not an I(1) process in the remainder of the chapter, by exploiting the implication that, conditional on the validity of the assumptions stated above (i.e. that agents are rational and that the risk premium is negligible), the order of integration of the expected rate of devaluation has to match the order of integration of the interest rate differential (remembering that the expected change of the exchange

rate within the band, conditional upon non-realignment, cannot be an integrated process) in order to show that g_t is actually a stationary process.

Other studies have recently tried to test directly for the order of integration of the expected rate of devaluation (see Lindberg, Soderlind and Svensson (1993) and Rose and Svensson (1991)). The procedure followed in order to estimate the devaluation risk has been proposed by Bertola and Svensson (1993); it has been defined 'drift-adjustment method', as the interest rate differential is adjusted by the drift of the exchange rate inside the band in order to get an estimate of the expected devaluation. The procedure involves the estimation of the expected change of the exchange rate inside the band, $E_t(dx)/dt$, which is then subtracted from the interest rate differential in order to get the expected rate of devaluation. Although in principle the relation between the expected change of the exchange rate inside the band and the current exchange rate is non-linear, BS suggest that a linear approximation can be acceptable for reasonable parameter values. It then follows that, according to the authors, the expected change of the exchange rate inside the band can be estimated by applying standard econometrics techniques (for applications of this method, see Lindberg, Soderlind, Svensson 1993, Svensson 1993, Rose and Svensson 1991).

In order to test for the order of integration of the devaluation expectation, Lindberg, Soderlind and Svensson (1993) and Rose and Svensson (1991) apply unit root tests to the series obtained by implementing the 'drift adjustment method'.

This procedure has the weakness that there is no agreement on how to measure expected future exchange rates inside the band, while the results of the tests do in fact depend heavily on how the expected rate of devaluation is estimated. In contrast, in this chapter we test for the order of integration of the expected rate of devaluation by using the interest rate differential, which can be observed directly. It must be noted that while the theoretical analysis is developed in a continuous time framework, the empirical analysis is conducted in a discrete time framework. The approximation is however acceptable if one uses high frequency data, as we do here.

2.3 Data and empirical analysis

In our empirical analysis we examine both the bilateral target zone given by the ERM and the unilateral target zone for the Swedish krona. The first choice is motivated by the fact that the ERM is the most well known target zone and it has lasted for a long period of time. We moreover consider the Swedish target zone in order to compare our results with those contained in Lindberg and Soderlind (1994 a, b).

For the ERM case, we are going to examine interest rates for one week maturity Eurodeposits denominated respectively in Belgian Francs, Danish Krona, Dutch Guilders, French Francs and Italian Lire against the corresponding interest rate for Eurodeposits denominated in Deutsche Marks. The frequency of sampling is weekly and the period examined is February 1987 - March 1992, during which no realignment occurred, with the exception of the Italian lira, which was devalued in January 1990 (at the same time the fluctuation band was narrowed from 6% to 2.25%). The quotation refers to the London market middle rate (source Datastream). The choice of the period can be justified on several grounds. First, this is the longest period 'between realignments', and hence the most suitable to be submitted to a unit root test; second, capital controls were present, before 1988, both in France and Italy, thus invalidating on of the key assumptions underlying UIP, i.e. perfect capital mobility.

Given that the interest rate differential is assumed to be equal to the sum of the expected rate of devaluation and the expected change of the exchange rate within the band conditional upon no realignment (see equation 2.3'), in the Italian case we have chosen to implement the analysis by splitting the sample into two subperiods and dropping the observations immediately before and after the realignment. Note also that on the occasion of the realignment of 1990:1:8 the band of fluctuations for the Italian lira was narrowed from 6% to 2.25%

For the Swedish case, we use the same data set as Lindberg and Soderlind (1994b) for comparative purposes, as noted above. In particular, we use daily data for annualised simple bid rates on Euro-currency deposits carrying maturity of 1 and 3 months (source: Bank for International Settlements). The interest rates on deposits

denominated in the basket currency are constructed from the Euro-deposit rate according to the currencies' effective (rather than the official) weights in the Swedish currency basket. The period spans from 1985:6:27 (i.e. after the band of fluctuations for the Swedish krona was narrowed to 1.5%) to 1990:12:31; a qualification has to be kept in mind, however, as capital controls were totally abolished in Sweden only in July 1989 and this might have affected the level of interest rates in Eurodeposits denominated in Swedish Krona.

Note that while for the ERM case the frequency of the data matches the term of maturity for the deposits (1 and 3 month), so that the problem of 'overlapping data' arises, causing strong autocorrelation in the series under scrutiny.

In order to examine the order of integration of interest rate differentials, we adopt the ADF (Augmented Dickey Fuller) test (Dickey and Fuller 1979), PP (Phillips and Perron) test (Phillips and Perron 1988) and the Johansen procedure to test for cointegration (Johansen 1988). Both the ADF and PP tests eliminate the dependency of the relevant limiting distributions on the serial correlation structure of the series under scrutiny y_t, albeit in different ways: ADF does this parametrically, PP non parametrically.

As is well known, the ADF consists in the calculation of the t-ratio of a in the regression

2.8) $$\Delta y_t = k + a\, y_{t-1} + bt + \sum_{i=1}^{p} c_i\, \Delta y_{t-i} + u_t$$

(where y_t is the series under scrutiny, Δ is the first difference operator, k is a constant term, t is the trend and u_t is the error term) and comparison with the critical values reported by Fuller (1976) and MacKinnon (1991). One issue of particular importance is the choice of the truncation lag parameter p, as it is often the case that the outcome of the test crucially depends on the particular choice of this parameter: while too small a truncation lag parameter leads to size distortions of the unit root test because of

autocorrelated residuals in equation 2.8), too large a truncation lag parameter results in loss of power. In this chapter we start from entering four lags in equation 2.8; we then check that no serial correlation is contained in the residuals and, in this case, we test for the significance of the fourth lag; where this appears insignificant, regression 2.8 is re-estimated including three lags. In all the cases, with the exception of Italy, for the first sub period, the third lag appears to be significant and thus an ADF (3) is applied.

The Perron and Phillips (1988) approach consists of the estimation by least squares of one of the following regressions:

2.8') $$y_t = ay_{t-1} + u_t$$

2.8") $$y_t = k + ay_{t-1} + u_t$$

2.8"') $$y_t = k + ay_{t-1} + b\,(t-T/2) + u_t$$

depending on whether the assumed Data Generation Process (DGP) is either:

2.9') $$y_t = y_{t-1} + u_t$$

2.9") $$y_t = \mu + y_{t-1} + u_t$$

and in the second case, if the alternative hypothesis is a stationary process either with or without a deterministic trend. The estimates are then corrected by a factor based on the structure of the residuals from the estimated regression. The procedure is non-parametric in the sense that there is no need to estimate the nuisance parameters c_i $(i=1,\ldots,p)$

A Monte Carlo study conducted by Godfrey and Tremayne (1988) shows that for finite sample size the ADF test performs better than the PP test; in particular, it is robust to non-normal, but still i.i.d., or heteroscedastic errors. However, it performs rather poorly if the errors are autocorrelated. In the latter case the PP tests are preferred, as well as in the heteroscedastic case with a fairly large sample size.

As mentioned above, we perform both tests for both the case of the ERM and the Swedish target zone. However, given the size of the data set and the absence or

presence of the problem of overlapping data, the most appropriate test is respectively the ADF test in the first case and the PP in the second.

An alternative approach to the ADF and PP tests is given in a multivariate context by the test for cointegration proposed by Johansen (1988), which contains as a special case a test for a unit root versus stationary alternatives.

Call $\underline{z}$ the vector of variables, whose order of integration we want to test and consider the VAR model

$$2.10) \qquad \Delta \underline{z}_t = \sum_{i=1}^{p-1} \Gamma_i \Delta \underline{z}_{t-i} + \Pi \underline{z}_{t-p} + \Psi \underline{D}_t + \underline{u}_t$$

where $\Pi = \alpha\,\beta'$, α is the matrix representing the speed of adjustment to disequilibrium, and β is the matrix containing the cointegrating vectors, D_t indicates the set of deterministic variables to be included in the VAR and p indicates the lag-length allowed in the VAR. One question of great importance with respect to testing for cointegration in multivariate systems is whether an intercept and trend should enter the short- and/or long-run model. Suppose that the only deterministic variables that enter the VAR are a constant and a deterministic trend and call $\underline{z}^{*\prime}_{t-p} = [\underline{z}'_{t-p}\ 1\ t]$.

Equation 2.10) can be rewritten as:

$$2.10') \qquad \Delta \underline{z}_t = \sum_{i=1}^{p-1} \Gamma_i \Delta \underline{z}_{t-i} + \alpha\,[\beta'\ \underline{\mu}_1\ \underline{\delta}]\ \underline{z}^*_{t-p} + \alpha_\perp\ \underline{\mu}_2 + \alpha_\perp \underline{\delta}_2 t + \underline{u}_t$$

where $\alpha_\perp$ is the orthogonal matrix to α so that $\alpha_\perp'\alpha = 0$.

In the case where there are linear trends in the level of the data and there is some long-run linear trend which cannot be accounted for by the model, then a time trend is allowed to enter the long-run relationship. However, if there is no quadratic trend in

the level of the variables, the trend does not affect the short-run dynamics and δ_2 is restricted to be zero.

The Johansen procedure allows one to estimate the number of cointegrating vectors by estimating the rank of the matrix Π in equation 2.10, or similarly, the rank of $\alpha\beta'$ in equation 2.10') . In the particular case where the matrix has full rank, all the variables under consideration are stationary. Hence, it is possible to examine the order of integration of the set of the variables z by calculating the rank of an estimate of the matrix Π.

As for the choice of entering the constant in either restricted or unrestricted form and entering a time trend in the long-run relationship, we decided to enter the constant in unrestricted form, due to the trending pattern of the interest rate differentials in the period considered in our analysis; moreover. We also decided to include a time trend in the long run relationship, as interest rates for different countries converge to the German one at different speeds, showing in a different importance of a trend in the pattern of interest rate differentials.

As our series are given by interest rate differentials, it would be reasonable to assume that a trend is not present in their behaviour in the long run. However, in the case of the ERM, as we are strictly interested in the analysis of the period 1987-1992, which is clearly characterised by the presence of a downward trend for all the series. From an economic point of view, the presence of a downward trend in the interest rate differentials has been commonly interpreted as a sign of increasing credibility in the ERM, implying a steady convergence of the nominal interest rates of the ERM members to the German rate (see figure 2.1-2.5).

On the contrary, as far as the Swedish target zone is concerned, the hypothesis of the presence of a deterministic trend cannot be supported (see figure 6). However, it does not seem appropriate to exclude the possibility of having a deterministic trend in this series on a priori grounds and we implement both the ADF and PP tests not restricting b in equation 2.8) to be equal to zero.

Generally, in the absence of any realignment, the presence of the expected rate of devaluation implies that any empirical work regarding the UIP or the unbiasedness hypothesis of the forward rate faces the 'Peso Problem', i.e. the expectation of an event that does not materialise in the period considered. In particular, there will be a wedge between the actual change of the exchange rate (equal to the exchange rate within the band) and the interest rate differential, thus invalidating the standard tests of UIP.

The implementation of both the ADF and PP tests shows that the hypothesis of the presence of a unit root can be rejected in all the cases, with, maybe, the exception of Denmark (see table 2.1).

When the ADF test is adopted, the null hypothesis of the presence of a unit root cannot be rejected for Denmark, is rejected at 10% significance level for Belgium, and (at least) at 5% significance level in the other cases. When the PP test is used, however, the null is rejected for all the series considered. The failure for the ADF test to reject the null for Denmark can be explained by observing that for several months in 1988: the series appears to be shifted downward. It is well known that the ADF test has very low power when the alternative hypothesis is a stationary series with one (or more) structural breaks (see Perron 1989, 1990 and Hendry and Neale 1991).

In order to find an explanation for the drift in the series, it is necessary to examine the behaviour of the single series of the interest rates on Eurodeposits expressed in Danish Krona and Deutsche marks (figure 2.3) and to refer to the kind of monetary policy implemented in the two countries at that time. By looking at the graph of the two series, it is possible to infer that while the strong decrease in the interest rate differential in May 1988 was due to an increase in the German interest rates that was not followed by the Danish ones (also in January 1989 the Danish interest rates did not follow the German ones), the sharp increase in September was due to a strong increase in the level of the Danish interest rates, due to the expectations of a realignment in the ERM and in particular of a devaluation of the Danish krona against the Deutsche Mark.

We finally adopt the Johansen test for cointegration for the variables considered in the chapter with the exception of the interest rate differential between Denmark and Germany, which seems to be affected by two structural breaks.

For the reasons given above we included in the system an unrestricted constant and a restricted trend. The results (see table 2.2) show that both the trace and the maximum eigenvalue statistics cannot reject the hypothesis of the presence of four cointegrating vectors, which implies that all the series of the system are stationary. The result is supported by inspecting the graphs of the four cointegrating vectors, which do not show any sign of nonstationarity (figure 2.8).

Also for Sweden, the results of both the ADF and PP tests for the one and three months interest rate differential show that the hypothesis of the presence of a unit root can be rejected; however, in this case the alternative hypothesis that seems most likely to hold is that of a stationary process without a deterministic trend (see table 2.3a and 2.3b).

For both the lag length chosen (5 and 10), $Z(\Phi_3)$ shows a strong rejection of the null hypothesis (H_0: b=0 and a=1 in equation 2.8'')) for any significant level; moreover, the t-statistics for b and a show that while the first is not significant, the second is significant and strongly so (also the t-statistics for k is significant). As Perron (1988) suggests, given that a rejection of the null hypothesis of the presence of a unit root in this case is possible, there is no need to go further. These results support the hypothesis that the series is stationary and that it does not contain a significant trend component.

This result is particularly interesting for two reasons: firstly, the assumption that the expected rate of devaluation follows a random walk has proved not to hold empirically not only for the case of the ERM, but also for the Swedish target zone. Secondly, the rejection of the unit root hypothesis for the interest rate differential holds despite the fact that we use exactly the same data set and period as Lindberg and Soderlind (1994b), who argue that their empirical analysis supports their theoretical model.

We are then quite confident in dismissing as unrealistic the hypothesis that, when the only alternative to maintaining the central parity is a realignment, the rate of expected devaluation, and hence the interest rate differential, follows an integrated process of the first order, both on theoretical and empirical grounds.

2.4: Conclusions and extensions

From the integration accounting given above, it follows that both the BS and the LS proposals imply a unit root in interest rate differentials. But this is rejected by the data. So, these models do not seem to offer a satisfactory explanation of the behaviour of the exchange rate in presence of non fully credible target zones.

The statistical properties of the hypothesised rate of expected rate of devaluation could, of course, always be reformulated to fit the data. But to do this means that one is defining as devaluation risk all that cannot be explained in terms of fundamentals and uncovered interest parity, without testing any meaningful hypothesis. A better approach would be to specify and test a theory of what economic factors are associated with realignments and hence with the expected rate of devaluation.

As mentioned above, the time series behaviour of the interest rate differential clearly shows a downward trend in all the cases considered. By recalling equation 2.3'), it is clear that 'raw interest rate differentials can be very misleading indicators of realignment expectations' (Svensson 1991), given the presence (in the interest rate differential) of the expected change of the exchange rate within the band. However, it seems plausible to assume that the trending pattern of the interest rate differentials carries over to the rate of expected devaluation.

Such pattern can be explained by the model of learning recently proposed by Driffill and Miller (1993). In their framework, agents use Bayesian updating to revise their beliefs about the arrival rate of a realignment, which can be either high or low. If no devaluation occurs, the probability that the public attach to the low arrival rate to be the true one increases and so the expected rate of occurrence of a realignment (which is a weighted average of the two arrival rates) decreases. Conversely, when a

realignment occurs, the expected rate of devaluation rises sharply. This is clearly not what one usually observed after realignments in the early '80s.

A qualification, however, is that the same negative trending pattern cannot be traced in the Swedish case; moreover, the model cannot explain the sharp increase in the interest rate differentials, and the subsequent exit of Italy and the UK from the ERM.

We conclude, therefore, that discriminating tests of a theory of realignments will need to be tested on a data set which goes back earlier than 1987 and includes periods after realignments.

Appendix to chapter 2

In the present section our aim is to present the main elements of the Bertola and Svensson and the Lindberg and Soderlind models, stressing the role of the assumption that the expected rate of devaluation follows a Brownian motion.

BS express, as is standard in target zone models, the current level of the exchange rate, s_t, as depending on the level of the 'fundamentals', f_t, and on a forward looking term, given by the expected change in the exchange rate, E_t (ds)/dt:

a 2.1) $$s_t = f_t + \alpha E_t (ds)/dt$$

It is assumed that f_t follows a stochastic process of the kind:

a 2.2) $$df_t = \mu_f dt + \sigma dW_f + dL(t) - dU(t) + dc_t$$

where W is a standard Wiener process, L(t) and U(t) are non decreasing, continuous processes, which increase only when the exchange rate hits the lower or the upper boundary of the band, and whose movements are necessary to hold the exchange rate inside the band of fluctuation. Finally, the process c_t, where c_t indicates the central parity, is assumed to be a jump process, with jumps which take place at the time of a realignment.

It is possible to define two new variables as the deviation of the fundamentals and the exchange rate from the central parity:

a 2.3) $$x_t = s_t - c_t \qquad f^o = f_t - c_t$$

Moreover, call the size of the exchange rate jump parity at the time of a realignment z_t and assume that the position of the exchange rate inside the band remains unchanged when a realignment occurs, such that z_t expresses also the jump in the central parity (at the realignment).

Assuming that the probability of a realignment to occur is equal to p_t, the expected rate of devaluation is equal to:

a 2.4) $$g_t = (1/dt)\,(\,p_t\, E_t\,(z_t \mid r)) = v_t\, \overline{z_t}$$

It is also possible to relax the assumption that the exchange rate inside the band does not move at the time of a realignment, along the lines of Lindberg, Svensson and Soderlind (1991). In this case z(t) can be expressed as:

a 2.5) $$\overline{z_t} = E_t\,((dc \mid r)\,/dt + (x_{t+dt} \mid r) - (x_{t+dt} \mid nr))$$

As mentioned in the main text of this note, BS assume that g_t follows a Brownian motion process, of the sort:

a 2.6) $$d\,g_t = \mu_g\, dt + \sigma_g\, dW_g$$

Following from the above equations, it is possible to express the expected change of the exchange rate as:

a 2.7) $$E_t\,(ds)/dt = E_t\,(dx)/dt + g_t$$

It is then possible to rewrite equation a 2.1) as:

a 2.1') $$s\,(f, g) = f(t) + \alpha\, g_t + \alpha\, E_t\,(dx)/dt$$

and by subtracting the value of the central parity both from the left and the right hand side

a 2.8) $$x(f^{\circ}, g) = f^{\circ}(t) + \alpha g_t + \alpha E_t (dx)/dt$$

By defining the new state variable

a 2.9) $$h_t = f^{\circ}(t) + \alpha g_t$$

which follows a Brownian motion process, being the sum of two Brownian motion processes,

it is then possible to reformulate the model as:

a 2.10) $$x(h) = h_t + \alpha E_t (dx)/dt$$

with boundary conditions:

$x(\bar{h}) = \bar{x} \qquad x(\underline{h}) = \underline{x} \qquad x'(\bar{h}) = x'(\underline{h}) = 0$

It turns out that the solution is fully analogous to that proposed by Krugman (1991) for a fully credible target zone and that an S-shaped relationship exists between h_t and x_t.

We noticed in the main text that, according to LS, the composite fundamental follows a Ornstein-Uhlenbeck process, while the expected rate of devaluation is still modelled as a Brownian motion. This is obtained as follows:

a 2.11) $$f^{\circ}_t = v_t + n_t + \alpha g_t$$

both v_t and g_t are assumed to follow a Brownian motion process and to be independent; moreover, contrary to BS, g_t is assumed to follows a Brownian motion without drift.

a 2.12) $$dg_t = \sigma_g dW_g$$

a 2.13) $$d(v_t + \alpha g_t) = dW_t$$

a 2.14) $$\sigma = \sqrt{(\sigma_v + \alpha\sigma_g)}$$

The policy rule is specified as:

a 2.15) $$dn_t = -\beta\,(h_t - h^\circ)dt + dL - dU$$

where $dL>0$ for $h=\underline{h}$ and $dU>0$ only if $h=\bar{h}$

and $\underline{h}$ and $\bar{h}$ are the boundaries of the band for h_t.

According to LS, h° corresponds to a preferred exchange rate level within the band, $x^\circ=x(h^\circ)$ and β is a constant positive policy parameter.

From the equations above, it follows that the composite fundamental follows, in the interior of the band, the Ornstein-Uhlenbeck process:

a 2.16) $$dh_t = -\beta(\,h_t - h^\circ)dt + \sigma dW_t$$

Compared to both the Krugman and the BS model, this formulation implies that the drift parameter is not constant, but it is variable and that h_t is a mean reverting process also without interventions at the boundaries.

Figure 2.1a: Interest rate differential Belgium Germany 2.1987 3.1992

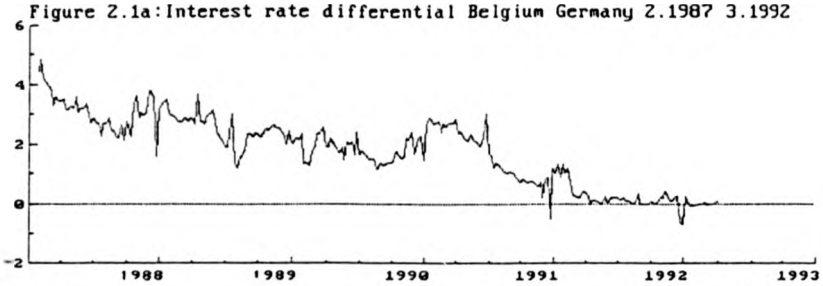


Figure 2.1b: Interest rates Belgium (____) and Germany(----) 2.1987 3.1992

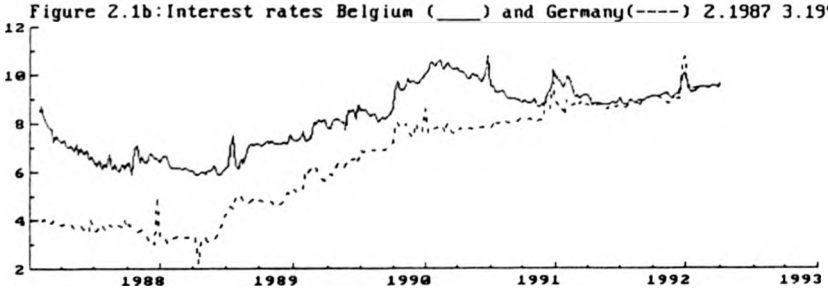


Figure 2.2a: Interest rate differential Denmark Germany 2.1987 3.1992

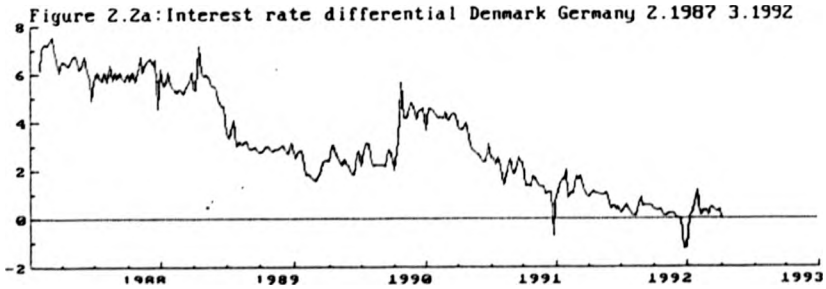


Figure 2.2b: Interest rates Denmark(__) and Germany (---) 2.1987 3.1992

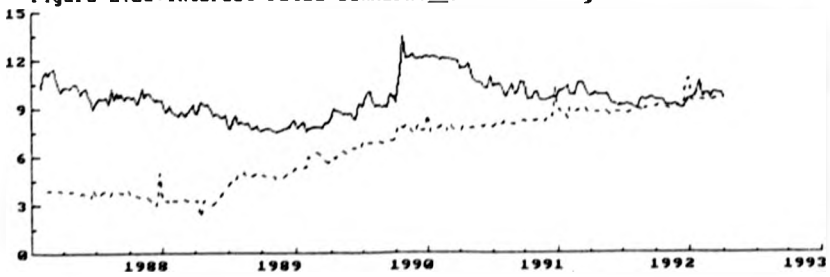


Figure 2.3a: Interest rate differential France Germany 2.1987 3.1992

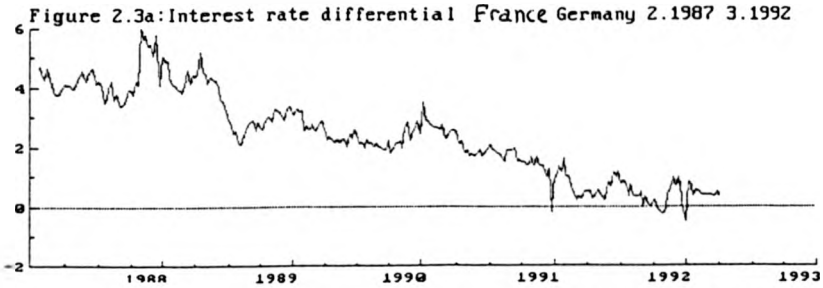


Figure 2.3b: Interest rates France(__) and Germany (---) 2.1987 3.1992

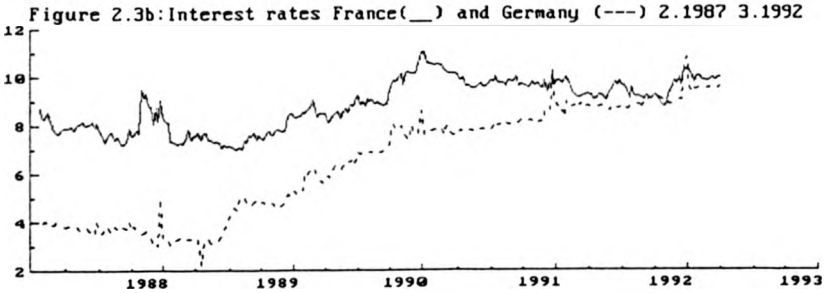


Figure 2.4a: Interest rate differential Italy Germany 2.1987 3.1992

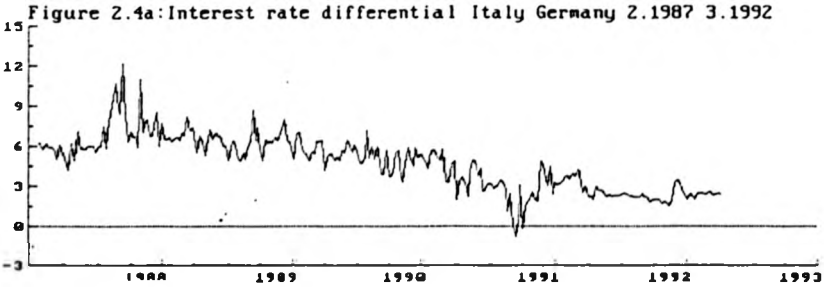


Figure 2.4b: Interest rates Italy(___) Germany(---) 2.1987 3.1992

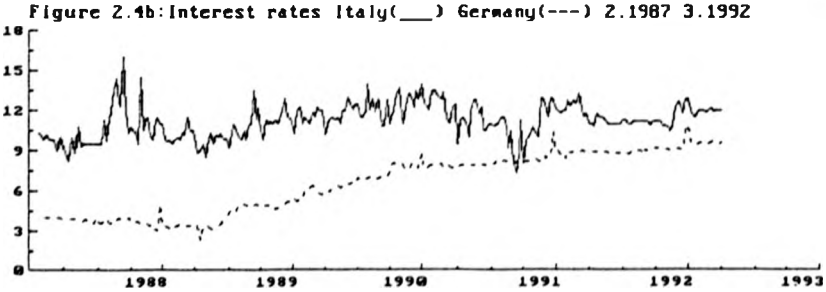


Figure 2.5a: Interest rate differential Netherlands Germany 2.1987 3.1992

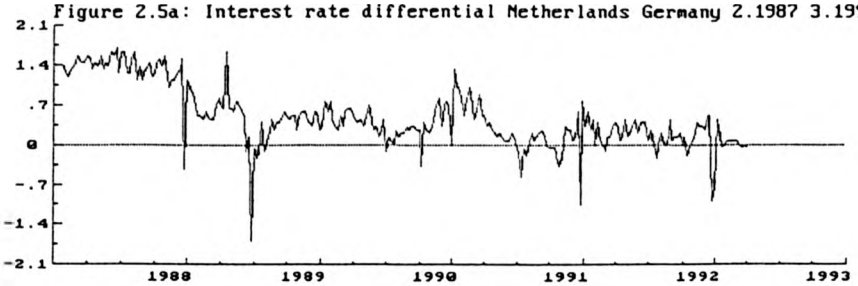


Figure 2.5b: Interest rates Netherlands(__) Germany(---) 2.1987 3.1992

Figure 2.6a: Interest rate differential Swedish krona basket
1 month 1982-1990

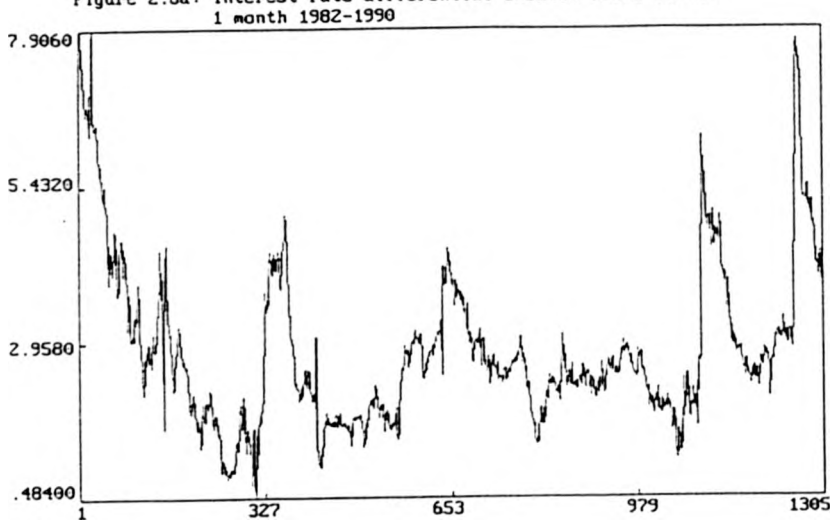


Figure 2.6b: Interest rates for Swedish krona (top line) and basket
(bottom line) 1 month 1982-1990

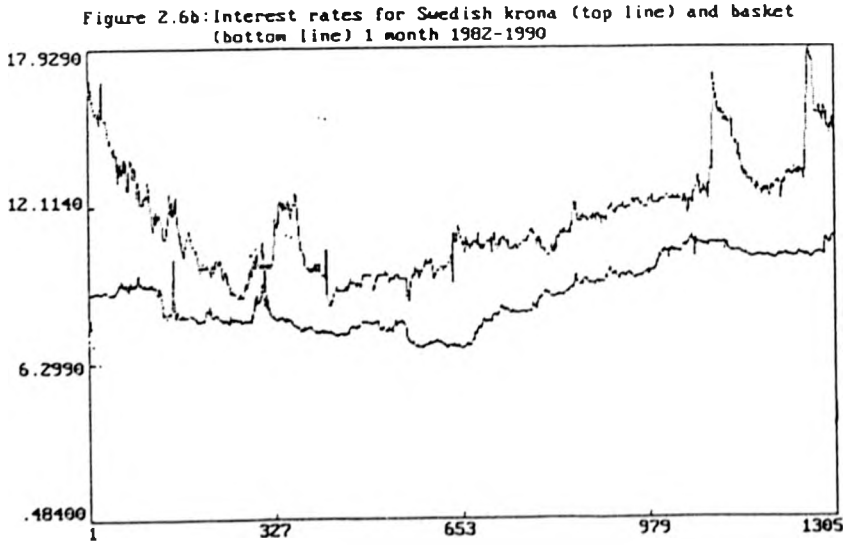


Figure 2.7a: Interest rate differential Swedish krona basket 3-month 1982-1990

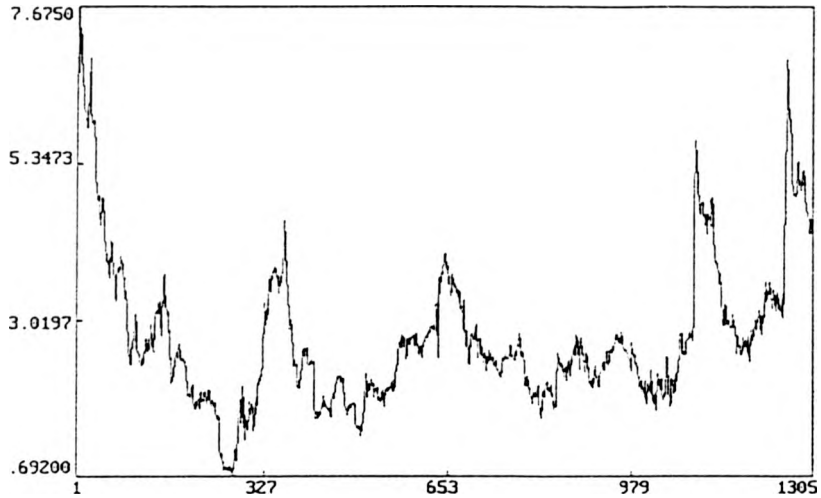


Figure 2.7b: Interest rates for Swedish krona (top line) and basket (botton line) 3 month 1982-1990

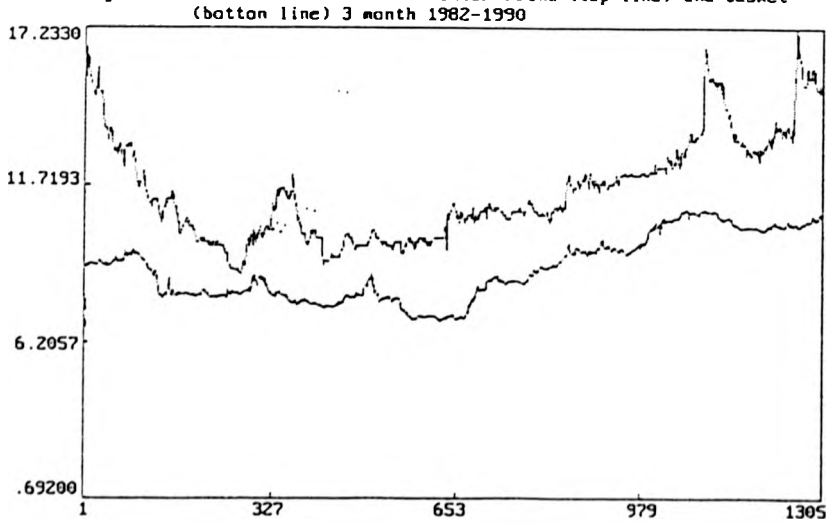


Figure 2.8: Cointegrating vectors for VAR in interest rates differentials

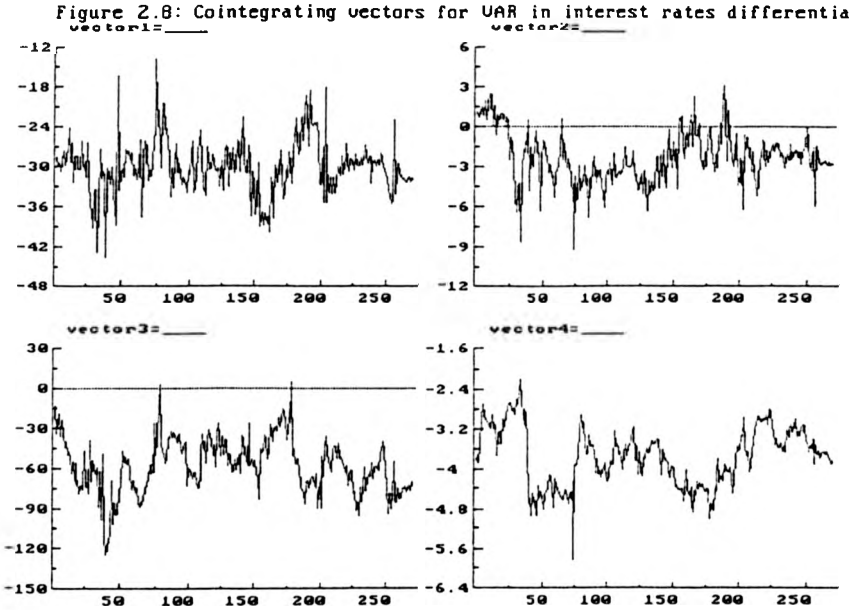


Table 2.1a: PP test
ERM Eurocurrencies
2.1987 3.1992
1 week maturity

Interest rate differential	Lags	t_μ	t_α	t_β	Φ_3
BF/DM	4	5.64*	-6.14*	-5.32	18.92*
DG/DM	4	6.72*	-8.96*	-6.04	40.13*
DK/DM	4	3.33**	-3.76*	-3.40	7.08**
FF/DM	4	4.73*	-5.06*	-4.67	12.79*
LIT/DM_1	4	7.23*	-7.39*	-3.18	27.28*
LIT/DM_2	4	5.37*	-5.82*	-1.79	16.99*

* significant at 2.5%
** significant at 5%
*** significant at 10%
All the statistics refer to the model 2.5''')
$Z(t_\mu)$ tests for the significance of k
$Z(t_\alpha)$ tests for the significance of a
$Z(t_\beta)$ tests for the significance of b
$Z(\Phi_3)$ tests jointly for a=1 and b=0

Table 2.1b: ADF test
ERM Eurocurrencies
2.1987 3.1992
1 week maturity

Interest rate differential	Lags	t_μ	t_α	t_β	Φ_3
BF/DM	3	2.93***	-3.42***	-2.9**	5.97***
DG/DM	3	2.58	-3.52**	-2.48***	6.23***
DK/DM	3	1.93	-2.47	-2.06	3.12
FF/DM	1	3.60*	-3.92*	-3.64*	7.67*
LIT/DM_1	2	3.98*	-4.05*	-2.29	8.23*
LIT/DM_2	4	3.63*	-3.87*	-1.25	7.55*

* significant at 2.5%
** significant at 5%
*** significant at 10%
All the statistics refer to model 2.5)
t_μ tests for the significance of k
t_α tests for the significance of a
t_β tests for the significance of b
Φ_3 tests for the joint significance of a and b

Table 2.2: Johansen test for cointegration for interest rate differentials 2 lags included

H_0: rank=r	LR test based upon max eigenvalue	LR test based upon trace
r=0	47.19**	111.3**
r<=1	28.63**	64.16**
r<=2	23.13**	35.53**
r<=3	12.4*	12.4*

**: significant at 1% level
*: significant at 5% level

Table 2.3a: PP test Swedish Eurocurrencies against basket 7.1985 12.1990 1 month maturity

Lags	$Z(t_\mu)$	$Z(t_\alpha)$	$Z(t_\beta)$	$Z(\Phi_3)$
10	3.79*	-4.36*	1.35	10.46*
5	3.76*	-4.33*	1.37	10.36*

Table 2.3b: PP test Swedish Eurocurrencies (against basket) 7.1985 12.1990 3 month maturity

Lags	$Z(t_\mu)$	$Z(t_\alpha)$	$Z(t_\beta)$	$Z(\Phi_3)$
10	3.66*	- 4.12*	2.14	10.11*
5	3.66*	- 4.13*	2.13	10.12*

* significant at 2.5%
** significant at 5%

Table 2.4a: ADF test
Swedish Eurocurrencies (against basket) 7.1985 12.1990
1 month maturity

Lags	t_μ	t_α	t_β	Φ_3
0	3.77*	-4.35*	1.36*	10.41*

Table 2.4b: ADF test
Swedish Eurocurrencies (against basket) 7.1985 12.1990

Lags	t_μ	t_α	t_β	Φ_3
1	3.77*	-4.35*	1.36*	10.41*

Chapter 3:

A model of the Currency Crisis of 1992: The Case of the British Pound and the Italian Lira

3.1 Introduction

The currency crisis that hit most of the ERM currencies and caused the exit of the Italian Lira and the British Pound from the System has been a crucial topic of research in the last two years. Several models have been proposed to explain the episode, each focusing on a different aspect of the crisis.

One strand of the literature (e.g. Masson 1994) has stressed the importance of the trade-off between exchange rate stability and unemployment facing a government and the opposite effect that high unemployment has on the credibility of the commitment of the government to defend the parity of its currency. Masson shows that a high unemployment level can have opposite implications for expectations of a future devaluation, and hence for the interest rate differential: on one hand it signals a 'tough' Government, strongly committed to defend its parity; on the other hand, if circumstances become too unfavourable, it makes the task too difficult, in such a way that also a government strongly committed to defend the parity is forced to realign.

Another strand of the literature (e.g. Ozkan and Sutherland 1994) has focused on the nature of the switch between a fixed and a floating exchange rate system as an optimising decision of the government, in order to loosen monetary policy and boost aggregate demand, and not as an action forced on the government. However, the agents in the foreign exchange market know the government's objective function and include the expectation of the switch of regime in their expectations, which are then reflected in the interest rate differential. The authors also show that the agents' knowledge of the government's objective function induces the regime switch to take place earlier than the time preferred by the government.

Several papers have also focused on the empirical aspects of the crisis (Rose 1993, Rose and Svensson 1993, Thomas 1994), but their results are far from being conclusive, on how and why the crisis took place.

The aspect which we want to analyse in this chapter is the role of the willingness (or unwillingness) of the Bundesbank in supporting the currencies under attack for the agents' expectations of the future exchange rate and, hence, the viability of the system. A close reading of the financial press of the time stresses the fact that the agents used the stance of the German central bank as a signal on the viability and the sustainability of the system; although this element of the crisis has been raised before (Kenen 1994), there is no formal theoretical model which captures this aspect in the literature to date. The degree of the willingness on the side of the Bundebank to support the weak currencies is strongly linked to the implications of this manoeuvre on the level of the money supply and its growth for Germany if the manoeuvre remains unsterilized. The stance of the Bundesbank to contain money supply is well known and so it is not surprising that the market questioned the validity of the commitment on the side of the Bundesbank to intervene for any required amount.

This can be seen as the 'political economy' aspect of the framework proposed in this chapter. There are two major differences with the models that focus on the political economic aspect of the crisis: first, the preferences of the 'strongest' country in the System, Germany, are not modelled in terms of a welfare function, but are taken into account as a dislike of an increase of the money supply beyond the target. Secondly, while in the models of the first type unemployment covers a major role, entering, either directly or indirectly, the government's welfare function, in the model proposed in this chapter unemployment does not have any role to play. The reason for this is that the theoretical framework for our model is the monetary model of exchange rate determination with flexible prices, where it is assumed that output is set exogenously at the full employment level.

The models that focus on political economy issues, moreover, analyse the case of a switch between a fixed exchange rate system and a free float, while in this chapter a

switch between a two-sided target zone and a free float is examined. This seems closer to the nature of the ERM, where currencies are allowed to move within a fluctuation band.

The model proposed here is a modified version of the model of the gold standard proposed by Krugman and Rotemberg (1992) and Fella (1993).

The second section of the chapter will outline the basic model of the gold standard by Krugman and Rotemberg and describe how the model can be extended to the target zone case. The third section is devoted to the description of our model and in the fourth section we will outline its empirical implications the model proposed will be the topic of the forth section. The conclusion also contains the proposal for a further extension of the model.

3.2: The Krugman and Rotemberg Model of the gold standard

The basic target zone model, proposed by Krugman (1991a) and all the models of the so-called 'second generation' (Bertola and Caballero 1992, Bertola and Svensson 1993, Lindberg and Soderlind, 1993, and Tristani 1994) implicitly assume that the amount of reserves available in order to defend the parity of the currencies in the system is unlimited.

This assumption seemed compatible with the characteristic of the ERM, giving that the Act of Foundation of the EMS states that support to currencies which approach the weak edge of the band is unlimited ('...These interventions shall be unlimited at the compulsory intervention rates...', Document 8, Section 1, Article 2.2); moreover, with the Agreement of Basle-Nyborg in September 1987, it was agreed that the access to the Very Short Term Financial Facilities was extended in use and duration.

However, in December 1978, in a hearing to the Bundestag, the German Finance Minister stated that '...the Bundesbank has the responsibility to intervene *and the option not to intervene* if it is its opinion that it is not able to do so' (italics added).

The events of the Summer 1992 showed that the amount of reserves available for the countries whose currencies were subject to a speculative attack was actually an issue

and that the central bank of the centre country, the Bundesbank, was not actually prepared to intervene for unlimited sums in defence of these currencies. For this reason, it seems necessary to extend the target zone model in order to incorporate limited reserves.

The issue of limited reserves has been studied extensively in the two-countries model of the gold standard proposed by Krugman and Rotemberg (1992) (henceforth KR).

In their model, the fixed exchange rate system is seen as a boundary between two one-sided target zones. The focus here is of course of the limited nature of the amount of reserves available to the two countries, whose sum is equal to the quantity of gold available in the system, and how this can cause a collapse of the fixed exchange rate system to a floating one. Each country has a fixed parity for the price of gold, and so the exchange rate between the two countries is fixed (see figure 3.1).

The model analyses the behaviour of the exchange rate between the two currencies as one of the two countries runs out of reserves (which implies that the other countries owns almost all the gold in the system).

The agents know that once a country runs out of reserves, it cannot defend the parity of its currency any longer and is forced to float. The authors show that in the event the switch to a floating regime is a reversible one, this takes place for values of the velocity shock which differ compared to the case of an irreversible switch.

The model can be summarised as follows.

First consider the equation of the exchange rate:

3.1) $$s = m - m^* + v + \alpha E_t (ds/dt)$$

s is the log of the exchange rate between the currencies of the two countries

m (m*) is the log of domestic (foreign) money supply

v is a velocity shock, which follows a Brownian motion process (without drift)

3.2) $$dv = \sigma dz$$

α is the semi-elasticity of the money demand to interest rate

E_t (ds/dt) is the instantaneous expected change of the exchange rate, which is equal to zero in a fixed exchange rate system with no expectations of a future jump in the exchange rate

m (m*) can be written as:

3.3) $$m = \log (D + R)$$
$$(m^* = \log (D^* + R^*))$$

D (D*) is the level of domestic credit for the domestic (foreign) country

R (R*) is the level of reserves for the domestic (foreign) country

The sum of the reserves belonging to the domestic and the foreign country is equal to the amount of gold available in the system

3.4) $$G = R + R^*$$

The monetary authorities of the two countries commit themselves to defend the fixed exchange rate until they run out of reserves, when they are forced to leave the exchange rate floating. The additional assumption that Krugman and Rotemberg make is that the country which has run out of reserves, commit itself to buy gold at the par value when there is the possibility to do so, thus reinstating the gold standard.

The boundaries of the gold standard are given by the two free float loci each corresponding to a total loss of reserves for one country (FF and F'F' in figure 3.1).

In particular, the free float locus when the domestic country has run out of reserves is:

3.5) $$s = \ln \left(\frac{D}{D^*+G}\right) + v$$

(this is the line FF in figure 1)

while the free float locus corresponding to the total loss of reserves by the foreign country is:

3.5') $$s = \ln(\frac{D+G}{D^*}) + v$$

(this is the line F'F' in figure 3.1).

However, given that the switch between the gold standard and the float is reversible, the float is not totally free, but it can be seen as a one-sided target zone.

As figure 1 shows, for values of the velocity shock smaller than v_A, the exchange rate float, but when v reaches v_A, then the gold standard is reinstated, and so the par value. Likewise, for values of v greater than v_B, the exchange rate floats, but if v becomes smaller than v_B, the gold standard is reinstated, and so the par value.

This implies that, for values of the velocity shock smaller (or equal) than v_B the exchange rate will be smaller or equal to the fixed exchange rate (corresponding to the par value of the gold); for values of v greater or equal to v_A the exchange rate will be greater or equal to the fixed exchange rate.

The prospect of returning to the gold standard either sustain (in the unilateral target zone A) or depresses (under the target zone B) the value of the exchange rate, compared to the corresponding free float values.

In order to find the equation that characterises the two one-sided target zones, the exchange rate is expressed as a twice-continuous function of the velocity shock v. Given that the velocity shock follows a driftless Brownian motion, it is possible to apply Ito's lemma and obtain the following second order differential equation:

3.6) $$s(v) = (m - m^*) + v + (1/2)\,\sigma^2 s''(v)$$

which has solution:

3.7) $$s(v) = (m - m^*) + v + A_1 e^{rv} + A_2 e^{-rv}$$

where +/- r are the roots of the characteristic equation (with $r > 0$)and A_1 and A_2 are arbitrary constants to be determined.

In order to pin down A_1 and A_2, boundary conditions must be used.

First, consider the unilateral target zone A: the value of v is unbounded from below, hence $A_2 = 0$. Secondly, for $v = v_A$ the exchange rate must be equal to the par value, in order to satisfy the non-arbitrage condition.

3.8) $$s(v_A) = s_{par}$$

For the same reason, the smooth pasting condition has to hold for $v = v_A$,

3.9) $$s'(v_A) = 1 + r A_1 e^{rv_A} = 0$$

The value of A_1 is then

3.10) $$A_1 = -(1/r)\, e^{-rv_A}$$

and so, the equation describing the behaviour of the exchange rate in the unilateral target zone A (see figure 3.1) is:

3.11) $$s(v) = \ln\left(\frac{D+G}{D^*}\right) + v - (1/r)\, e^{r(v-v_A)}$$

(given that the relative money supply when the domestic country has all the gold is equal to $\ln(\frac{D+G}{D^*})$. In a similar way, it can be shown that the equation characterising the exchange rate under the unilateral target zone B is:

3.12) $$s(v) = \ln\left(\frac{D}{D^*+G}\right) + v + (1/r)\, e^{-(v-v_0)}$$

(given that the relative money supply when the foreign country has all the gold is equal to $\ln\left(\frac{D}{D^*+G}\right)$.

It is important to stress two characteristics of this model, which are going to be recalled later in the chapter.

First, at the time of the switch from the fixed regime to the unilateral target zone A (B) there is a discrete loss of reserves from the foreign (domestic) to the domestic (foreign) country. The reason for the loss of reserves is given by what follows: while under the gold standard the expected change of the exchange rate is equal to zero, under the target zone A (B) the exchange rate is expected to appreciate (depreciate) and hence at the edges of the gold standard there will be a sudden purchase (sale) of the domestic currency by means of a sale of gold reserves.

Secondly, the switch between the unilateral target zone and the gold standard can be seen as a state-contingent condition, i.e. the switch takes place once the velocity shock reaches v_A (v_B). As a consequence, in order to avoid the possibility of infinitely large gains, the exchange rate before and after the switch needs to be the same, i.e.

3.13) $s(v_{A-}) = s(v_{A+})$

3.13') $s(v_{B-}) = s(v_{B+})$

where a + indicates the 'after-collapse' regime, while a - indicates a 'pre-collapse' regime.

The framework proposed by Krugman and Rotemberg has been extended by Fella (1993) in order to analyse the issue of limited reserves in the framework of a fully credible two-sided target zone, instead than in a gold standard.

The free float lines, as well as the unilateral target zones are the same, and so have the same equations, as the ones in the Krugman and Rotemberg model. The difference lies in the state-contingent conditions of the switch between, in this framework, the two-sided and the one-sided target zone (see figure 3.2).

The two free float lines determine the area of sustainability of the two-sided target zone, in the case the switch to a floating exchange rate is irreversible. In the case of a reversible switch, the area of sustainability is limited within v_A and v_B.

The S-shaped curve (which characterises the two-sided target zone) position inside this area is given by the level of the relative money supply. The money supply, in turn, changes once one of the two boundaries of the fluctuation band is hit and the authorities are forced to intervene (when the country whose currency is weak looses gold in favour of the country whose currency is strong).

Consider first a reversible switch to floating exchange rates: this takes place in correspondence of the value of the velocity shock where the exchange rate inside the band has reached the upper (lower) boundary (of the fluctuation band) and this equals the exchange rate, for the same velocity shock, under the one-sided target zone where the foreign (domestic) country has all the gold available in the system. The values of v_A (v_B) can be determined by solving the following equation:

3.14) $$v_A + (m - m^*) + \Lambda_1 e^{rv_A} + \Lambda_2 e^{-rv_A} = v_A + \ln\left(\frac{D+G}{D^*}\right) - (1/r)$$

and

3.14') $$v_B + (m - m^*)' + \Lambda_1 e^{rv_B} + \Lambda_2 e^{-rv_B} = v_B + \ln\left(\frac{D}{D^*+G}\right) + (1/r)$$

where v_A and v_B are the only unknowns in the equations above (A_1 and A_2 have the same values as in the original target zone model (Krugman 1991a)).

Because the smooth-pasting condition has been imposed on both the two-sided target zone and the two one-sided target zones at the boundary, then these curves smooth paste to each other.

On the contrary, if the switch is between the two-sided target zone and an irreversible float, then the smooth-pasting does not take place, while the value matching condition still holds). Moreover, it can be shown that the values of the velocity shock in correspondence of which the change in regime takes place, v_A' and v_B' , are respectively smaller, the first, and bigger, the second, than the corresponding values if the switch is reversible.

This framework has been extended by the same author to include the possibility for the country which has run out of reserves to borrow reserves from the other country in the system. This implies that the area of sustainability of the two-sided target zone is wider compared to the non-borrowing case (see figure 3.3).

Suppose that the domestic country is running out of reserves, but the agents attach a given probability, λ, that the monetary authorities of the foreign country will grant a loan of size C, in case there is an attack on the domestic currency. In other words, at the time of the attack, the target zone will be defended, and the loan granted, with probability λ; the zone will not be defended, and the exchange rate will be forced to float, with probability $(1-\lambda)$. In each case, at the time of the attack the exchange rate will jump, to the value corresponding to the one-sided target zone if the loan is not granted, and to a new two-sided fully credible target zone if the loan has been granted. The value of the velocity shock that triggers the speculative attack can be found by exploiting the non-arbitrage condition, so that the exchange rate before the attack equals its expected value after the attack. This, in turns, equals the weighted average of the exchange rate in the case the exchange rate is defended (and so the target zone is preserved) and the one when the exchange rate is forced to float.

Supposing that the switch to the float is reversible, this implies:

3.15) $$s(v_{C'}) = \lambda P'Q' + (1 - \lambda) P'R'$$

If the domestic currency is attacked and the loan is granted, then the target zone is going to be sustainable until the velocity shock reaches a level where also the loan has been depleted and the currency is forced to float, in which case the relative money supply equals:

$$m - m^* = \ln ((D - \bar{s}C) / (D^*+G+C))$$

As in the model by Krugman and Rotemberg, also in this framework the switch to the float is a state-contingent condition. This implies that, in order to satisfy the non-arbitrage condition, the exchange rate before the switch is either equal to the one prevailing after that or to the weighted average of the two possible level of the exchange rate which takes place after the attack, as it was said above.

The consequence of these assumptions and conditions is that, before the switch, the behaviour of the exchange rate is perfectly identical to the case where there is an unlimited amount of reserves available in the system and, hence, the target zone is sustainable for any value of the velocity shock. If this is true, also the interest rate differential (given by the vertical distance between the exchange rate along the S-shaped curve and the corresponding free float locus) will have exactly the same behaviour if reserves are either limited or unlimited.

3 A target zone model with an overdraft facility

The implications of the models described above, however, do not seem very consistent with the evolution of the interest rate differentials before the Italian Lira and the British Pound were forced to leave the European Monetary System. The interest rate differentials for the Italian lira started increasing rapidly after the no vote to Maastricht in Denmark in June 1992 and the ones for the British Pound increased towards the end of the summer. For these reasons, it seems important to formalise a model of the target zones, in the phases preceding its collapse, which generates positive interest rates

differentials between Italy and Britain, on the one hand, and Germany, on the other hand, before the fall as an implication.

As it was mentioned in the introduction of this chapter, one aspect of the crisis of the ERM which has been overlooked in the theoretical literature is the role of the attitude of the Bundesbank to intervene in defence of the weak currencies of the system as a signal of the sustainability of the system. The model will focus on this aspect. It is important to stress that the model proposed here can only offer a partial explanation of the ERM crisis. In particular, it is not possible to address issues related to the pressure on the exchange rate parities given by an appreciation of the real exchange rate, which Italy experienced before the crisis; this is due to the fact that our framework is based on the monetary model with flexible prices, which assumes that Purchasing Power Parity holds continuously. Furthermore, the model does not have anything to say on the role of unemployment, as it is assumed that output is fixed at full employment level.

It was shown above that by imposing a state-contingent condition (so that for given known values of the velocity shock there will be a switch of regime), it is necessary that the exchange rate after the switch (or its expected value) is equal to the exchange rate before the switch, in order to satisfy the non-arbitrage condition.

In order to relax this restriction without violating the non-arbitrage condition, it seems preferable to drop the state-contingent condition and view the switch to the float as a probabilistic event. This approach also implies the presence of a 'peso problem' (i.e. the expectation of an event which does not take place in-sample), before the fall, for the weak currency, which is obviously a very important factor before the lira and the pound were forced to float.

For reasons of simplicity, the model does not take into account the possibility of a realignment, but focuses on the switch of regime between the target zone and the free float. For the same reason, an irreversible switch is considered, in order to keep a simple analytical framework. It would be interesting to extend the model to an

environment where realignments can take place and the switch to the float is reversible.

As in the KR framework, the model is a two-country one. It is also assumed that once the domestic country has run out of disposable reserves, the monetary authorities of the foreign country, Germany, agrees to grant a loan of, possibly, an unlimited amount. The loan, however, can be called back at any time, in other words an 'overdraft facility' is in place. If the loan is called back, the target zone becomes unsustainable and the exchange rate is forced to float; moreover, the relative money supply jumps to the level where the foreign country money supply equals its domestic credit and all the gold in the system, while the domestic country's money supply equals its domestic credit (as in the previous models, both D and D* are assumed to be constant).

It is assumed that the probability for the loan to being called back follows a Poisson process with (constant) arrival rate equal to p, so that in the time interval dt the loan will be recalled with probability pdt and it will be continued to be granted with probability (1 - pdt). Note that this is a simplification of the model. In reality, loans between central banks cannot be called back. However, the framework proposed in this chapter can be reinterpreted as assuming that the loan has infinitesimal duration and that the probability of renewal follows a Poisson process, where p is the probability for the loan not to be renewed.

The model proposed in this chapter has some similarities with the target zone model by Dumas et al. (1993), who model the probability of a realignment as a Poisson process; when the realignment takes place, the central parity is shifted upwards onto the free float line with the same money supply and the exchange rate is adjusted correspondingly; at the time of the realignment there is no change in the money supply of in the fluctuation limits of the fundamentals.

In our model, similarly to the models outlined above, the exchange rate behaviour can be expressed by the equation:

3.1) $$s(v) = (m - m^*) + v + \alpha E_t (ds/dt)$$

The difference with the models outlined in the previous section lies in the expression E_t (ds/dt). In the Krugman and Rotemberg model, when the gold standard prevails, the instantaneous expected change of the exchange rate is equal to zero; in the Fella model, , the equation for the target zone is the same as the one of the original Krugman target zone model (where there is no concern for limited reserves) in the area between the two float loci, and so also the expected change of the exchange rate is the same as in the fully credible target zone.

In the model proposed in this chapter, however, E_t(ds/dt) has two components, the first given by the expected change inside the band, the second given by the expected change if the loan is called back, and so the exchange rate jumps to the free float value. Then, the exchange rate after the jump to the free float locus equals:

3.16) $$s^+ (v) = \ln \frac{D}{D^*+G} + v$$

(where the sign + indicates the after-collapse regime)

so the expected jump if the loan is called back equals:

3.17) $$s^+(v) - s(v) = \ln \frac{D}{D^*+G} + v - s(v)$$

Then, equation 3.1) will become (by ignoring the terms in dt^2 and rearranging):

3.18) $$s(v) = (m - m^*) + \alpha p \, [\ln(D/(D^* + G))) + v - s(v)] + v + (\alpha/2)\, \sigma^2 s_{vv}$$

and so:

3.19) $s(v) = (1 + \alpha p)^{-1}((m - m^*) + \alpha p \ln(D/(D^* + G))) + v + (1+ \alpha p)^{-1} (\alpha/2) \sigma^2 s_{vv}$

This equation is a second-order differential equation and has the following solution:

3.20) $s(v) = (1 + \alpha p)^{-1}((m - m^*) + \alpha p \ln \frac{D}{D^* + G}) + v + A'_1 e^{r'v} + A'_2 e^{-r'v}$

(where a ' indicates that the arbitrary constants and the roots of the characteristic equation refer to the target zone with an overdraft facility)

+/- r' are the roots of the characteristic equation:

3.21) $(1 + \alpha p)^{-1}(\alpha/2) \sigma^2 r^2 - 1 = 0$

and are equal to

3.22) $r' = +/- (2 (1 + \alpha p) / \alpha\sigma^2)^{1/2}$

r' is greater, in absolute value, than the root of the characteristic equation for the basic Krugman model of a fully credible target zone (Krugman 1991), equal to

$r = +/- (2/\alpha\sigma^2)^{1/2}$.

Boundary conditions in the form of smooth pasting conditions at the boundaries of the fluctuation band for the velocity shock need to be imposed in order to determine the arbitrary constants A'_1 and A'_2.

As in this type of models it is assumed that interventions are of infinitesimal size, $\bar{v}'$ and $\underline{v}'$ are uniquely determined by the condition that:

3.23) $s(\bar{v}') = \bar{s}$ and $s(\underline{v}') = \underline{s}$

where $\bar{s}$ ($\underline{s}$) is the upper (lower) limit of the fluctuation band for s. Moreover, it can be shown that the exchange rate band is symmetric and so $\bar{s} = -\underline{s}$.

The family of curves corresponding to equation 3.20) has the well-known S-shaped form (see figure 3.4). The consequence of taking into account the possibility that the overdraft facility can be recalled at any time is both a shift of the curve to the left and a change of the curvature of the curve itself (see the appendix to this chapter for a proof), compared to the fully credible target zone.

Note that given the assumptions of the model, the whole family of curves lies at the right of the free float locus where the exchange rate jumps if the loan is called back (line FF in figure 3.4), which is described by the equation

3.16) $$s^{+}(v) = \ln \frac{D}{D^{*}+G} + v$$

The line crosses the v-axis for

3.24) $$v_{\Lambda} = -\ \ln \frac{D}{D^{*}+G}$$

The fact that the whole family of curves OFTZ (overdraft facility target zone) lies at the right of the free float locus can be shown by making explicit the expression (m - m*), i.e. the relative money supply once the overdraft facility is in place, in equation 3.19) and 3.20)

3.25) $$(m - m^{*})_{OFTZ} = \ln \frac{D-L}{D^{*}+G+L}$$

where L represents the loan in use at a given time.

Giving that L > 0, it follows that

3.26) $$(m - m^{*})_{OFTZ} < (m - m^{*})_{FCTZ}$$

3.26') $$\ln \frac{D-L}{D^*+G+L} < \ln \frac{D}{D^*+G}$$

i.e. under a target zone with an overdraft facility the relative money supply is <u>smaller</u> than under a fully credible target zone (FCTZ).

Note that s(v) will cross the v-axis at v_C, such that, by recalling equation 3.26'

$$3.27)\ v_C = -(1+\alpha p)^{-1}[\ln \frac{D-L}{D^*+G+L} + \alpha p \ln \frac{D}{D^*+G}]$$

Moreover, v_C lies at the right of v_A, as:

$$3.28)\ v_C - v_A = (1+\alpha p)^{-1}\ [\ln \frac{D}{D^*+G} - \ln \frac{D-L}{D^*+G+L}\ ] > 0$$

and so the family of 'Overdraft Facility Target Zone' (OFTZ) will lie to the right of the free float locus (see figure 4).

The fact that the money supply is smaller under an overdraft facility target zone, i.e. when the central bank of the domestic country is using up the loan granted by the foreign country, and that once the loan is called back the relative money supply increases (thus generating a devaluation) can be explained as follows:

suppose that the Bank of Italy (the domestic bank) intervenes to defend the lira by selling DM made available through a loan by the Bundesbank; this will, in absence of offsetting operations either in the foreign exchange or capital markets, have an equal effect of opposite sign in the money markets of the two countries: contractionary in Italy and expansionary in Germany (see Mastropasqua et al. 1988).

Conversely, when the loan is paid back, the money supply in Italy will increase and the one in Germany will decrease.

The size of the relative money supply after the loan is called back will be exactly the same as the one before the loan was started being used,

$$3.29)\ m - m^* = \ln \frac{D}{D^* + G}$$

Having established the characteristics of the target zone with an overdraft facility, we need to analyse how, as a consequence of cumulative velocity shocks, the system moves from a fully credible target zone (FCTZ) to a target zone with an overdraft facility (OFTZ), recalling that the central bank of the foreign country agrees with certainty to make a loan to the central bank of the domestic country in order to defend its currency.

The switch between the two will take place once the domestic country has completely run out of reserves, so that

$$3.29) \qquad m - m^* = \ln \frac{D}{D^* + G}$$

and the exchange rate hits the upper bound of the band, so that an intervention to keep it inside the band is needed. Let's call the value of the velocity shock that corresponds to this situation v**. (This can also be seen as a state contingent condition) (see figure 3.5).

In order to avoid the violation of the arbitrage condition, we need to impose the value matching condition between the exchange rate under a fully credible target zone and a target zone with an overdraft facility:

$$3.30) \qquad s_{FCTZ}(v^{**}) = s_{OFTZ}(v^{**})$$

Moreover, given that it is assumed that intervention takes place only at the boundary, it must also be true that:

$$3.31) \qquad \bar{s} = s_{FCTZ}(v^{**}) = s_{OFTZ}(v^{**})$$

Recall that under a FCTZ the equation for the exchange rate, when v = v**, is:

3.32) $$s_{FCTZ}(v^{**}) = \ln\frac{D}{D^{*}+G} + v^{**} + (\alpha/2)\,\sigma^{2}\,s_{vv}$$

and that under a OFTZ the equation for the exchange rate is:

3.19') $$s_{OFTZ}(v^{**})=(1+\alpha p)^{-1}[\ln\frac{D-L^{\circ}}{D^{*}+G+L^{\circ}}+\alpha p\ln\frac{D}{D+G}]+v^{**}+$$
$$+(1+\alpha p)^{-1}(\alpha/2)\sigma^{2}s_{OFTZ,vv}$$

$$= \ln\frac{D}{D^*+G} + (1+\alpha p)^{-1}[\ln\frac{D-L^\circ}{D^*+G+L^\circ} - \ln\frac{D}{D+G}] + v^{**} +$$
$$+ (1+\alpha p)^{-1}(\alpha/2)\sigma^2 s_{OFTZ,vv}$$

where L° indicates the initial size of the loan.

Note that, as the curve for the OFTZ is steeper than the FCTZ,

$PP' < PP''$

(see figure 3.5)

but $PP' = -(1+\alpha p)\, s_{OFTZ,vv}$ and $PP'' = -s_{FCTZ,vv}$

hence:

3.33) $$-(1+\alpha p)\, s_{OFTZ,vv} < -s_{FCTZ,vv}$$

It then follows that if equation 3.30) has to hold, it is necessary that

3.34) $$\ln\frac{D-L^\circ}{D^*+G+L^\circ} < \ln\frac{D}{D+G}$$

so that at the time of the switch between the FCTZ and the OFTZ there is a discrete negative jump in the money supply. Given that the model assumes that D and D* are constant, the money supply can decrease only if the loan starts being used and if the initial loan is of discrete size.

Intuitively, the fact that at the time of the switch the initial loan needs to take a positive, discrete value can be explained by observing that at the time of the switch, the expected change of the exchange rate, which is negative under a fully credible target zone, becomes positive due to the presence of expected devaluation if the loan is called back. L° must be large enough so to compensate for the expected devaluation. Note that the size of the initial loan depends on the size of the probability p that the

loan is called back: the higher p, the higher L° has to be in order for equation 3.30) to hold.

The distance $v_B - v_A$ is proportional to the initial size of the loan, L°, giving that, similarly to equation 3.28)

3.28') $$v_B - v_A = (1 + \alpha p)^{-1} \left[\ln \frac{D}{D^* + G} - \ln \frac{D - L^\circ}{D^* + G + L^\circ} \right]$$

so that as L° increases also $v_B - v_A$ increases.

Note, however, that $v_B - v_A$ represents both the decrease in the money supply due to the initial loan, L° and the effect of the change in curvature and the expected devaluation, in case the loan is called back.

3.4 Implications of the target zone model with an overdraft facility

A crucial aspect of this model is the specification of the expected change of the exchange rate:

3.35) $$E_t\,(ds/dt) = (1/2)\sigma^2 s_{vv} + p\,(\ln(D)/(D^*+G) + v - s(v))$$

The first component, $(1/2)\sigma^2 s_{vv}$, reflects the expected movement of the exchange rate inside the band.

The second component is the expected devaluation, where the size is given by the difference between the freely floating exchange rate, which prevail if the loan is recalled, and the exchange rate inside the band, and the probability is given by the arrival rate of the Poisson process, p.

One assumption of the target zone model, which we need to recall here, is the one of validity of the Uncovered Interest Parity, $E_t(ds/dt) = i - i^*$, where i (i^*) is the instantaneous domestic (foreign) interest rate on Eurodeposits (i.e. offshore financial assets).

The former specification of the instantaneous expected change of the exchange rate implies the presence of a 'peso problem' in the interest rate differential and, via the

Covered Interest Parity, on the forward premium in case the loan is not recalled, and so there is no switch between the target zone and the free float.

If the agents form expectations rationally, then the actual future value, say at time t+dt, of the exchange rate equals the expected value of the exchange rate formed at time t, given the information available at time t plus a white noise disturbance which represent the news occurring after the expectations have been formed:

3.36) $$s_{t+dt} = E_t\, s_{t+dt} + u_{t+dt}$$

If, however, there is some probability, even small, of an event which does not materialise in the time interval considered, then:

3.36') $$s_{t+dt} \neq E_t s_{t+dt} + u_{t+dt}$$

The wedge between the LHS and the RHS of equation 3.34') is the measure of the 'peso problem' (the first mention of the 'peso problem' is contained in Krasker (1980); for a detailed explanation see Obstfeld (1987)).

In other words, even if the UIP holds, the realised change of the exchange rate will differ from the instantaneous interest rate differential plus a white noise disturbance.

The presence of the 'peso problem' in the behaviour of the interest rate differentials compared to the actual change of the exchange rate for the period preceding the exit of the British Pound and the Italian Lira from the ERM, has been widely recognised by the literature: with the exception of Italy and Spain, which had sizeable positive interest rate differentials with Germany for quite a long time, the interest rate differentials with respect to Germany remained subdued until late in the Summer of 1992, but at that time they increased very rapidly and reached very high levels (see Edison and Kole (1994), Rose (1994), Rose and Svensson (1994)). Therefore, any model which aims at explaining the behaviour of exchange rates and interest rates

before the fall should generate this phenomenon: the model proposed in this chapter has this characteristic.

In addition to generating a 'peso problem' in the phases anticipating a switch between a target zone and a free float, the model outlined here has another implication for the interest rate differential, which can be tested empirically and, again, focuses on the 'peso problem' component of the interest rate differential:

$$3.37)\ p(s^{+} - s(v)) = p(\ln(D/(D^{*}+G)) + v - s(v))$$

By looking at figure 3.4, it is possible to observe that the jump in the exchange rate at the time of the switch is not bounded and increases as the loan used by the domestic central bank to defend the parity of its currency increases. The FF locus can be seen as the free float 'shadow' exchange rate, in a similar fashion as in Flood and Garber (1984), i.e. as the exchange rate which would dominate in absence of the authorities' intervention and the presence of the loan, intervention which allows the domestic country to live on borrowed time. At the time of the switch the exchange rate 'rewinds' the effect of the cumulated shocks and jumps onto the shadow exchange rate locus. For this reason, the 'peso problem' component in the interest rate differential will show nonstationarity and so the interest rate differential.

Note that this is a very particular case and is caused by the jump of the money supply at the time the switch between a target zone and the free float takes place.

We will test for this empirical implication of the model for interest rate differentials in chapter four.

3.5 Conclusion

This chapter offers an explanation on one of the factors of the currency crisis which caused the exit of the British Pound and the Italian Lira from the ERM in September 1992. It focuses on the willingness of the Bundesbank to support the existing parity, and so the existing fluctuations band, for the above currencies, by granting

respectively to the Bank of England and the Bank of Italy a loan which could become infinite in size. The willingness of the Bundesbank to do so, or the probability that it calls back the loan granted to the above central banks is a signal of the sustainability of the system: the model proposed in this chapter shows how this feeds in the expectations of the future exchange rate from the agents in the foreign exchange market. This particular aspect of the crisis has not been considered until now in the theoretical literature on the topic. Note, however, that our model does not cover other significant elements of the crisis, such as the pressure coming from the real exchange rate appreciation and the consequent loss of competitiveness, which hit most notably Italy, and the influence of the increasing unemployment level on the governments' actions. These limits derive from the theoretical framework of our model, given by the monetary model of exchange rate determination with fully flexible prices, where it is assumed that Purchasing Power Parity holds continuously and that output is fixed at the level corresponding to full employment.

A particularly desirable implication of the model is the presence of a 'peso problem' in the interest rate differentials before the switch from the target zone and the free float takes place. It is a very well established fact that in the months immediately preceding the switch, the domestic interest rates rose considerably compared to the ones prevailing in Germany.

The model proposed here can be extended in a number of ways. Two, however, seem to be the most important extensions. First, it is possible to consider in the model not only the possibility that the loan is recalled and, hence, the exchange rate is forced to float, but also the possibility that the exchange rate can be subject to a realignment, despite the loan being granted. Secondly, it could be possible to express the arrival rate of the Poisson process for the recall of the loan as an increasing function of the amount of loan being used. We also noticed how an empirical implication of the model is that the interest rate differential when there is an expectation that the loan is recalled, and the domestic country is forced to float its currency, has a nonstationary component in it. We will investigate the empirical implication of the model in the next chapter.

Appendix to chapter 3

In this appendix we will prove that the S-shape curve for a target zone with an overdraft facility (OFTZ) is steeper than the one for a fully credible target zone (FCTZ).

Consider s_{FCTZ} and s_{OFTZ} and shift them so that:

a 3.1) $$s_{FCTZ}(0) = s_{OFTZ}(0) = 0$$

(i.e. they pass through the origin) (figure 3.6).

By making explicit the expressions for A'_1 and A'_2 it is possible to write $s_{FCTZ}(v)$ as:

a 3.2) $$s_{FCTZ}(v) = \frac{e^{rv}\left[e^{-r\bar{v}} - e^{r\underline{v}}\right] + e^{-rv}\left[e^{r\bar{v}} - e^{r\underline{v}}\right]}{r\left[e^{r(\bar{v}-\underline{v})} - e^{-r(\bar{v}-\underline{v})}\right]}$$

and similarly:

a 3.3) $$s_{OFTZ}(v) = \frac{e^{r'v}\left[e^{-r'\bar{v}} - e^{r'\underline{v}}\right] + e^{-r'v}\left[e^{r'\bar{v}} - e^{r'\underline{v}}\right]}{r'\left[e^{r'(\bar{v}-\underline{v})} - e^{-r'(\bar{v}-\underline{v})}\right]}$$

where:

a 3.4) $$|r'| > |r|$$

the root of the characteristic equation for the OFTZ is greater than the one for the FCTZ (see equation 3.22 in the main text)

and

a 3.5) $$\bar{v} = -\underline{v}\ ;\quad \bar{\bar{v}} = \underline{\underline{v}}$$

(where $\bar{v}$ ($\underline{v}$) is the upper (lower) limit for the FCTZ and $\bar{\bar{v}}$ ($\underline{\underline{v}}$) is the upper (lower) limit for the OFTZ) given to the symmetry of the two families of curves.

In order to prove that s_{OFTZ} is steeper than s_{FCTZ}, we need to prove that

a 3.6) $$\bar{\bar{v}} < \bar{v}$$

We do this by exploiting the relationship:

a 3.7) $$s_{OFTZ}(\bar{\bar{v}}) = s_{FCTZ}(\bar{v}) = \bar{s}$$

and so

a 3.7') $$\bar{v} + \frac{2 - e^{2r\bar{v}} - e^{-2r\bar{v}}}{r\left[e^{2r\bar{v}} - e^{-2r\bar{v}}\right]} = \bar{\bar{v}} + \frac{2 - e^{2r'\bar{\bar{v}}} - e^{-2r'\bar{\bar{v}}}}{r'\left[e^{2r'\bar{\bar{v}}} - e^{-2r'\bar{\bar{v}}}\right]}$$

where the second term of both LHS and RHS is negative.

Suppose, now, that

a 3.8) $$\bar{\bar{v}} < \bar{v}$$

and such that:

a 3.9) $$r\bar{v} = r'\bar{\bar{v}}$$

the equality a 3.7) thus becomes:

a 3.7') $$\bar{v} - (B/r) = \bar{\bar{v}} - (B/r')$$

where:

a 3.10) $$B = B_{OFTZ} = B_{FCTZ} > 0$$

a 3.11) $$B_{FCTZ} = \frac{-2+\left(e^{2rv}+e^{-2rv}\right)}{\left[e^{2rv}-e^{-2rv}\right]} > 0$$

and

a 3.11') $$B_{OFTZ} = \frac{-2+\left(e^{2r'\bar{v}}+e^{-2r'\bar{v}}\right)}{\left(e^{2r'\bar{v}}-e^{-2r'\bar{v}}\right)}$$

given a 3.4) and a 3.10), it follows that:

a 3.12) $$-(B/r') > -(B/r)$$

and the equality a 3.7') holds.

Suppose now, instead, that

a 3.8') $$\bar{\bar{v}} > \bar{v}$$

it then follows that:

a 3.13) $$r'\bar{\bar{v}} > r\bar{v}$$

This implies:

a 3.14) $$-(B_{OFTZ}/r') > -(B_{FCTZ}/r)$$

but this would violate condition a 3.7')!

Hence,

a 3.15) $$\bar{\bar{v}} < \bar{v}$$

and $s_{OFTZ}(v)$ is steeper than $s_{FCTZ}(v)$, as we intended to prove.

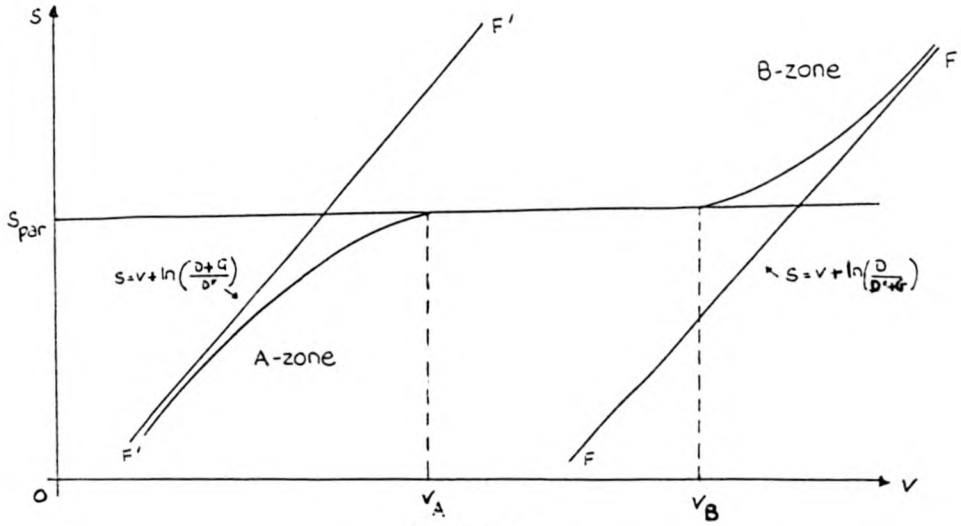


Figure 3.1

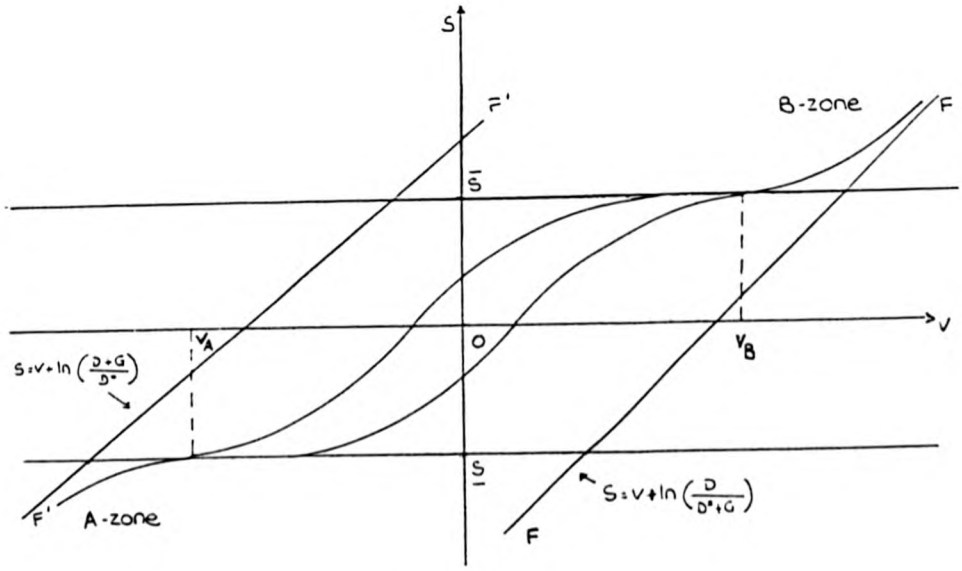


Figure 3.2

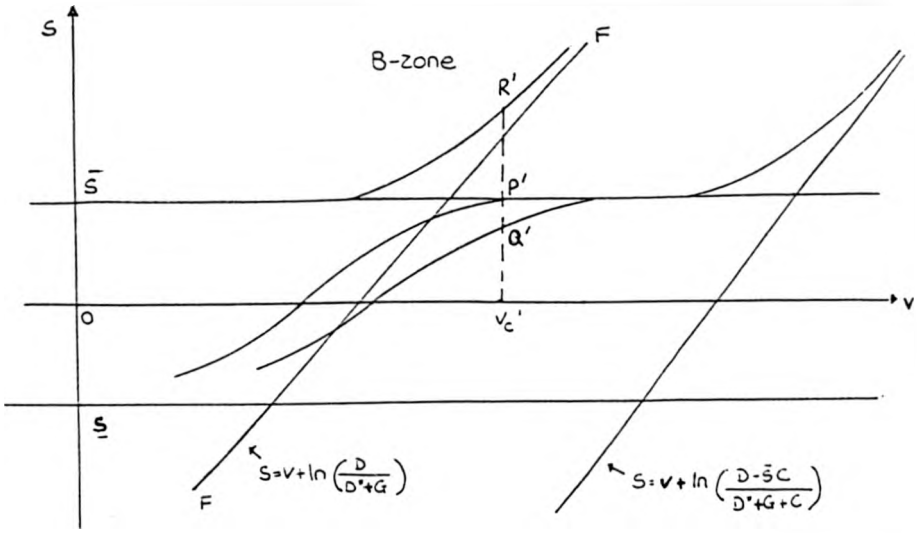


Figure 3.3

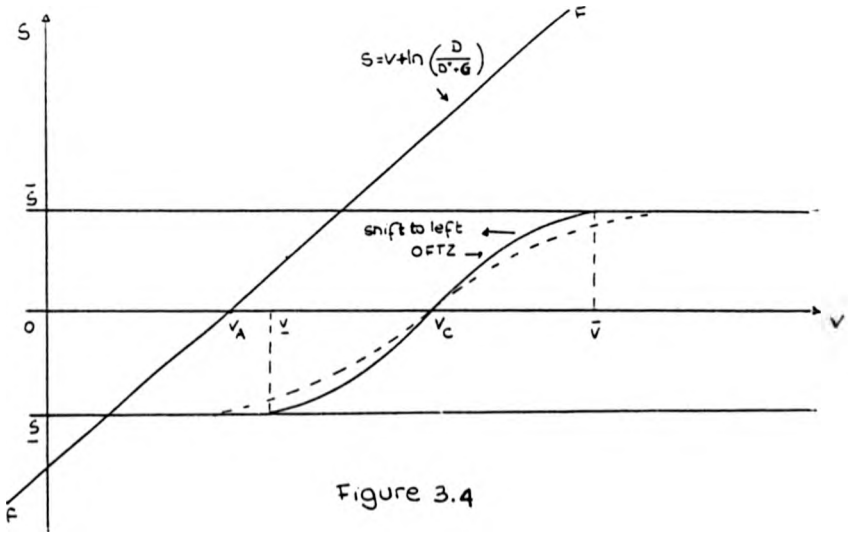


Figure 3.4

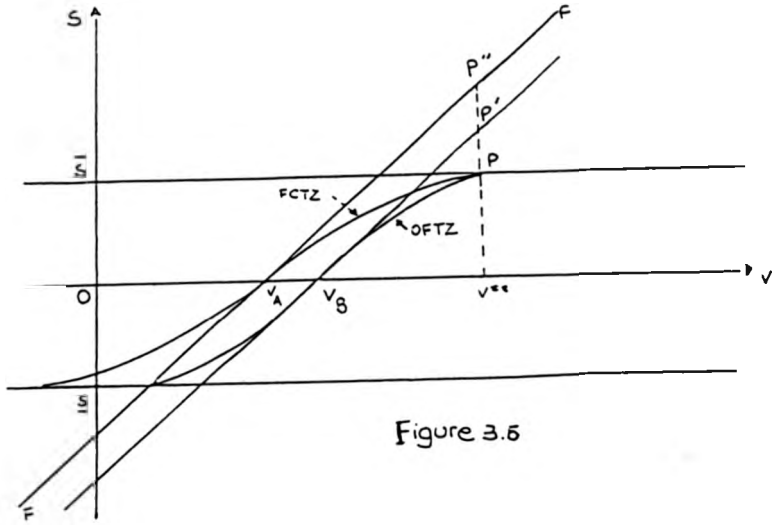


Figure 3.5

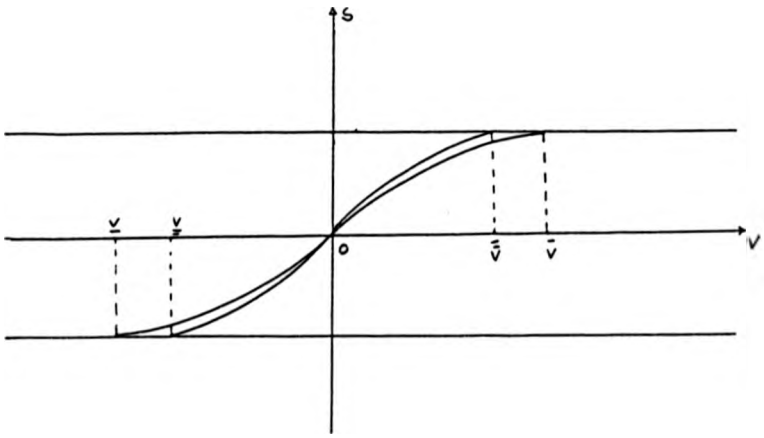


Figure 3.6

Chapter 4:

Expected Regime Switches and the Behaviour of Spot and Forward Exchange Rates

4.1: Introduction

In the previous chapter we proposed a model of the ERM currency of 1992, which analysed the effect of the stance of the Bundesbank towards defending or not defending the currencies of the System under attack. In particular, we assumed that the countries whose currencies are weak live on 'borrowed time', by using a loan made by the Bundesbank which can be called back at any time, and investigated the effect of the probability that the loan is called back and the exchange rate forced to float on the expectations of future exchange rate and the interest rate differential.

This chapter focuses on the behaviour of spot and forward exchange rates and interest rate differentials, when the agents expect a switch between two different regimes.

The second section describes the model proposed by Evans and Lewis (1993), which aims to explain the presence of a nonstationary component in the excess returns of the major exchange rates. It will be shown that in general this model does not seem to be satisfactory. The third section presents an alternative model, proposed by Engel and Hamilton (1990) which is a better framework for modelling regime switches. There is however a particular case in which the model by Evans and Lewis is still valid: this involves the switch between a target zone and a free float, under the circumstances shown in chapter three. Its analysis is the subject of the fourth section. Section five considers the empirical implication of this framework and an application to the case of the regime switch for the Italian Lira and the British Pound in September 1992; the case of the French Franc will be considered as a control variable.

4.2: The Evans and Lewis Model for Excess Returns in the Foreign Exchange Market

In their article published in the European Economic Review (June 1993), Evans and Lewis find evidence that, for the exchange rates of the Deutsche Mark, the British Pound and the Yen during the period 1975-1989, excess returns in the foreign exchange market (i.e. the differences between spot rates at, say, time t+k and the forward rate set at time t for maturity t+1, $s_{t+1} - f_{t,1}$) contain a permanent component, in other words follow a nonstationary process.

The explanation offered by the authors for this phenomenon is given by a so-called 'generalised peso problem'. This takes place when the agents expect a shift in the process of fundamentals determining the exchange rate, which then generates a shift in the process for the exchange rate, but this does not occur in sample.

The authors consider the possibility of switching between two alternative floats, having each a different mean and variance. Formally, for each regime j, with j = C (current) or A (alternative) the exchange rate may be written as the sum of a permanent and a transitory component:

4.1) $$s_t | j = u_t|j + e_t|j$$

(this is equation 6 of their paper)

where:

4.2) $$u_{j,t} = u_{t-1}|j + \eta_t|j$$

with $\eta_{j,t} \sim$ i.i.d. $(0, \sigma^2)$

and $e_{j,t} \sim I(0)$.

Given the specification for $u_{j,t}$, it is also possible to express u_t as the sum of the past shocks:

and so:

4.2') $$u_t | j = \sum_{\tau=1}^{t} \eta_\tau | j$$

and

4.2") $$s_{t,j} = \sum_{\tau=1}^{t} \eta_\tau | j + I(0) \text{ terms}$$

If the agents attach a positive probability, λ_t, to the switch between the current (C) and the alternative (A) regime between time t and t+1, and the switch does not occur in sample, so that the regime prevailing at time t+1 is still C, then:

4.3) $$\begin{aligned} s_{t+1} | C - E_t (S_{t+1}) &= s_{t+1} | C + (1 - \lambda_t) E_t (S_{t+1} | C) + \lambda_t E_t (S_{t+1} | A) \\ &= s_{t+1} | C - E_t (S_{t+1} | C) + \lambda_t ((S_{t+1} | C) - (S_{t+1} | A)) \\ &= \lambda_t (\sum_{\tau=1}^{t} \eta_\tau | C - \sum_{\tau=1}^{t} \eta_\tau | A) + I(0) \end{aligned}$$

It is also assumed that excess returns can be decomposed in two components: the ex-post forecast error, $s_{t+1} - E_t s_{t+1}$, and the risk premium (in other words, the risk premium is not restricted to be equal to zero as in the case of the UIP), so that:

4.4) $$s_{t+1} - f_{t,t+1} = s_{t+1} - E_t s_{t+1} - rp_t$$

The authors also note that both on theoretical and empirical grounds the risk premium can be modelled as a I(0) variable.

It then follows that the nonstationary component in the excess returns is given by the difference between the two random walks (the term in brackets) in equation 4.3).

In order to get this result, however, it is <u>crucial</u> to assume that at the time of the switch of regime the exchange rate is expected to be subject to a discrete jump from the level under the current regime, $s_{t+1} | C$, to the one that would have prevailed if for the <u>whole</u> period from $\tau = 1$ to $\tau = t + 1$ the exchange rate would have followed regime A, $s_{t+1} | A$ (see note 9 in Evans and Lewis paper).

The authors refer to the two alternative regimes as one of a depreciating dollar and one of an appreciating dollar. Then, the implications of the model outlined above are such that at the time the switch occurs, say from an appreciating to a depreciating phase, the exchange rate is expected to jump to the level that would have prevailed if for the whole period the exchange rate kept depreciating instead than appreciating.

When the possibility of a switch between two random walks with different drifts is considered, this setting is not either very satisfactory or very realistic. In particular, it does not seem very realistic that at the time of the switch of the exchange rate jumps from $s_{t+1}|C$ to $s_{t+1}|A$.

4.3: A more satisfactory model: The Hamilton model

The model proposed by Engel and Hamilton (1990), an application of the Hamilton filter, discussed in chapter 1, and Kaminsky (1993), an extension of the same technique, appears, on the contrary, to offer a more satisfactory framework when a switch from a depreciating (appreciating) to an appreciating (depreciating) regime is considered.

In her model, Kaminsky assumes that the change in the exchange rate can follow either of two regimes, formally:

4.5) $$s_{t+1} - s_t = \delta_i$$

where $i = 0, 1$

and $\delta_i \sim N(\mu_i, \sigma_i^2)$

(compare with equation 4.2").

In the first part of her paper, Kaminsky assumes that the agents know the current state, but don't know the timing of the switch to the alternative regime.

The transition probabilities between the two states can be expressed as follows:

$$p(r_{t+1} = 1 \mid r_t = 1) = p_{11}$$

$$p(r_{t+1} = 2 \mid r_t = 1) = 1 - p_{11}$$

4.6)

$$p(r_{t+1} = 1 \mid r_t = 2) = 1 - p_{22}$$

$$p(r_{t+1} = 2 \mid r_t = 2) = p_{22}$$

It follows that the expected change of the exchange rate (given that the agents know the current regime) may be expressed as:

4,7) $E_t\, s_{t+1} - s_t = p_{11}\, \mu_1 + (1 - p_{11})\, \mu_2$ if $r_t = 1$

and

7') $E_t\, s_{t+1} - s_t = (1 - p_{22})\, \mu_1 + p_{22}\, \mu_2$ if $r_t = 2$

As in the model by Evans and Lewis, also this setting considers a switch between two random walks, each having a different mean and variance, but the empirical implications of this model are substantially different compared to the ones of the former model.

As equation 4.7) and 4.7') show, the expected change in the exchange rate does not have any permanent component in it, it is simply a weighted average of the drift prevailing in the two regimes. It then follows that there is no reason why, even taking into account that the agents know that the process followed by the spot exchange rate can shift between two alternative regimes, the excess returns should follow a random walk.

4.4 A Particular Case where the Evans and Lewis model is valid

There is, however, a particular case where a modified version of the model proposed by Evans and Lewis can be applied satisfactorily.

Instead than two random walks, let's assume that the two alternative regimes for the spot exchange rate are given by:

- a free float
- a target zone, such that the exchange rate can fluctuate only inside a given band

A theoretical model that considers this framework in a continuous-time environment has been proposed in chapter 3 of this thesis .

One of the assumptions of the model is that the velocity shock follows a Brownian motion without drift; a consequence of this assumption is that the exchange rate under a free float regime follows a Brownian motion too, i.e. by considering a discrete-time environment, a random walk Also, it is assumed that the domestic country, Britain or Italy, has run out of reserves and that the target zone is still sustainable for the presence of a loan from the Bundesbank to the national monetary authorities. At any time, however, the 'overdraft facility' can be called back and if this happens, the exchange rate will jump on the free float locus and the loan paid back. Call the probability of the loan being called back, and so the probability of the switch between the target zone and the free float λ_t. The locus where the exchange rate jumps if the loan is called back is the one which would have prevailed if for the <u>whole</u> period, subsequent to the moment when the loan started being used, the exchange rate was floating (alternative regime) instead than being in a target zone (current regime); this situation would have occurred if no 'overdraft facility' was in place. In this setting, then, it is satisfied the condition, outlined in the previous section, which needs to hold for the Evans and Lewis model to describe regime switches in a satisfactory way.

Formally, it is possible to rewrite the equation for the exchange rate (in a target zone) as:

$$4.8) \quad s_{t,TZ} = m - m^* + \alpha\lambda_t E_t (s_{t+1} \mid FF) + \alpha(1 - \lambda_t) E_t (s_{t+1} \mid TZ) - \alpha s_t|TZ$$

$$= m - m^* + \alpha\lambda_t s_{t,FF} + \alpha(1 - \lambda_t) E_t (s_{t+1} \mid TZ) - \alpha s_t|TZ$$

where $s_{t+1} \mid FF$ is the exchange rate which would prevail if for the whole period (since when the loan started being used) the regime was one of a free float.

Consider now the order of integration of the variables appearing in equation 4.8). As Ball and Roma (1992) observe, the presence of the fluctuation bands for the exchange rate induces a mean reverting behaviour for this variable, so that it is a I(0) variable; the same can be said, for the same reason, for $E_t\ (s_{t+1} \mid TZ)$. On the contrary, the exchange rate in the free float, the 'shadow' exchange rate, follows a I(1) process, and so its expected future value.

It follows that the order of integration for the spot exchange rate under the current regime, the target zone, and the one for the expected future exchange rate is different, the first being a stationary variable, while the second is a nonstationary one.

The difference of order of integration among variables can be exploited empirically, in order to detect any expectation of a switch between the target zone and the free float on the parts of the market, for example for the Italian Lira and the British Pound during the currency crisis of September 1992.

By recalling equation 4.4), it is possible to express the forward rate as the sum of the expected future spot rate and a risk premium:

$$4.9)\quad f_{t,t+1} = E_t\, s_{t+1} + rp_t = \lambda_t\, E_t\,(s_{t+1} \mid FF) + (1 - \lambda_t)\, E_t\,(s_{t+1} \mid TZ) + I(0)$$
$$= E_t(s_{t+1} \mid FF) + I(0)$$

It is then clear that the forward exchange rate and the exchange rate that is expected to prevail in case of the switch to the free float follows the same process. It then follows that given the assumptions above, the forward exchange rate follows a I(1) process.

As was noted in the case of the switch between two different random walks, the type of process followed by the expected future exchange rate (and hence the forward rate) depends crucially on the definition of the exchange rate prevailing in case the switch occurs, that is the 'shadow exchange rate'.

If at the time of the switch there is no step change in the fundamental determining the exchange rate or the step change is only due to the change in drift in the process followed by the fundamentals, then the forward exchange rate is still a stationary process.

An example of this alternative scenario is given by the model of speculative attacks proposed by Obstfeld (1986), which considers the switch between a fixed exchange rate system and a free float and the speculative attacks issues linked to this.

His argument is that the attack of a fixed exchange rate system is self-fulfilling, so that it can occur even if the current stance of the monetary policy is consistent with maintaining fixed exchange rates, and so it can happen irrespective of the current values of economic fundamentals.

In his model, Obstfeld assumes that in case of a collapse of the system and a switch to the free float, the monetary policy changes from a restrictive one to an inflationary one.

Formally, under a fixed exchange rate regime, the domestic credit, D_t, evolves according to an autoregressive rule:

4.10) $$D_t = \overline{D} + v_t$$

where

4.11) $$v_t = \rho\, v_{t-1} + \varepsilon_t$$

$0<\rho<1$ and ε_t is i.i.d. $E_t(\varepsilon_{t+1}) = 0$

Subsequent to a collapse of the system, the rule followed by the domestic credit is:

4.10') $$D_t = D_{t-1} + \mu_t$$

where $E_t(\mu_{t+1}) > 0$

or, in terms of equation 11),

$\rho = 1$ and $E_t(\varepsilon_{t+1}) > 0$

In other words, the adoption of an inflationary policy is contingent to the occurrence of the attack (and hence to the switch to the floating of the exchange rate). If the attack does not occur, then the monetary policy is not going to be subject to any change in stance. Given this assumption, Obstfeld proves that it is possible to get multiple equilibria, each corresponding to a different set of public beliefs about the probability of the run.

A crucial element in the analysis is the possibility of having two different states of the world:

a) under the first, which occurs with probability π, the agents believe that a run will occur if the shock to domestic credit will be higher than a given threshold;

b) under the second, which occurs with probability $(1-\pi)$, no run will take place, irrespective of the value of the shock to domestic credit

Hence, the occurrence of the attack depends on two factors:

a) the probability that the state of the nature according to which a run can occur, indicated by π,

b) the probability that the shock to domestic credit is greater than a given threshold, $q(\upsilon)$.

The outcome of either state 1 or state 2 is determined by an exogenous lottery. The expected future exchange rate is then a weighted average of the fixed exchange rate (with probability $(1 - \pi q(v))$ and the rate expected to equilibrate asset markets in the event of an exchange rate collapse (with probability $\pi q(\upsilon)$) (see equation (12) in Obstfeld paper).

Because the change of the rule for domestic credit pertains only to the future, i.e. from the moment of the collapse onward, it then follows that the domestic credit (and the fundamental) up to the time of the collapse follows the 'stationary rule' given by equation 4.10) and so the shadow exchange rate and the expected future exchange rate are stationary variables.

A similar conclusion (a stationary process for the expected future exchange rate, and hence for the forward rate) can be obtained also if another class of models of

speculative attacks is considered: the one which attributes the collapse to a non-contingent change in the rule for domestic credit. In this case, the fixed exchange rate regime collapses as soon as the agents realise that the monetary authorities will modify the domestic credit rule (see Eichengreen and Wyploz 1993). The difference between this type of models and the one proposed by Obstfeld is that in the first there is no expectation of a collapse until the change of the monetary policy is perceived as inevitable, while in Obstfeld's model it is perfectly possible that there is a positive expectation of a collapse, without this happening.

In the previous models the step change in the fundamental at the time of the switch is due to the change in drift in the rule for the domestic credit. In the model of an imperfectly credible target zone proposed by Krugman (1991a), in case of a switch to the free float, there is no change in the fundamental itself, given by the fact that in both regimes (the target zone and the free float) the fundamental has zero drift (or the same drift). In his framework, a switch to the free float is only possible when the exchange rate hits either of the two limits of the fluctuation band. When this happens, it is assumed that with probability ϕ the band is defended and the exchange rate jumps to a perfectly credible target zone; with probability $(1 - \phi)$ the band is not defended and the exchange rate jumps to its free float value, given by the current level of the fundamentals.

Recently Ozkan and Sutherland (1994) have proposed a model that explains the currency crisis in terms of the behaviour of the German interest rates.

They assume that the German interest rate can me modelled as a driftless Brownian motion, so that:

4.12) $$i^* = \varepsilon$$

and

4.13) $$d\varepsilon = \sigma dz$$

In their model, the switch from fixed exchange rates to a free float takes place at a threshold value for ε, $\varepsilon = \bar{\varepsilon}$, the and is the outcome of an optimising decision on the part of the government.

Also, under the free float the exchange rate is equal to ε_t and at the (expected) time of the switch, i.e. when $\varepsilon_T = \bar{\varepsilon}$ (T indicates the time of the switch), the exchange rate is equal to $k\bar{\varepsilon}$.

Now, as the switch is expected to take place the first time ε_t hits $\bar{\varepsilon}$, it is also possible to write:

4.14) $$s_T = k\varepsilon_T = k\bar{\varepsilon}$$

ε_T is nothing else that the sum of all the past shocks, given that, for $t < T$, $\varepsilon_t < \bar{\varepsilon}$.

Also, at the time of the switch there is a jump in the exchange rate from s=0 (the level at which the exchange rate is fixed) to $s_T = k\bar{\varepsilon} > 0$.

In the model, the domestic and foreign interest rates are defined as composite rates, formed as weighted averages over all maturities; it is also assumed that UIP holds. The distribution for the maturities is given by a Gamma distribution of the form $r^2 (\tau - t) e^{-r(\tau - t)}$.

If UIP holds, then, the composite expected rate of change of the exchange rate, F, can be expressed as:

4.15) $$F = E_t \quad [s(\tau) - s(t)]\, r^2 e^{-r(\tau - t)}\, d\tau$$

Given the assumptions relative to the shadow exchange rate, it then follows that the interest rate differential, F, has a random walk component.

4.5 Empirical Methodology, Description of the Data and Results

The implications of the modified Evans-Lewis model are empirically tested by using forward exchange rates and interest rate differentials.

Both the forward rates and the interest rate differentials will follow a stationary process if there is no expectation of a switch or if the probability of a switch is very small; on the contrary they will follow an integrated process if there is a probability of a switch and this is large.

We use Eurocurrencies with 1 and 3 months maturity and the forward exchange rate with similar maturities, for the Italian Lira, the British Pound and the French Franc against the Deutsche Mark. The frequency of the data is daily.

The period considered goes from 5 October 1990 (when the British Pound joined the ERM) to the day preceding 'Black Wednesday' (15 September 1992) for the British pound, from 9/1/1990 to 15/9/1992 for the Italian lira and from 2/1/1990 to 15/9/1992 for the French Franc, for a total of 719 observations (see figure 1 to 6). The data source is DATASTREAM .

The technique used is given by the test for unit roots due to Phillips and Perron (1988), which, as we observed in chapter 2, is more appropriate than the ADF one in the presence of overlapping data, i.e. when the frequency by which the data are collected is shorter than the maturity of the contracts.

The results mainly support what expected by the model presented in chapter 3(see table 4.1). The analysis of the forward rate usually shows a higher percentage of rejection of the null hypothesis than the one of the interest rate differential at both maturities examined here. For the French Franc the overall result is that no shift has been expected, as the theoretical model we proposed would suggest. For the Italian Lira, the hypothesis of the presence of a permanent component is not rejected in most cases, but the analysis of the forward rate with 1 month maturity shows that the permanent component has appeared only very late in the period. The results for the British pound show an overall impossibility to reject the null hypothesis, but the analysis of the graph of the series induces to consider the result with caution. We are aware that unit root tests are affected by low power, and so our results need overall to be taken with caution, however it is comforting that the hypothesis of the presence of a unit root for France is rejected, as we expected.

The difference between the results shown above in this chapter and the ones contained in chapter 2 does not come to a surprise, in our opinion. As we reported in this chapter, as well as in chapter 3, and as it is possible to note by looking at the graphs (figures 1 to 6), interest rate differentials started increasing substantially only during the summer of 1992; the sample we used in chapter 2 is limited to March 1992, when there were still no signs of the crisis showing up in the pattern followed by interest rate differentials.

Finally, one issue that needs to be mentioned is the maturity of the forward rate and the interest rate differential which are used for the empirical estimation. Ideally, very short maturities should be considered, but for these maturities the interest rate have a very high component due to the interventions of the monetary authorities on the monetary market in order to guarantee its liquidity; this component might strongly bias the results. For this reason, longer maturities have been chosen.

4.6: Conclusions

This chapter has focused on the analysis of forward exchange rates, compared to spot exchange rates, once there is an expectation on the side of the agents of a switch of regime. It has been shown that the model recently proposed by Evans and Lewis (1993) is not satisfactory in general. More satisfactory, on the contrary, is the framework due to Engel and Hamilton (1990) and Kaminsky (1993). There is however, a particular case in which the Evans and Lewis model might be applied: this concerns the switch between a target zone and a free float, under certain conditions. A theoretical model that develops this idea, focusing on the phases before the exit of the British pound and the Italian Lira from the ERM, is contained in chapter 3 of this thesis. Here we have shown that the empirical implications of the model for the behaviour of forward exchange rates and interest rate differentials seem consistent with the data. Given, however, the very low power which characterises unit root tests, it could be useful to extend the analysis to test for the presence of a break in the series as well as to test for stationarity of forward rates and forward premiums on a sample

which excludes the period prior to the crisis. In the first case our model would be supported if a structural break was found; in the second case we would expect to find a stationary behaviour for the series under scrutiny in periods where no switch of the type described in chapter 3 is expected (see the analysis contained in chapter 2).

One extension that could be fruitful would imply the analysis of other financial instruments conveying information on the expectations of the agents, such as options on foreign exchange rates.

Figure 4.1a: Interest rate differential France Germany
1 month maturity 1.1990 9.1992

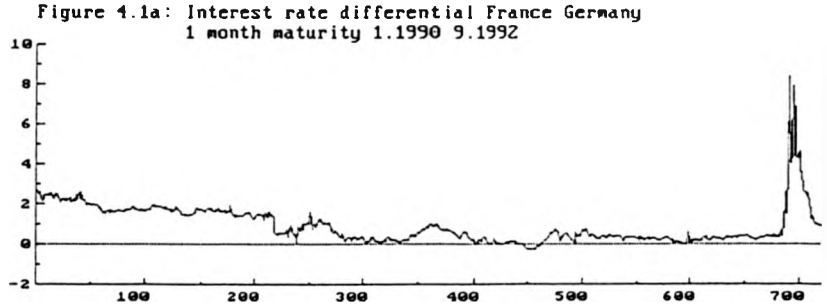


Figure 4.1b: 1 month forward exchange rate FF/DM 1.1990 9.1992

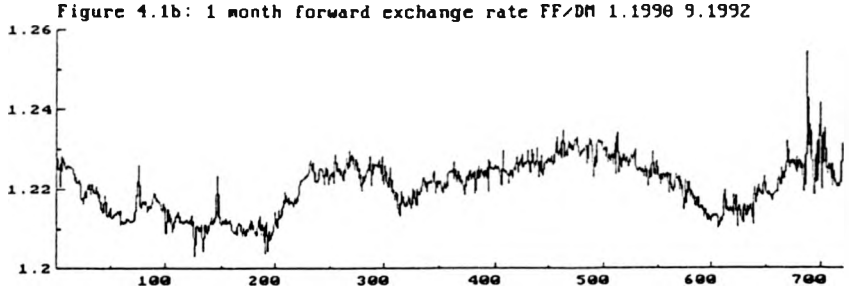


Figure 4.2a: Interest rate differential Italy Germany
1 month maturity 1.1990 9.1992

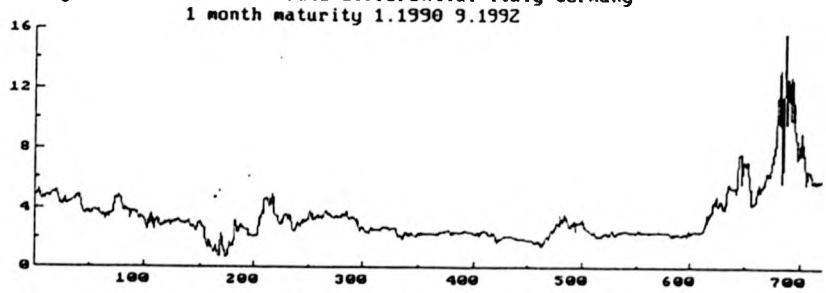


Figure 4.2b: 1 month forward exchange rate Lit/DM 1.1990 9.1992

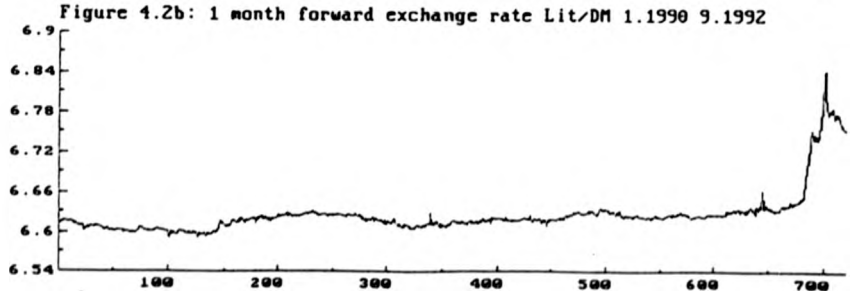


Figure 4.3a: Interest rate differential UK Germany
1 month maturity 1.1990 9.1992

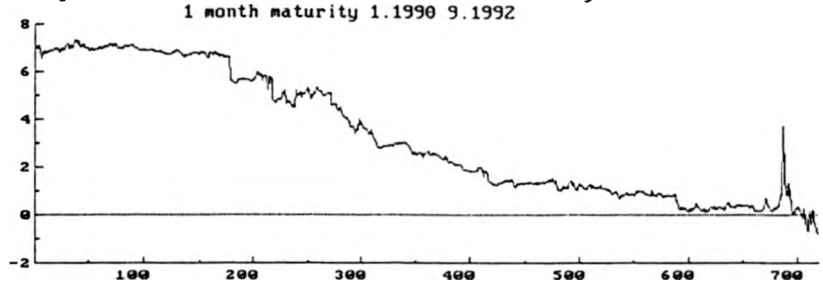


Figure 4.3b: 1 month forward exchange rate £/DM 1.1990 9.1992

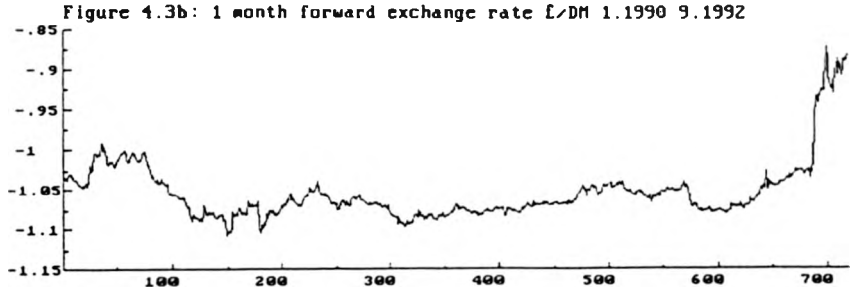


Figure 4.4a: Interest rate differential France Germany
3 month maturity 1.1990 9.1992

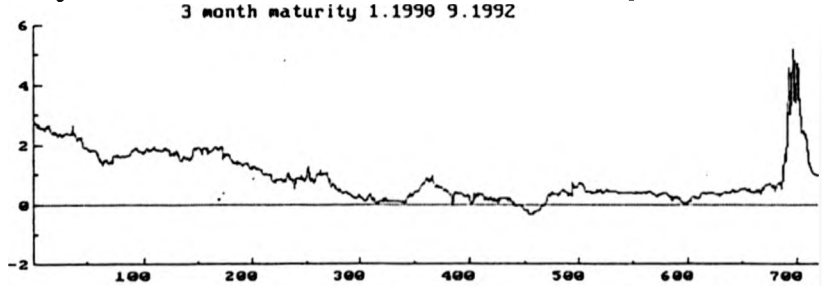


Figure 4.4b: 3 month forward exchange rate FF/DM 1.1990 9.1992

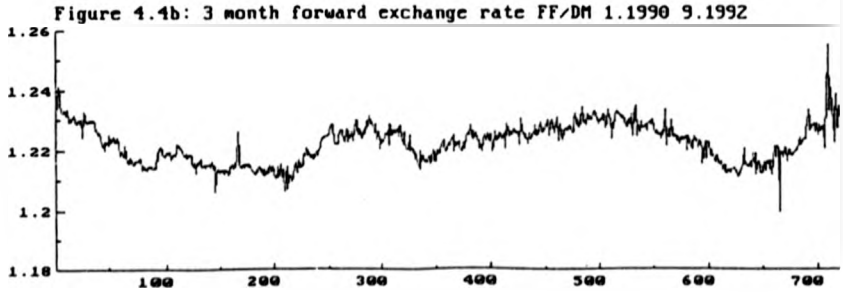


Figure 4.5a: Interest rate differential Italy Germany
3 month maturity 1.1990 9.1992

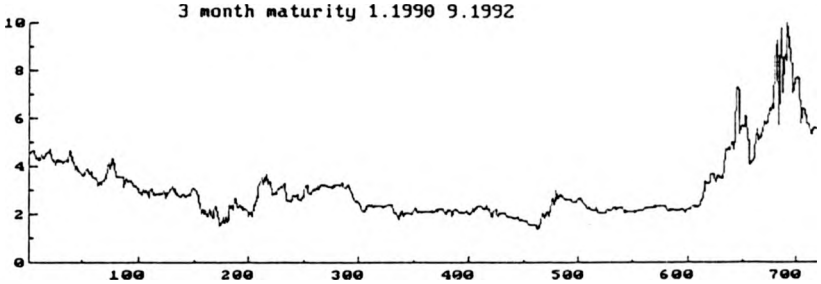


Figure 4.5b: 3 month forward exchange rate Lit/DM 1.1990 9.1992

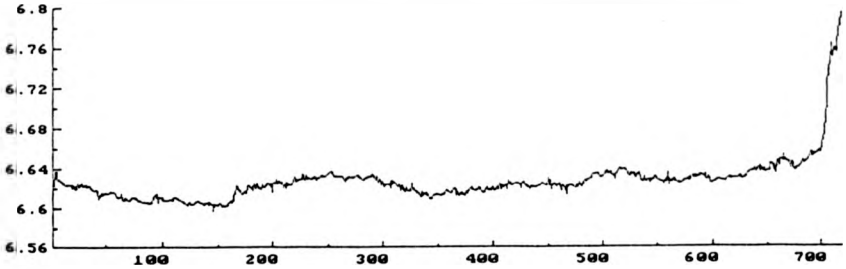


Figure 4.6a: Interest rate differential UK Germany
3 month maturity 1.1990 9.1992

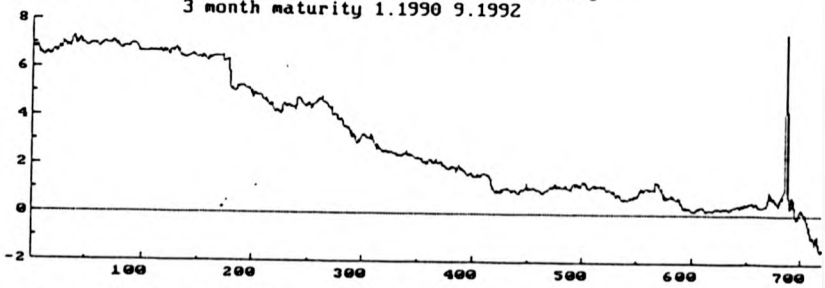


Figure 4.6b: 3 month forward exchange rate £/DM

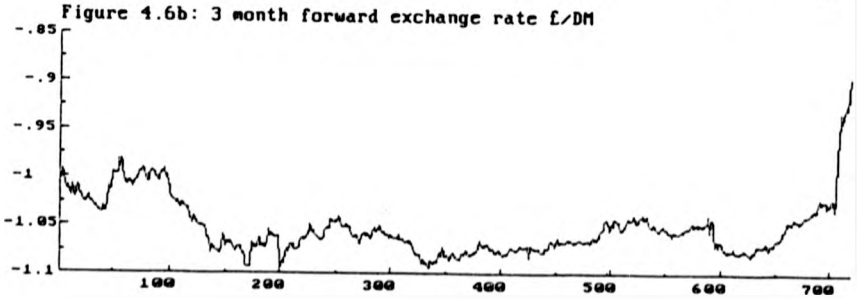


Table 4.1: Empirical Results from Phillips and Perron test for interest rate differentials and forward exchange rates 1.1990-9.1992

	$Z(t_\alpha)$	$Z(\Phi_3)$	$Z(\Phi_2)$	H_0
FFDM1	-4.67	10.98	7.34	R
FFDM3	-4.69	11.09	7.41	R
GBPDM1	-2.46	4.35	2.96	NR
GBPDM3	-2.01	2.64	1.81	NR
LITDM1	-1.59	2.82	2.30	NR
LITDM3	-3.78	7.57	5.09	R
FGINT1	-3.30	6.09	4.39	R
FGINT3	-2.29	3.78	3.02	NR
PGINT1	-1.10	2.05	2.77	NR
PGINT3	-0.61	1.80	3.43	NR
IGINT1	-2.99	5.10	3.43	NR
IGINT3	-0.85	2.39	1.70	NR

The estimated regression is:

$\Delta x_t = \mu + \alpha x_{t-1} + \beta t + \varepsilon_t$

$Z(t_\alpha)$ is the (modified) t-test for the significance of α

$Z(\Phi_3)$ is the (modified) F-test for the hypothesis $\alpha = \beta = 0$

$Z(\Phi_2)$ is the (modified) F-test for the hypothesis $\mu = \alpha = \beta = 0$

4 lags included (similar results are obtained by including 10 lags)

Critical values for a 10% size of the test are: -3.13 for $Z(t_\alpha)$, 5.36 for $Z(\Phi_3)$ and 4.05 for $Z(\Phi_2)$.

'R' means that the null hypothesis is rejected

'NR' means that the null hypothesis is not rejected

FFDM, GBPDM, LITDM are the forward exchange rates between the French Franc the British Pound and the Italian Lira against the Deutschmark; 1 and 3 refer to the maturity horizon.

FFDMINT, LITDMINT, GBPDMINT are the correspondent interest rate differentials; again, 1 and 3 refer to the maturity horizon.

Chapter 5:

Employment, Unemployment and Participation Rates in Europe: EU versus EMU

5.1: Introduction

The ongoing discussion on the prospect of the implementation of the European Monetary Union and its viability has been widely reflected in the academic literature. One strand of the literature has resulted in a return of popularity for the theory of optimum currency areas, proposed by Mundell (1961). As Krugman (1992) points out: ' ....(the traditional optimum currency area approach) still captures the most fundamental considerations (relative to policy problems of a Monetary Union)...my guess is that when dust has settled, the old optimal currency area approach will still occupy centre stage..' (Krugman 1992, page 194).

An 'optimal currency' area is one where the loss of the instrument given by the possibility of modifying exchange rates as a response to shocks in the system, is not costly. For this to be true, and so to have an 'optimal' currency area, two conditions need to hold: first, most of the shocks to the system have to be of a common and not idiosyncratic in nature; second, efficient adjustment methods must be in place, in other words the production factors must be highly mobile. Bayoumi and Eichegreen also note that another condition is that, in case of idiosyncratic shocks, these must be limited in size.

One of the focus in the recent literature has been the labour market in the light of the criteria just outlined: the research to date has considered, on one hand, the case of the US (Blanchard and Katz 1992), as the major example of a currency union, and, on the other hand, some of the European countries and their relationship with their regions (Eichengreen 1992b) and the European regions as a whole (Decressin and Fatàs 1995). No systematic study, however, is available to date for the European countries as a whole. The

aim of this chapter is to analyse the characteristics of the labour market in Europe as well as in each member country in the light of the optimum currency area theory and to evaluate the feasibility of a European Monetary Union for the European countries.

The chapter has seven sections: in the second section we will survey the literature available to date and introduce the analysis contained in this chapter. In the first part of the third section, the choice of countries considered here and the time span will be detailed and motivated. We will then describe the time series behaviour of the variables analysed in the paper: employment growth, unemployment rates and participation rates, both for each individual country and in comparison with the corresponding series at EU level.

The fourth section will be devoted to the analysis of the nature of employment shocks (i.e. either common or idiosyncratic) hitting the European labour markets; section five will focus on unemployment rates and on the long run relationship between national unemployment rates and the EU one. Section six will contain the univariate analysis for the country-specific, or relative, variables, the size of shocks and the analysis of the impulse response function thus obtained; in this section we will take advantage of the cross-section dimension of the data, as well as the time series one, by estimating the univariate behaviour for relative variables by pooling all the countries together and adopting panel data analysis. The European case will then be compared with the US one. Finally, conclusions on the feasibility of a currency union for the EU will be drawn in the seventh section.

5.2: A Review of the Literature

The analysis of currency unions encompasses a large number of issues, ranging from monetary policy, to fiscal policy, problems related to the transition period and the degree of optimality of a currency area (see De Grauwe 1994 and Masson and Taylor 1993 for

very extensive surveys of the literature on all these issues). It is within the framework of the last issue that the analysis contained in this paper lies.

The seminal paper by Mundell (1961) stresses the importance of the nature of shocks, whether they are symmetrical or asymmetrical, in order to establish the degree of optimality of a currency union: while symmetric shocks can be easily absorbed within a currency union, asymmetric shocks might be difficult to cope with, once it has become impossible to change nominal exchange rates. That is to say, adjustments in exchange rates are not a useful instrument for symmetric shocks to be absorbed, while they are for asymmetric shocks. Another relevant aspect is the mobility of production factors: given that the higher their mobility, the easier is the adjustment process. Finally, also the size of asymmetric shocks is relevant, as a large one could demand the adoption of an independent national policy in order to be absorbed.

The recent empirical literature has tackled the issues just outlined by pursuing a comparative analysis of the US, which has been a successful currency union for over two hundred years, and the EU, as it was until 1993, i.e. before Austria, Finland and Sweden joined. A strand of the literature has focused on the analysis of aggregate output and prices. Bayoumi and Eichengreen (1993) estimate a structural VAR, on the lines suggested by Blanchard and Quah (1989), for 11 of the EU countries and the US states over the period 1960-1988, in order to identify the nature of demand and supply shocks and determine the response to these. Their results show that the correlation of both supply and demand shocks tends to be higher in the US states than in the EU countries and so in the EU shocks tend to be relatively more asymmetric. Moreover, as for the response to shocks, the US states adjust more quickly than the EU countries, reflecting the higher factor mobility for the US states. Another important finding, relative specifically to the EU, is that supply shocks are larger in size and less correlated with the EU as a whole for the 'periphery' than for the 'core' countries.

A similar methodology, implying the estimation of a structural VAR, has been adopted by Bayoumi and Thomas (1995), who consider the relationship between fluctuations in relative prices and real relative output, again for the US and the EU and for the period 1961-1989. Both output and prices have been measured here relative to the behaviour in the rest of either the US or the EU and so reflect intra-state or intra-country movements. The most important result of this analysis is the finding that the EU is characterised by a high relative price response to both demand and supply shocks, which is not matched by the US, where other adjustment mechanisms, in particular through more integrated goods and factors markets, are in action; according to the authors, this might imply a more difficult and costly adjustment process for the EU, once the single currency will be adopted. Also in this paper, as well as in the one reviewed above, there is a clear core-periphery pattern emerging within the EU.

Another strand of the literature has focused on labour market adjustment to shocks. Eichengreen (1990) analyses the experience of the US compared to the EC9 (i.e. the members belonging to the EU before 1981) and observes that in Europe the dispersion of unemployment rates among the member countries is much higher than in the US. Because this dispersion might be due either to the high incidence of asymmetric shocks or to different responses to common shocks, the author analyses the long run relationship between unemployment rates at country (state) level and for the whole EU (US) and the speed of adjustment to the long run equilibrium, by modelling the statistical relationship between unemployment at EU (US) and each country (state) as an 'error correction form' (ECM). The author observes that, both for the US and for the EU, it is necessary to include a time trend in the ECM in order to find a long run relationship between the variables. The result shows that the estimated speed of adjustment to equilibrium for the US is much higher than for the EU; this implies that response of unemployment to shocks for the states of the US is much higher than for the countries of the EU. The inclusion of a time trend in the long-run relationship does not seem very satisfactory and in the analysis

contained in this chapter we adopt different techniques in order to test for the long-run relationship between unemployment rates at country (state) and at Community (federal-US) level.

A much broader analysis of the US labour market and of its response to shocks is contained in the seminal paper by Blanchard and Katz (1992). The analysis focuses on the effects of a state-specific negative shock to employment and, in particular they examine how the state labour market adjusts, if wages decrease relative to the rest of the US or people migrate as response to the employment shock and if jobs are created once the effect of the shock has died out. The stylised fact shown by the authors for the US states is that while negative shocks have permanent effects on employment, thus implying that employment never recovers to the pre-shock level, the same shocks seem to have only transitory effects on unemployment. The explanation the authors suggest of this phenomenon is that, given the mobility of labour within the states of the US, the response to adverse regional shocks, in addition to an initial decrease in real wages, is the out-migration of workers, not the creation of jobs.

The importance of inter-state migration as an important adjustment mechanism in the US labour market has been observed also by Bayoumi and Prasad (1995), who also note that labour flows across countries in Europe have a very little role to play. This is also true within some of the EU countries: as Eichengreen (1992b) shows, the inter-migration between regions in the UK and Italy is substantially lower than migration between US states.

A similar type of analysis to the one by Blanchard and Katz is contained in the paper by Decressin and Fàtas (1995), who consider the behaviour of the labour markets and their response to shocks for the regions of the EU countries. Their results indicate that regional employment shocks tend to be more asymmetrically distributed in Europe than in the US, that the persistence of employment shocks is higher in the US than in Europe and finally that while in the US the major response to an employment shock is migration among

different states, in Europe the burden is carried by changes in participation rates. Given that the analysis refers to the EU on a regional-basis, it is not possible in this framework either to compare the relative performance of each of the EU countries in absorbing employment shocks or to see if there is any clear pattern core-periphery as the one found in the dynamics of prices and output, reviewed at the beginning of this section. It is for this reason that the analysis of the EU countries and not regions has been preferred and pursued in this chapter.

5.3: The Data: choice and description

5.3.1 The choice of countries, time span and data set

The choice of countries, time span and data source is far from being a trivial matter, when the analysis involves an institutional grouping of countries, like the EU, which has increased the number of members over time and variables like the ones relative to the labour market, and specifically unemployment, where definitions adopted by national statistical offices may not be comparable across countries.

As for the choice of countries we faced three different alternatives: we could consider the small subsample given by the countries which joined the EU, then called Common Market, at its outset in 1957, or we could consider the 15 countries which belong to the EU now; we chose a middle ground and decided to run the analysis for the 12 countries, which were part of the EU until Austria and Sweden joined at the beginning of 1994. The reason for this choice is the aim to be consistent with the literature reviewed above, which usually focuses on the so-called EC12. However, once the choice of countries was made, we had to drop the consideration of Portugal, because data are available only from 1974 and the cost of dropping a country seemed smaller than reducing the sample size for the whole group.

As for the time span considered, the period considered ranges from 1971 to 1990 in the majority of cases. Ideally, a longer period, starting from the early '60s, would have been preferred, but data for the EU aggregate, as well as for several countries, are only available, on a consistent basis, since 1971.

It is understood that the limited sample size can be a cause of concern, and caution will be advocated in interpreting the results of the empirical analysis, however the importance of the issues analysed in this paper is such that work in the field is required, no matter the limitation of the data.

Finally, we had two choices in terms of data sources: OECD and EUROSTAT. OECD provides data on a quarterly basis, while EUROSTAT provides quarterly data for unemployment, but annual data for the other variables under scrutiny; hence our first choice was obviously OECD. However, once the data were collected and processed, the graphs representing the time series evolution of the series showed that while for some countries the variables had been seasonally adjusted, others were showing clear seasonal patterns. Not knowing the type of seasonal adjustment, where we thought the variables had been filtered, we preferred to turn to the EUROSTAT dataset (we used the data recorded in the dataset *Cronos*/EUROSTAT, available on-line). Furthermore, according to the latest report 'Employment in Europe: 1994', by the European Commission, 'the Community Labour Force Survey, which is directed by Eurostat,....is the main source of comparable unemployment figures for the Community as a whole' (p. 30).

5.3.2: A look at the data

Before outlining the methodology followed and the results obtained it is important to inspect graphically the time series behaviour of the variables under scrutiny, for each country and for the EU counterpart.

Figure 5.1 reports the graphs for annual employment growth, defined as the first difference of the log of total employment, in each of the EU countries, compared to the average in the EU as a whole.

The European experience shows that employment growth was positive for the very beginning of the '70s, between the late '70s and the beginning of the 1980s and since 1984, while it was negative in the mid '70s and in the first part of the 1980s. The most prominent aspects for the national counterparts are as follows: Germany experienced a 3% decrease in employment in 1975, much higher than the one for the EU as a whole. The pattern of employment growth for France and Italy is broadly in line with the EU average. The Netherlands had an unusual rate of growth in 1987, far above the one of any other EU country (1). The UK faced a negative growth of up to 4% at the beginning of the '80s. Ireland performed substantially better than the EU in the second part of the '70s, but much worse in the '80s. On the contrary, Spain under performed in the '70s, while it outperformed the EU in the '80s. The Danish experience is quite difficult to explain as the growth rate for employment does not seem to follow a clear pattern; finally, Greece seems to have outperformed the EU for most of the second part of the '70s and the first part of he '80s, while it under performed in the second part of the '80s.

The same message, but shown more clearly, can be drawn by examining the graphs of the relative employment growth rates (see figure 5.2), calculated as the difference between employment growth rates in each EU country and the EU average.

The analysis of the cumulated relative employment growth allows one to examine how each country performed over the long term compared to the rest of Europe (see figure 5.3).

Figure 5.3 shows, first, that for the majority of cases there was a substantial divergence between each country and the EU as an average. The most striking cases are for Germany, the Netherlands, Belgium, Spain and Greece. Germany experienced a highly negative relative employment growth in the mid '70s: employment growth in Germany stayed in

line with the one in Europe since then, thus the initial drop was never recovered. Belgium experienced an employment growth rate smaller than the EU average over the period and thus the cumulated pattern appears ever decreasing. The Netherlands and Greece seem to share an outlier in relative growth, which took place in 1987 for the Netherlands and in 1981 for Greece (2). Spain had a consistently smaller growth than the EU until the mid 1980s, but recovered, at least partially, since.

Figure 5.4 reports unemployment rates, calculated as the difference between the log of the labour force and the log of total employment.

It is very well known in the literature (see, among the most recent papers, Bean 1994a and 1994b, Alogksoufis et al. 1995, Bertola and Iachino 1995) that all the European countries not only faced a sharp increase in unemployment in the 1970s, but the effect of the negative shocks that hit the Western economies in the 1970s was highly persistent: although unemployment decreased in the second half of the 1980s, it still remained on relatively high levels and it started increasing again since the beginning of the 1990s. This phenomenon has been widely analysed in the literature and many models have been proposed in order to explain it (see Bean 1994b for a very comprehensive survey). The unemployment pattern in Europe in the 1980s is strikingly different compared to the US case, where, after the increase in the 1970s, unemployment decreased sharply in the decade after. Given the common experience for the Western European countries, however, the literature has not paid much attention to the analysis of each EU country compared to the EU average, which will be developed later in the chapter.

As for participation rates, figure 5.5 shows that, contrary to what observed for relative employment growth, there is a clear difference between the 'core' countries (Germany, France, the Netherlands, Belgium) and the EU periphery (Greece, Spain and Ireland): the 'core' countries tend to have higher participation rates than the EU average, the opposite being true for the periphery of the Community, as well as for Italy.

In most cases the difference between participation rates at country level and at the EU one tend to be almost constant throughout the period; exceptions are France, where the difference vis-à-vis the EU average switched from positive to negative between 1986 and 1987, the Netherlands, which experienced a positive step change in its participation rate in 1987 and Greece, subject to a similar, albeit smaller in magnitude, phenomenon in the early 1980s (3).

5.4: Are employment shocks common or idiosyncratic in nature?

The first part of the analysis contained in the chapter focuses on the nature of employment shocks, asking if these are mostly common or country-specific. In order to do this, I follow the methodology proposed by Blanchard and Katz (1992) and regress employment for each EU country against the EU counterpart. However, before doing that, it is essential to examine its time series properties and order of integration, so that it is known if the variables need to enter the regression in levels or in first differences.

As shown in table 5.1, it is impossible to reject, according to the ADF test, the hypothesis of a unit root for the level of employment (in logs), for all the European countries as well as the EU aggregate, although we allowed for the presence of a deterministic trend in the alternative hypothesis (4).

Given that all the series, with the only exception of the one for Denmark, appear to be integrated of order one, it is interesting to test if there is there is a long run relationship between total employment in each country and in the EU as a whole.

To test for cointegration with such a small sample (1971-1990) is not an easy task. As Banerjee, Dolado, Galbraith and Hendry (1993, chapter 7) stress, the two-step procedure suggested by Engle and Granger (1987), which provides super-consistent estimates of the cointegrating relationship, might need a large sample before the estimate biases are small; in these cases the authors suggest to run a dynamic regression of the type:

(5.1) $$e_{i,t} = k_i + \sum_{l=1}^{p} \alpha_{il}\, e_{i,t-l} + \sum_{m=0}^{q} \beta_{im}\, e_{EU,t-m} + \varepsilon_{i,t}$$

(where $e_{i,t}$ represents the log of total employment in country i at time t, k is the constant of the regression, ε is the disturbance term).

This can provide generally unbiased estimates of the long run parameter and valid t-statistics. It is possible to test for the null hypothesis of no cointegration in a dynamic regression setting by testing :

(5.2) $$H_0 : \sum_{l=1}^{p} \alpha_{il} = 1$$

The condition for the dynamic model to converge to a long run solution is that the sum of the α-coefficients is smaller than 1. The critical values for this test have been provided by Banerjee, Dolado and Mestre (1992).

The results of the implementation of this procedure to the log of employment cannot reject the null hypothesis of no-cointegration between employment in each of the EU countries and the EU as a whole, except for France (see table 5.2).

For this reason, we pursue the rest of the analysis by considering employment growth in the EU countries and the EU.

The next task is the evaluation of the nature of employment shocks; we do this by running the following regression for each EU country:

(5.3) $$\Delta e_{i,t} = k_i + \beta_i\, \Delta e_{EU,t} + \varepsilon_{i,t}$$

(where Δ indicates first differences).

The results of the estimation of equation (5.3) by OLS are shown in table 5.3.

The values of $\bar{R}^2$ indicate how much of the yearly percentage change in employment at country-level is shared at European level, i.e. how much of the movement in employment

growth is common (and so symmetric) and how much is country-specific (i.e. idiosyncratic); the values of $\bar{R}^2$ range from 0.8 for Belgium to -0.004 for Denmark; the weighted average, where the weights are given by the country employment shares, is equal to 0.26. The analysis contained in Decressin and Fatas (1995), on the lines of Blanchard and Katz (1992), shows that, once regression (5.3) is run for the states of the US on a similar time horizon to the one used in this paper, the average $\bar{R}^2$ is 0.60, which clearly shows a much higher degree of integration of the US labour market compared to the European one. For the European regions, they obtain an average $\bar{R}^2$ equal to 0.20; this clearly reflect the smaller degree of integration of the European regions compared to the European countries. It is interesting, however, to note that the average $\bar{R}^2$ at country level is not much higher that the one at regional level and both are far from the corresponding value for the US, indicating that, at European level, employment shocks tend to be idiosyncratic in nature.

In accordance with what we observed relative to the cumulated employment growth, there is no clear difference, in terms of $\bar{R}^2$, between the core and the periphery of the EU.

The second aim of this part of the analysis is the calculation of country-specific employment growth (relative employment growth), which will be the focus of a latter part of the analysis. In order to do this, we specify a dynamic regression for the employment growth in each EU country and the one in the EU :

$$(5.4)\quad \Delta e_{i,t} = k_i + \sum_{l=1}^{2} \alpha_{i,l}\, \Delta e_{i,t-l} + \sum_{m=0}^{2} \beta_{i,m}\, \Delta e_{EU,t-m} + \varepsilon_{i,t}$$

and calculate the long run parameter $\beta^*_i = \sum_{m=0}^{2} \beta_{i,m} \,/\, (1 - \sum_{l=1}^{2} \alpha_{i,l})$

We then test for the hypothesis

(5.5) $$H_0 : \beta^*_i = 1$$

A long run coefficient, β^*, equal to one implies, in equilibrium, unit long run elasticity of employment growth in country i with respect to employment growth in the EU as a whole, as far as common shocks are concerned. If the null cannot be rejected, we can define the relative employment growth as the difference between the country and the EU value, i.e. as:

(5.6) $$\Delta re_{i,t} = \Delta e_{i,t} - \Delta e_{EU,t}$$

(where Δre_i stands for <u>relative</u> employment growth in country i)

otherwise, it will be defined as 'β-difference', i.e.:

(5.6') $$\Delta re_{i,t} = \Delta e_{i,t} - \beta^* \Delta e_{EU,t}$$

The null can only be rejected for France, Greece and Italy (see table 5.4); we will then adopt in the analysis to follow simple differences (5).

5.5: Unemployment rates: long run relationships and definition of the relative counterpart

After having analysed the nature of employment shocks in the EU, the long run relationship between employment growth in each EU country and the EU as a whole and having defined the concept of <u>relative</u> employment, we now focus on the long run relationship between unemployment rates in the EU countries and the EU itself as a whole. This type of analysis allows one to examine if the variables at a national level tend to maintain a stable relationship with their European counterpart. Previous work for the US (Blanchard and Katz 1992) has run this type of analysis by applying unit root tests to the difference between state variables and the ones for the whole US; for the European

regions, Decressin and Fatas (1995) estimated the long run relationship implicitly running the approach to cointegration suggested by Engle and Granger (1987). In particular, they first run the regression:

$$u_{i,t} = \alpha_i + \gamma_i u_{EU,t} + \varepsilon_{i,t} \tag{5.7}$$

where $u_{i,t}$ is the unemployment rate for country i at time t; the unemployment rate has been calculated as the difference between (the log of) labour force and (the log of) total employment in country i.

The authors then test for the stationarity of the relative unemployment rate so obtained, given by $u_{i,t} - \gamma_i u_{EU,t}$, which is equivalent to test for the stationarity of the residuals (which is the ordinary Engle and Granger procedure).

As it was observed in section 5.4, due to the small sample size, the estimates of the long run relationships are potentially biased and the test for cointegration, based on the residuals of equation 5.7 has low power. The results obtained by Decressin and Fatas do not allow, in the majority of cases, to reject the null of no cointegration between unemployment at country and EU level and they are forced to rely on their 'a priori' assumption that relative unemployment rates are stationary.

In this chapter, we propose to tackle the issue on long run relationship between national and EU unemployment rates in a different way. We first note that it is impossible to reject the null hypothesis of the presence of a unit root in the series of unemployment rate for all the countries considered as well as for the EU as a whole (see table 5.5).

Clearly, the hypothesis that unemployment rates in Europe behave like a I(1) process is not very appealing, but it is by now widely accepted that unemployment rate is a series showing a very high degree of persistence, as was reported in section 5.2, and great attention has been devoted in the literature to the issue of hysteresis in unemployment (see, among others, the seminal work by Blanchard and Summers 1987). It is very well

known that unit root tests have very low power, especially when the alternative hypothesis is a stationary series around a deterministic trend or a stationary series displaying a high degree of persistence. With respect to the latter, Campbell and Perron (1991) observe that it can be acceptable to model as I(1) processes stationary processes with very high persistence. For these reasons, recent empirical papers (e.g. Snower and Karanassou 1995) model the unemployment rate as a process behaving like a I(1) and we follow the same route here.

In order to test for a long run relationship between unemployment rates in each of the EU countries and the EU aggregate, we follow the methodology outlined in section 5.3 and thus estimate the following dynamic regression:

5.8) $$u_{i,t} = k_i + \sum_{l=1}^{p} \alpha_{il}\, u_{i,t-l} + \sum_{m=0}^{q} \beta_{im}\, u_{EU,t-m} + \varepsilon_{i,t}$$

In most cases p=q=2 is sufficient for all the diagnostic tests to be passed; only for Italy and Spain three lags are needed. Our prior is that there is a long run relationship between the country variables and the EU counterpart: the graphical analysis (see figure 5.4 and section 5.2) strongly supports this prior.

We test for the presence of a long run relationship for unemployment rates at country and EU level also by implementing the Johansen maximum-likelihood technique (see table 5.6). We specify the VAR by including two lags and allowing an unrestricted constant.

The results stemming from the estimation of the dynamic equation 5.7) are in line with the ones obtained by adopting the Johansen procedure: the null hypothesis of no cointegration (and so of absence of a long run relationship between unemployment at country and at EU level), is rejected, or is accepted only marginally at the standard significance levels, in the majority of the cases: the only exceptions are Italy, Ireland and Greece (6)).

In the cases where the null of no cointegration could not be rejected, we run the same set of dynamic regressions, as well as the Johansen procedure, for unemployment rates, as

recorded directly by EUROSTAT. In this case the null hypothesis is strongly rejected for Italy (see table 5.7), while it is still impossible to reject it for Greece, Ireland and Denmark.

Although the hypothesis that there is no long run relationship between the rate of unemployment in Denmark, Greece and Ireland does not seem very appealing, we adopt a cautious position here and consider in the analysis to follow both the whole set of EU countries and the subsample where Denmark, Greece and Ireland have been left out. The fact that the result is different, as Italy is concerned, according to the way unemployment is defined is an additional warning that the interpretation of the results must always proceed with caution.

After having tested for the presence of a long run relationship, we need to calculate, in the cases where a long run relationship has been found, the long run equilibrium. This is very important in our analysis, given that it enters the definition of the relative unemployment rate, which can be expressed as:

5.9) $$ru_{i,t} = u_{i,t} - \gamma^* u_{EU,t}$$

(where γ^* is the long run parameter).

Another approach that can be adopted to obtain an efficient estimator of the long run parameter, and indeed of cointegrating vectors, has been recently suggested by Stock and Watson (1994): it implies, in our framework, a simple OLS regression between unemployment for each EU country on a constant, the average unemployment rate for the EU and leads and lags of its first difference:

5.10) $$u_{i,t} = k_i + \theta\, u_{EU,t} + \sum_{l=-p}^{p} \tau_l\, \Delta u_{EU,t-l} + \varepsilon_{i,t}$$

(we chose p=1).

We report the results in table 5.8: the estimates obtained by solving for the long run equilibrium in the dynamic regression are in line with the ones obtained adopting the procedure suggested by Stock and Watson. The only exception to this is Italy.

Finally, we investigate the speed of adjustment with which national labour markets respond to divergence's between national and EU-wide unemployment rates.

The dynamic equation 5.8) can be seen as a reparametrization of the Error Correction model, which (in case p=q=2) can be written as:

$$5.8')\ \Delta u_{i,t} = k_i + \beta_1 \Delta u_{EC,t} - (1-\alpha_{i1}-\alpha_{i2})\,(u_{i,t-1} - (\beta_1+\beta_2+\beta_3)/(1-\alpha_1-\alpha_2)u_{EU,t-1}) + \\ +\alpha_2 \Delta u_{i,t-1} - \beta_3 \Delta u_{EC,t-1} + \varepsilon_{i,t}$$

Hence, the speed of adjustment can be measured as:

$$5.11)\qquad -(1-\alpha_{i1}-\alpha_{i2})$$

or, in general terms,

$$5.11')\qquad -\left(1-\sum_{l=1}^{p}\alpha_{il}\right)$$

Clearly, if there is no long-run relationship between unemployment at the national and EU level unemployment rate, the speed of adjustment is zero, which is exactly the test (of no cointegration) we have adopted before.

In the cases where we decided to reject the null of no long-run relationship, we examined the size of the speed of adjustment.

In the majority of the cases (see table 5.5) the speed of adjustment is quite high, ranging from - 0.742 for the Netherlands to -0.51417 for the UK; only for Italy its value is quite low, being equal to - 0.39589.

We finally consider relative participation rates. If the problem of a small sample size is severe for employment growth and unemployment rates, it is even more so for participation rates: comparable data are available only between 1975 and 1989; as a consequence even more caution has to be used in interpreting the results.

Our prior hypothesis, supported by the graphical analysis contained in section 5.3, is that participation rates are stationary. Due to the limited sample size it becomes virtually useless to try and test for this hypothesis. Also the estimation of the long run parameter between country participation rates and the EU one becomes unfeasible and we prefer to calculate the relative log of participation rates as a simple difference between the country and the EU-wide ones.

5.6: The analysis of relative variables and their impulse response functions

The focus of this section is the analysis of relative variables, which were defined in the previous sections. In particular, we will examine how labour markets in the EU respond to idiosyncratic shocks and measure the size of these shocks. As mentioned in the introduction of the paper, in order for a currency union to be optimal idiosyncratic shocks should be small in size.

In particular we first estimate the univariate process for each of the country-specific variables above as an autoregressive process, by allowing two lags:

5.12a) $\Delta re_{it} = k1_i + \lambda_{i1}\, \Delta re_{i,t-1} + \lambda_{i2}\, \Delta re_{i,t-2} + \varepsilon_t$

5.12b) $ru_{it} = k2_i + \varphi_{i1}\, ru_{i,t-1} + \varphi_{i2}\, ru_{i,t-2} + \varepsilon_t$

5.12c) $rlpr_{it} = k3_i + \eta_{i1}\, rlpr_{i,t-1} + \eta_{i2}\, rlpr_{i,t-2} + \varepsilon_t$

where Δre_i represents relative employment growth for country i, ru_i is the relative unemployment rate and rpr is the relative participation rate; k1, k2 and k3 are the constant terms in each equation and λ, ϕ and η are the autoregressive parameters.

We also run the same type of analysis for the EU as a whole: we do this by pooling together the relative variables for each country, allowing for country-specific effects. This type of analysis allows one to examine how the European labour market as a whole responds to idiosyncratic shocks and to compare the European experience with the US one.

By using the estimates of equations 5.12a-5.12c, we can measure the size of the shocks as the standard error of the regression. We then build the corresponding impulse response functions (figures 6 to 8) which trace the effect over time of a one-standard innovation in relative employment growth, unemployment rate and participation rates (7). The results are contained in tables 9 to 11.

Regarding relative employment growth, the size of the initial shock for the EU as a whole is not too dissimilar to the one calculated by Decressin and Fatas for the US on a very similar time horizon; however, the cumulative impulse response function, which measures the degree of persistence of (relative) employment to employment shocks, is substantially smaller for the EU as a whole than for the US. As for the experience of individual countries, the size of the shocks tends to be larger than for the EU average for the countries at the periphery of the EU, in particular for Spain and Greece, but also for the Netherlands and Denmark. In the case of the Netherlands this could be due to the outlier in employment growth in 1987. For Belgium, France, Germany, Italy and the UK the initial shock tends to be smaller that the EU counterpart; the degree of persistence tends to be higher than the one for the EU as a whole, for Italy, Ireland, Spain, while it tends to be smaller for France, Belgium, Denmark and the UK and is very similar for Germany and the Netherlands. With respect to the size and persistence of employment shocks, then, it is possible to trace a different pattern for the periphery of the EU relative to the rest of the member countries. This seems in line with the results obtained by Bayoumi and Eichengreen (1993) and Bayoumi and Thomas (1995), reviewed in the second section of the chapter.

In the case of relative unemployment shocks (8), their size seems to be smaller for the EU than for the US(similarly to the results obtained by Decressin and Fatas 1995): moreover the shape of the impulse response functions shows that the effect of the initial shock tend to die out slightly more quickly in Europe. This corresponds to the high speed of adjustment to equilibrium in the long run relationship between national unemployment rates and unemployment in the whole EU that was analysed earlier in the paper.

The size of unemployment shocks once again tends to be smaller for the countries at the core of the EU, in particular for France and Germany; on the contrary their size is substantially higher than for the EU as a whole for Spain and the UK. The shape of the impulse response function for the effect of unemployment shocks indicates that it tends to die out more quickly (than for the EU) for France, Germany, the Netherlands and Spain, while it tends to be slower for Italy, Belgium and the UK.

The analysis of relative participation rates must proceed with extreme caution, given the very limited sample size available. In particular, the estimate of the autoregressive process for the Netherlands is not acceptable, given that it would imply an explosive process; this is most likely caused by the step change in the evolution of participation rate for this country in 1987. We then leave this case outside the analysis as well as the EU panel. The shocks to participation rates tend to be small, compared to the EU as a whole, for France, Germany, Italy as well as for Spain.

The impulse response analysis for participation rates shows that there is very little persistence for Germany, Greece, Italy, Spain and most of all for the UK. The EU as a whole seems to show a substantially higher degree of persistence, however this result might be due to the strong persistence found for France and Belgium. Even if the results obtained by using a longer sample size might show a lower degree of persistence for the EU as a whole, it is unlikely that it would be lower than the one observed for the US. The explanation of this result might lie in a different adjustment mechanism under way in Europe compared to the US: while in the US employment shocks are absorbed through

migration among states, in Europe the flow in and out the labour force might cover an important role in the adjustment process, in addition to the role covered by the movement in relative prices (as found in Bayoumi and Thomas 1994 and Krugman 1993).

Ideally, the estimation of a VAR between relative employment growth, relative unemployment rates and relative participation rates for all the EU countries could provide information on the adjustment mechanisms to employment shocks; however the limitation of the sample makes this task impossible.

5.7 Conclusion

This chapter has focused on the analysis of employment growth, unemployment rates and participation rates of the EU countries vis-a-vis the EU as a whole and on the study of the dynamics of their relative, i.e. country-specific, counterparts. This fills in a gap in the literature, where a systematic study of this type is unavailable to date.

Considerable attention has been devoted to the long run relationship between unemployment rates for the single countries and for the whole European Union; it has emerged that, while high persistence in unemployment is a common factor, in most of the cases the deviations from the EU average are absorbed quite quickly.

From the analysis of the relative (or country-specific) employment growth rates it is possible to conclude that, when the EU experience is compared with the US one, idiosyncratic employment shocks are more widespread in Europe than in the US, but they tend to have a more persistent effect in the US than in the EU. The results have to be evaluated with caution, as the total employment series for the Netherlands is affected by a structural break due to a change of its definition, which has not been corrected; although the break carries over the corresponding EU employment series, the distortion is limited by the fact that this variable is defined as a weighted average and the weight corresponding to the Netherlands is small.

The results obtained for the analysis of relative empoyment growth might be due to two different and, possibly concomitant, reasons: first the greater role played in Europe by relative prices in the adjustment process, as shown in Bayoumi and Thomas (1995); second, as Krugman (1991c, 1993) points out, US states tend to be much more specialised than the EU countries, thus implying that idiosyncratic shocks have more persistent effects on the state economies. In principle, higher specialisation might also lead to a higher percentage of shocks being idiosyncratic; the fact that we find a lower percentage of idiosyncratic shocks in the US might be attributed to the presence of federal fiscal stabilisers in the US, which, most likely, will not be available, at least in the same degree, in the EU.

The consideration of relative unemployment rates has led us to conclude that there seems to be a slightly quicker response to shocks in Europe compared to the US, mostly due to the performance of countries like France and Germany, if we exclude from the analysis countries like Denmark, Greece and Ireland, for which a stable long run relationship between their unemployment rates and the EU average has not been found. If the analysis is pursued by considering all the EU countries, however, than the response to shocks is of a similar type in the EU and the US.

Given the quick adjustment of relative unemployment rates, once a subsample of EU countries is considered, there has to be another adjustment mechanism in place in order to balance the persistence in relative employment. In the case of the US this role is played by migration inter-state, as shown in Blanchard and Katz and Krugman (1993); in Europe, however, migration is low: this is true not only among countries, but also within countries (Eichengreen 1992b). The fact that the response of relative participation rates is more persistent in Europe than in the US might be the adjustment mechanism in action in Europe alternative to migration; in particular, it is possible that most of the adjustment takes place through the movement in and out the labour force of women, who are more likely than men to move out the labour force in case they cannot find a job. Another

aspect of the could be the decision to spend more time in education, and so out of the labour force, by young people when they cannot find a job.

The interpretation of the results obtained for relative participation rates, however, has to be cautious, given the small sample size available for the empirical analysis.

The findings contained in this chapter regarding the response to shocks of relative employment growth rates, unemployment rates and participation rates for the EU as a whole support the ones, obtained for the European regions instead than countries, contained in the paper by Decressin and Fatás.

Our analysis, however, allows us to draw also some conclusions on the performance of each country compared to the one of the EU as a whole, as far as relative variables are concerned. An interesting picture emerges here: there is a core-periphery pattern emerging. Usually the size of the asymmetric shocks hitting periphery-countries, namely Greece, Ireland and Spain, is larger than for some of the core countries, such as France, Germany, Belgium (but not for the Netherlands) and they tend to have a slower response to them: it might be possible, then, that they find themselves in a disadvantaged position within a currency union. The situation might worsen once the process of integration will have had its full effect on the EU economy. Krugman (1991c, 1993) notices that the process of integration and the elimination of the remaining barriers in the EU will, most likely, generate agglomeration economies (see the model by Krugman and Venables 1990) and increase the incidence of asymmetric shocks, thus making the adjustment process more difficult.

In the light of the optimum currency area theory, then, it can be said that while the core-countries might be effectively become part of a currency union, the same for the periphery-countries is much more an open question.

Notes

(1) We checked the data for any input mistake; in particular we checked another definition of employment, civilian employment instead than total employment, as well as the data published on the quarterly Eurostat bulletin and found exactly the same pattern as the one reported in the chapter. We understand that there was a change in the definition of labour force and total employment, which makes the series relative to the Netherlands pre and post-1987 not comparable. We should have corrected for the change in definition, possibly by constructing comparable series using pre-1987 data on levels and growth rates, as the results of the analysis will be affected by the break caused by it. The results for the Netherlands are, obviously, the most affected and need to be interpreted with extra caution. As the EU average for total employment is concerned, however, the distortion is limited by the fact that this variable is defined as a weighted average and the weight corresponding to the Netherlands is fairly small (around 4%).

Note that the change in definition of the labour force and total employment for the Netherlands should not affect substantially the analysis of unemployment rates as this is defined as the log difference of the two variables above mentioned.

(2) For Greece we made the same checks as the ones outlined for the Netherlands and we got the same results.

3) The step change in participation rates for the Netherlands and Greece can be reconducted to the step change in the labour force; see footnotes (1) and (2).

(4) The trend was included in the ADF regression due to the trending pattern of employment in all the countries considered.

(5) Decressin and Fatàs (1995) define relative employment growth as the residuals from equation (5.3). Given that, however, they then estimate an autoregressive process for the relative employment growth, the approach does not seem satisfactory because it implies that the residuals are autocorrelated, thus generating estimates of β which are biased and inconsistent.

(6) Note that by running the Engle and Granger procedure, the null of no cointegration cannot be rejected for any of the countries considered

(7) Consider a stationary AR(2) process X_t:

<f1> $\Phi(L)\, X_t = \varepsilon_t$

where $\Phi(L) = 1 - \phi_1 L - \phi_2 L^2$

and ε is a white noise process.

The AR(2) can be inverted and written in the MA form:

<f2> $X_t = \Phi(L)^{-1}\varepsilon_t = A(L)\, \varepsilon_t = (A_1 L + A_2 L^2 + \ldots + A_k L^k + \ldots)\, \varepsilon_t$

where A(L) is an infinite polynomial in the lag operator.

The impact of a shock at time t on X_{t+k} is given by A_k.

The graphs of the impulse response function are represented by the sequence of the A_k for k=0,1,2.....

Consider now an I(1) process Y_t which can be written as:

<f3> $\Phi(L)\, \Delta Y_t = \varepsilon_t$

where $\Phi(L)$ has been specified above.

As noted before, the process can be written as:

<f4> $\Delta Y_t = \Phi(L)^{-1}\varepsilon_t = A(L)\, \varepsilon_t = (1 + A_1 L + A_2 L^2 + \ldots + A_k L^k + \ldots)\, \varepsilon_t$

The impact of a unit shock on ΔY_{t+k} is A_k, while the impact on Y_{t+k} is given by:

$c_k = 1 + A_1 + A_2 + \ldots + A_k$

The entire sequence of cumulative responses $C=(c_1, c_2, \ldots, c_k, \ldots, c_\infty)$ allows one to measure persistence, i.e. the effect of a unit innovation in ΔY on the entire future levels of Y (see Diebold and Rudebusch (1989)).

The cumulative impulse response function represents the plot of the sequence of the c_k for k=1,2,.....

Note that in order to generate impulse response functions from the estimation of an AR(2) process. two initial conditions are required; we follow the following steps:

a) sample 1 1

$x = 0$

b) sample 2 2

$x = 1$

c) sample 3 n

sim $x = a_1 * x(-1) + a_2 * x(-2)$

In order to derive a <u>cumulative</u> impulse response function we follow:

a) sample 1 1

$y = x$

b) sample 2 2

$y = x + y(-1)$

c) sample 3 n

$y = x + y(-1)$

(8) For the Italian case we performed the analysis also by considering the relative unemployment rate as obtained by using the long run parameter from the Stock and Watson procedure; the results, however, are very similar and we do not report them here.

Figure 5.1: Employment growth rates 1972 1990

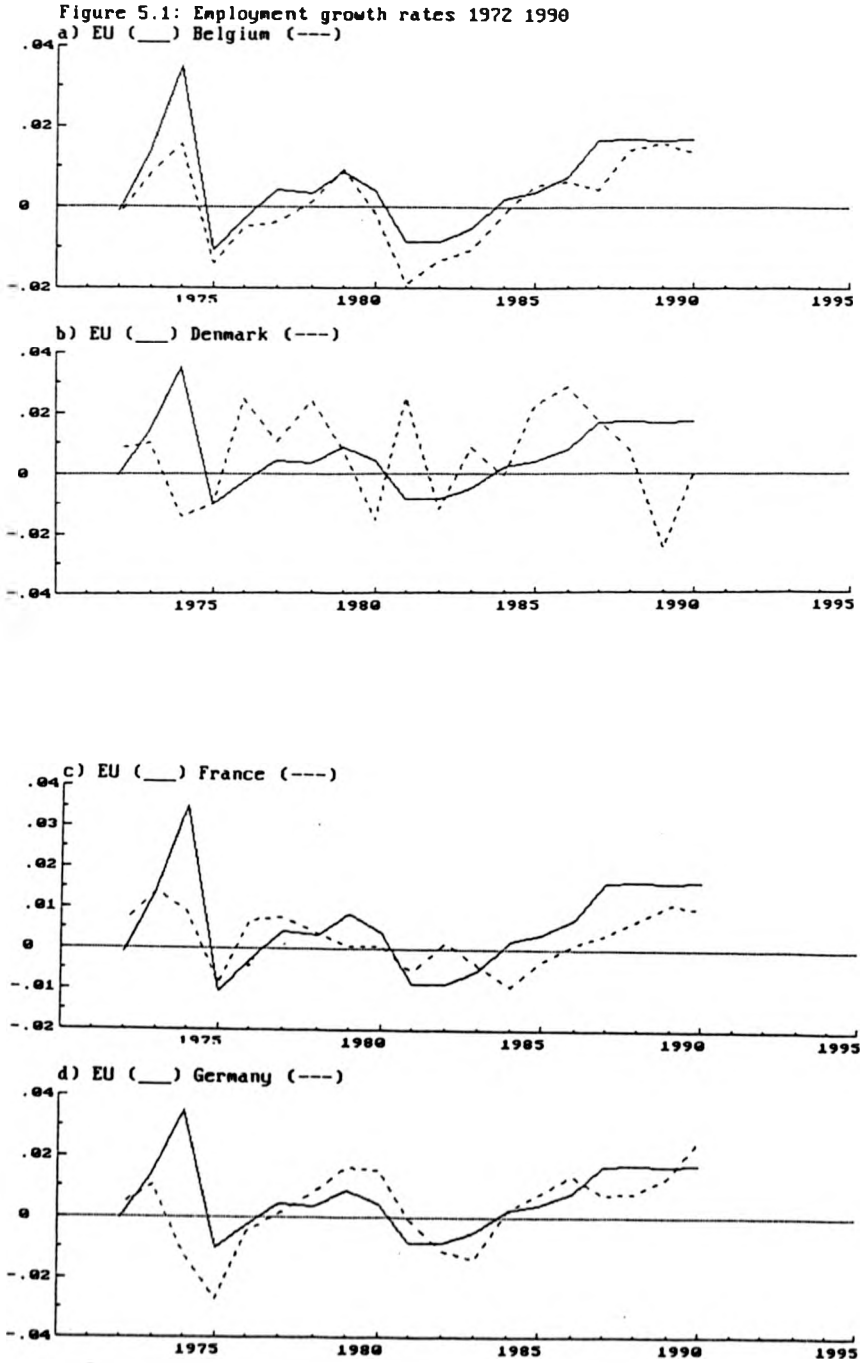
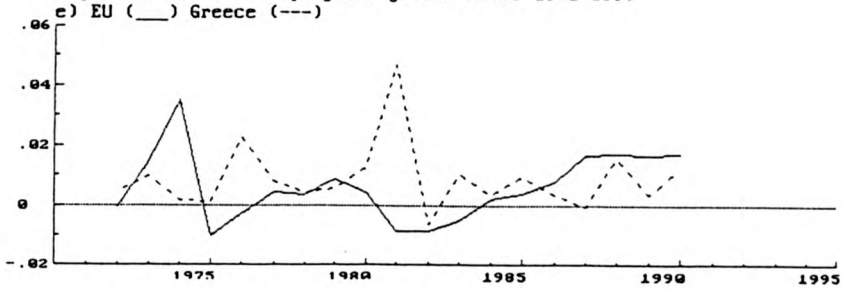
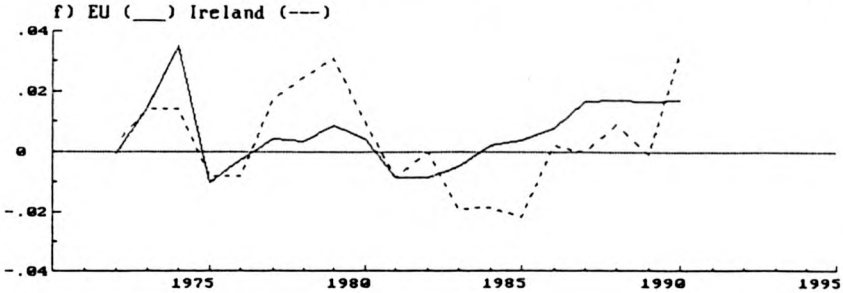


Figure 5.1 (cont): Employment growth rates 1972 1990

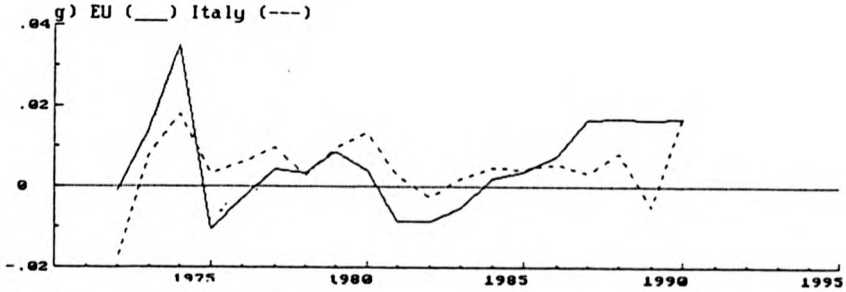
e) EU (___) Greece (---)



f) EU (___) Ireland (---)



g) EU (___) Italy (---)



h) EU (___) Netherlands (---)

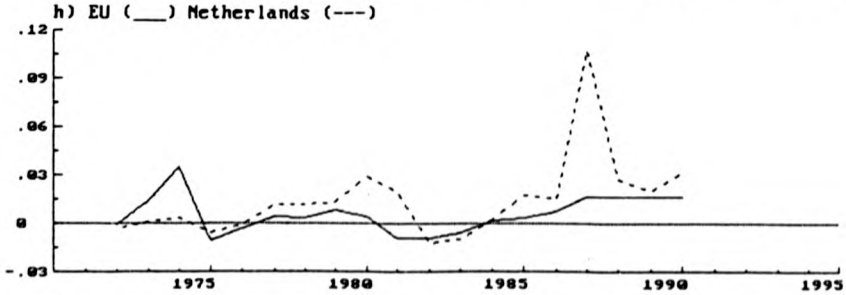
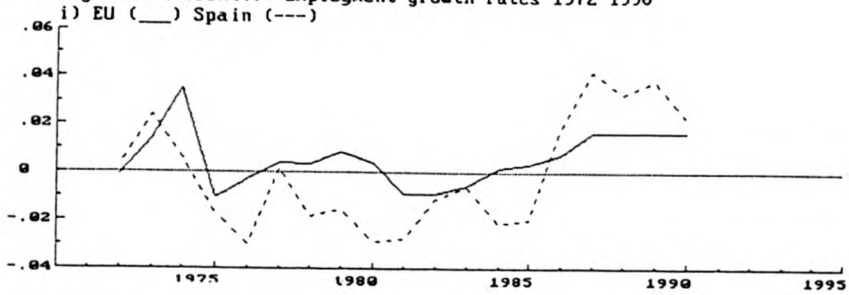


Figure 5.1 (cont.): Employment growth rates 1972 1990

i) EU (___) Spain (---)



j) EU (___) UK (---)

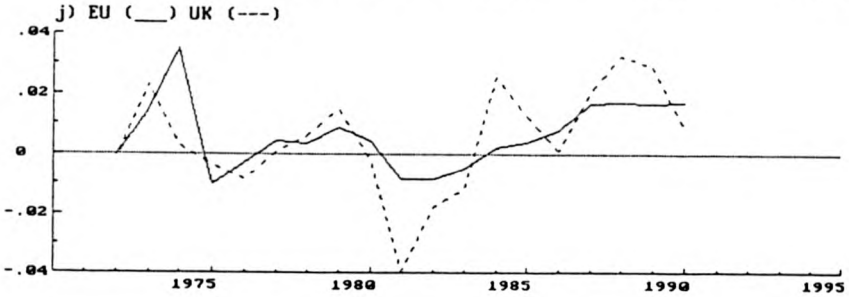


Figure 5.2: Relative employment growth rates 1972 1990

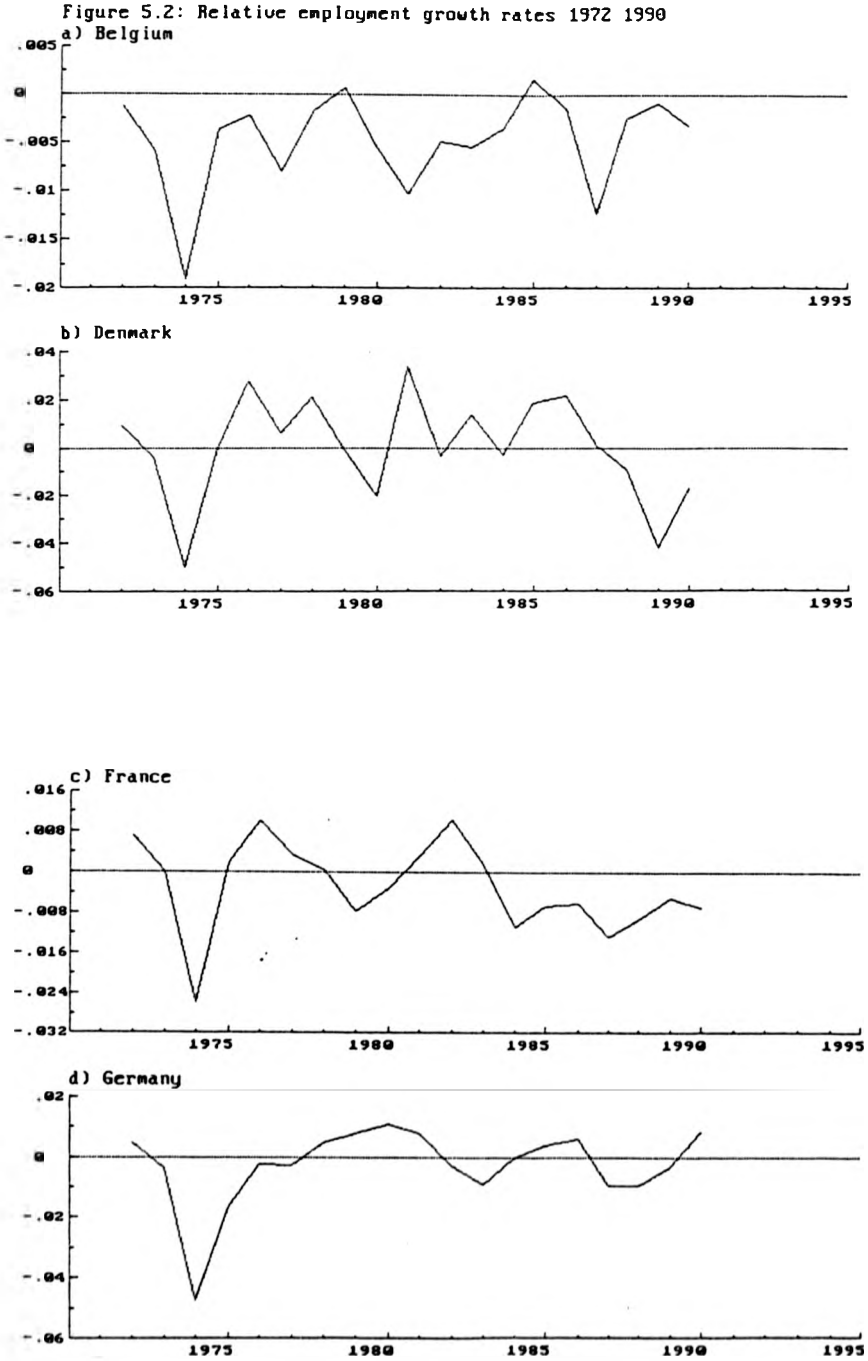
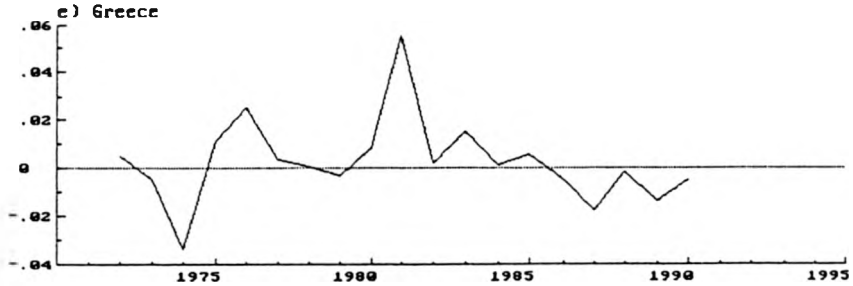
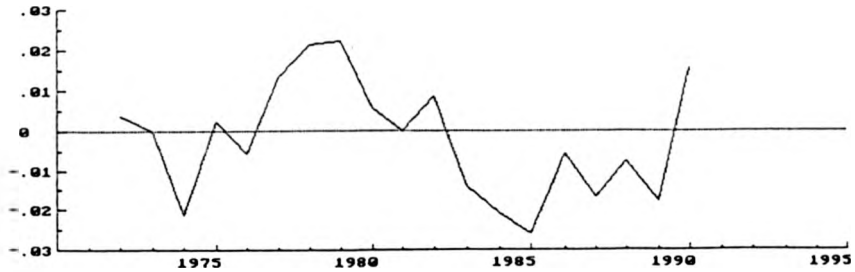


Figure 5.2 (cont): Relative employment growth rates 1972 1990

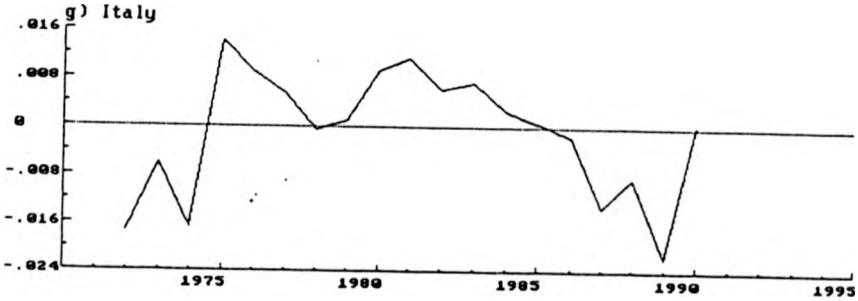
e) Greece



f) Ireland



g) Italy



h) Netherlands

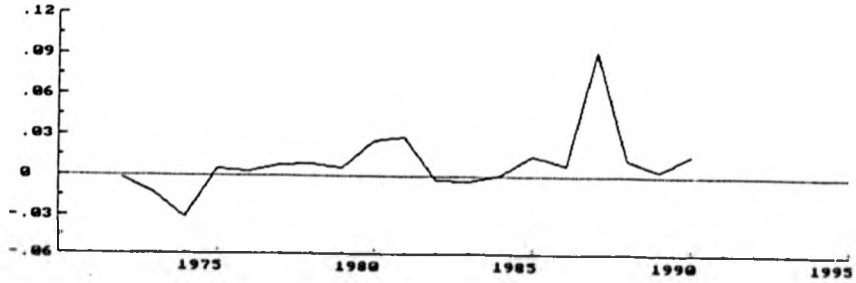


Figure 5.2 (Cont): Relative employment growth rates 1972 1990

i) Spain

j) UK

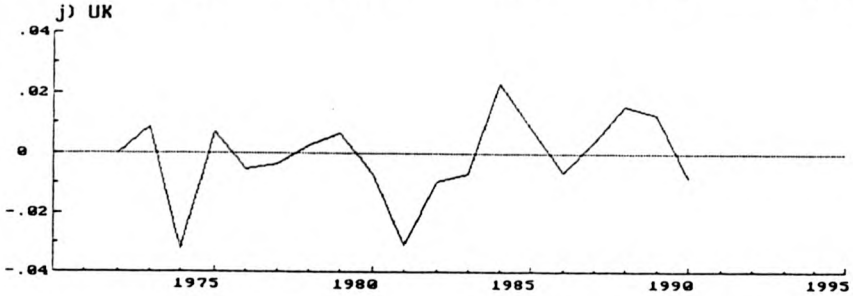


Figure 5.3: Cumulative relative employment growth rates 1972 1990

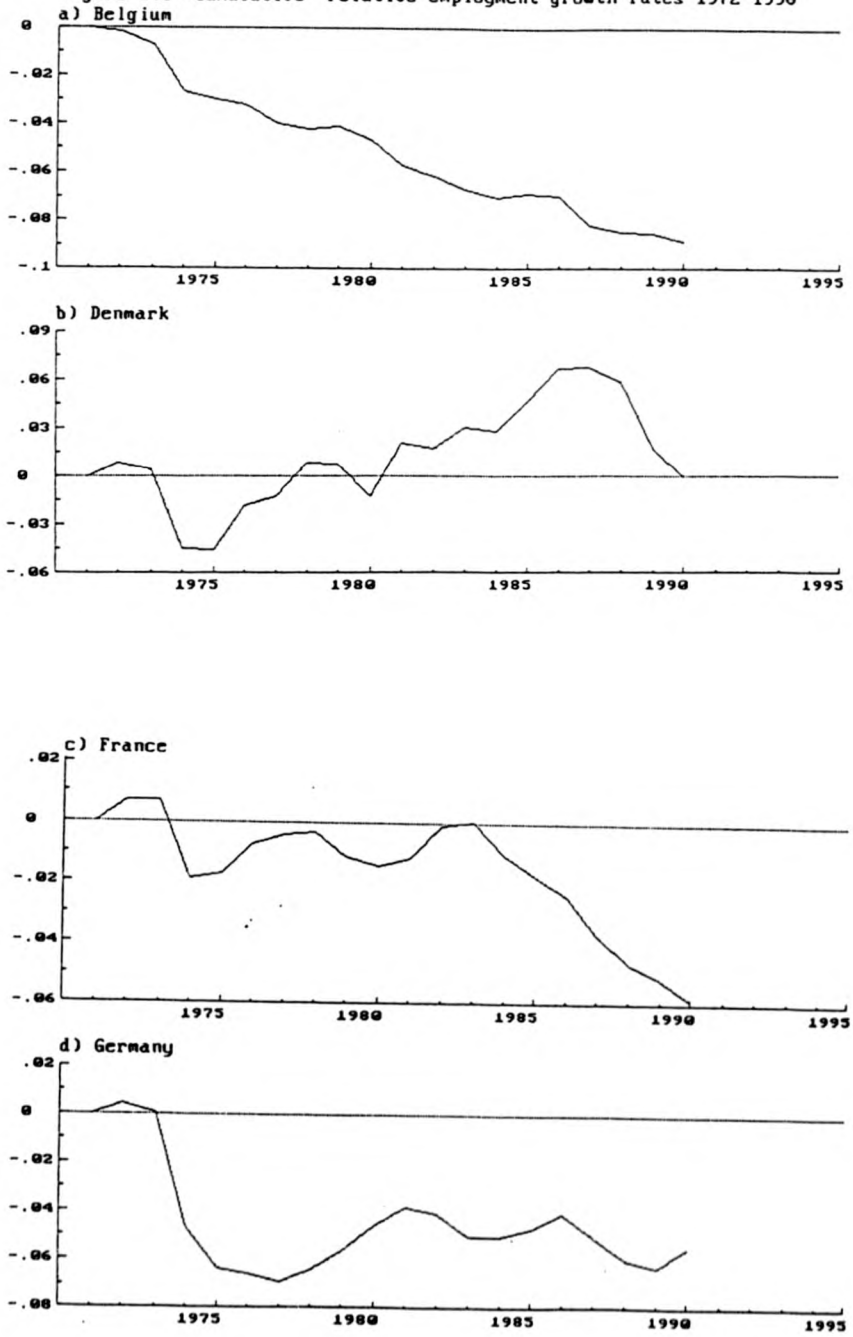
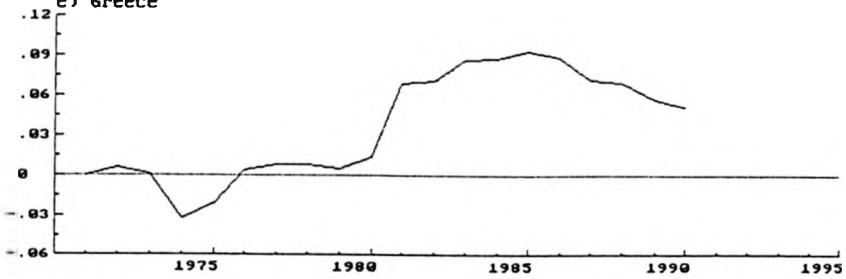
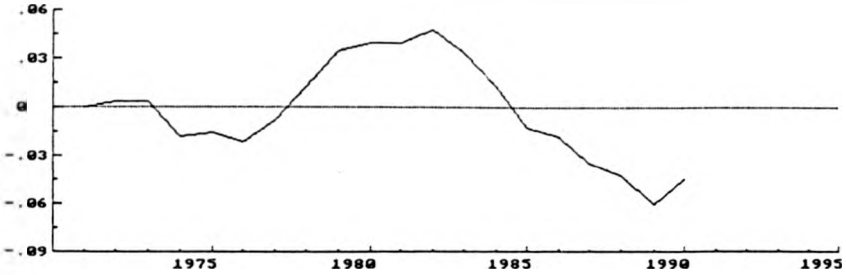


Figure 5.3 (cont): cumulative relative employment growth rates 1972 1990

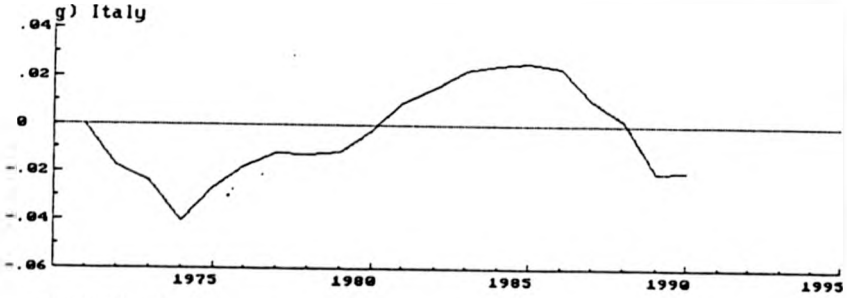
e) Greece



f) Ireland



g) Italy



h) Netherlands

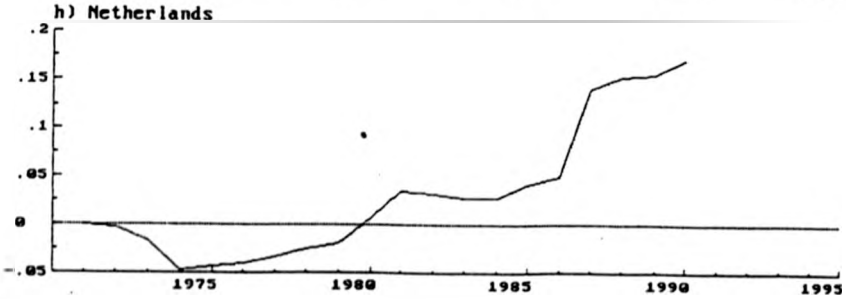
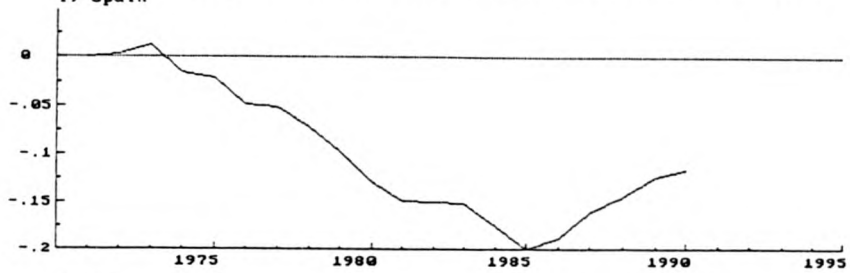


Figure 5.3 (cont): Cumulative relative employment growth rates 1972 1990

i) Spain



j) UK

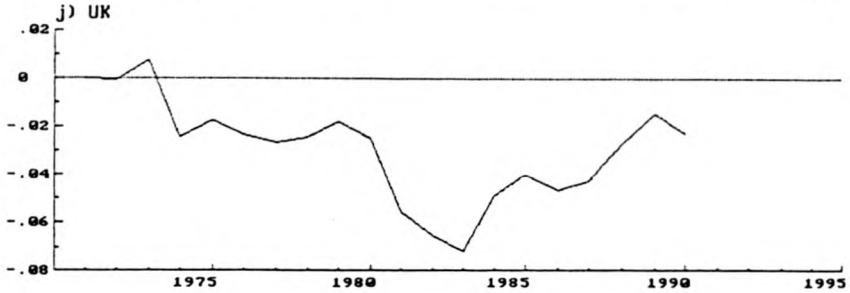


Figure 5.4: Unemployment rates 1971 1990

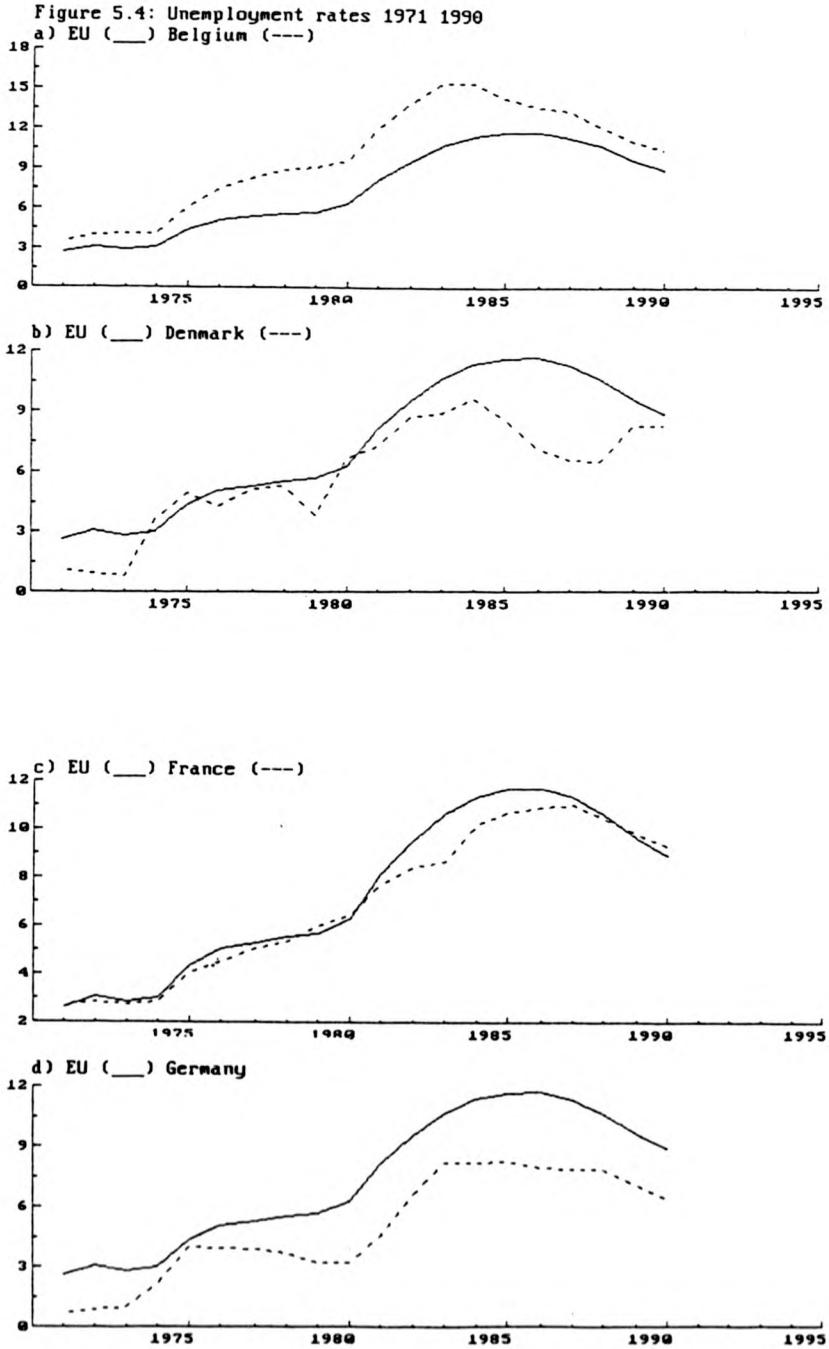


Figure 5.4 (cont): Unemployment rates 1971 1990

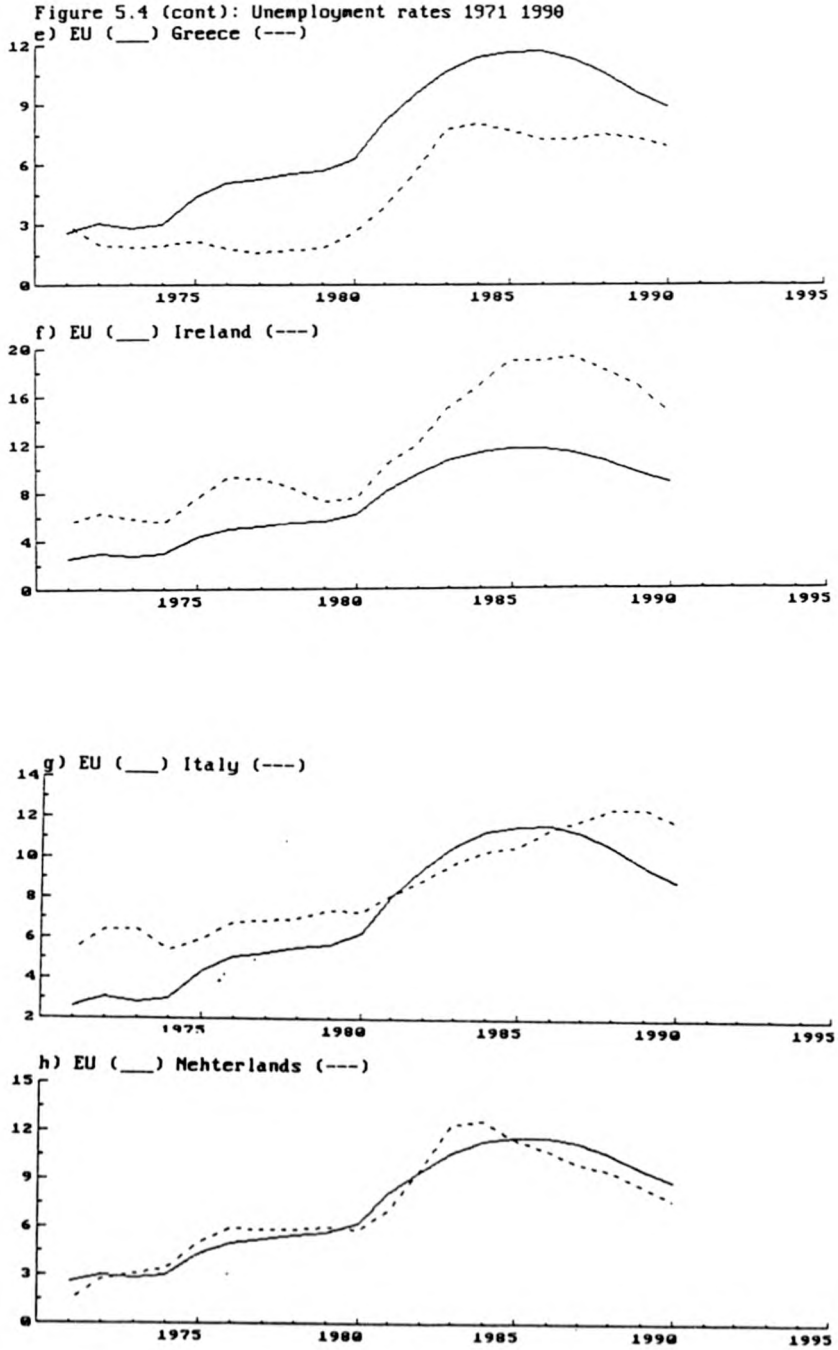
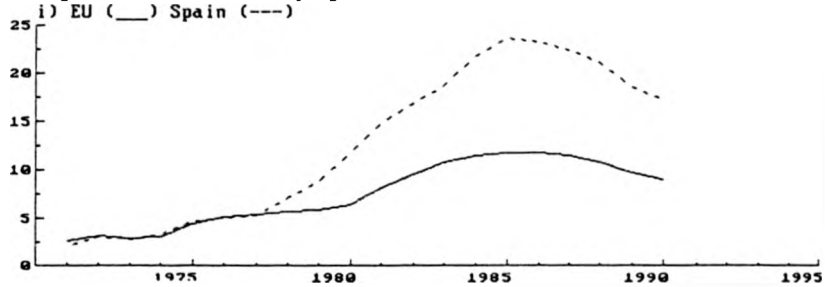


Figure 5.4 (cont): Unemployment rates 1971 1990

i) EU (___) Spain (---)



j) EU (___) UK (---)

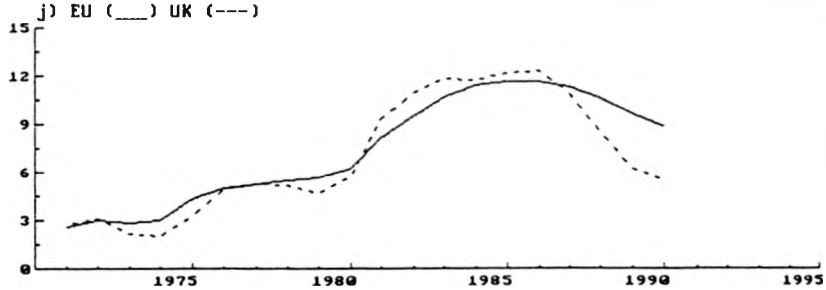


Figure 5.5: Participation rates 1975 1989

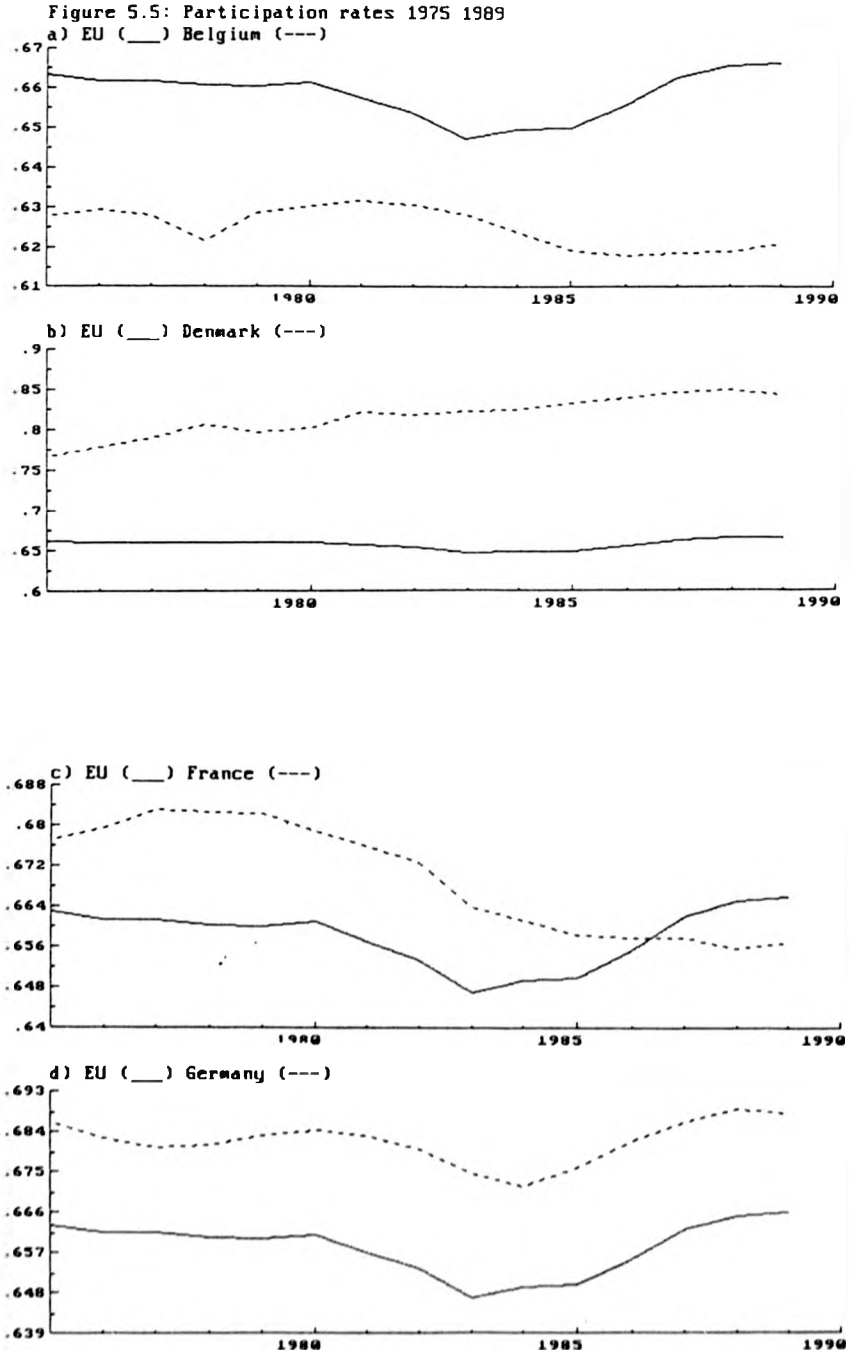
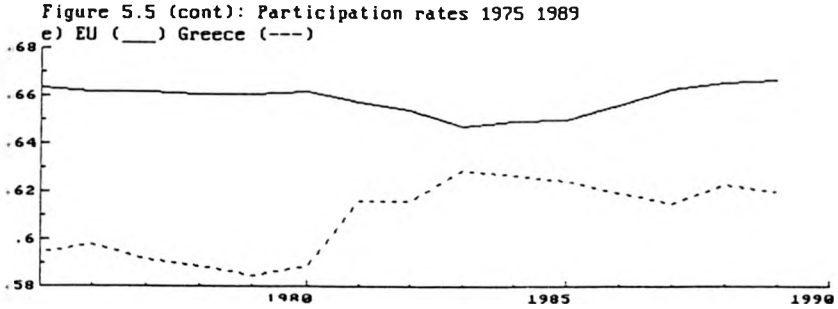


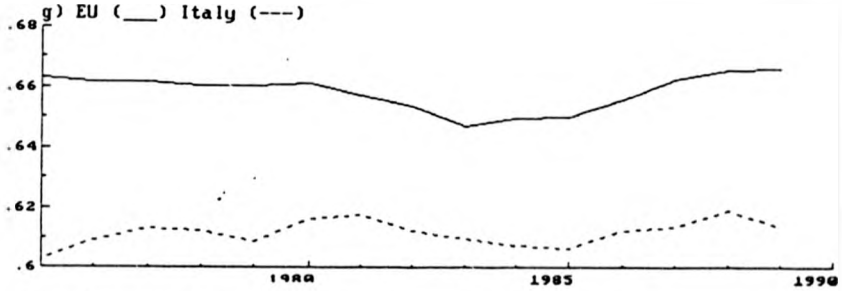
Figure 5.5 (cont): Participation rates 1975 1989

e) EU (___) Greece (---)



f) EU (___) Ireland (---)

g) EU (___) Italy (---)



h) EU (___) Netherlands (---)

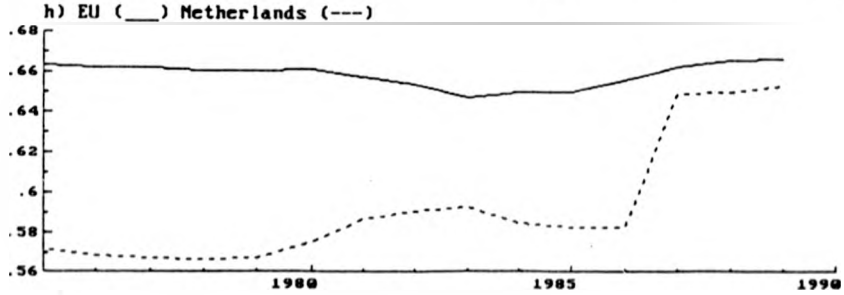
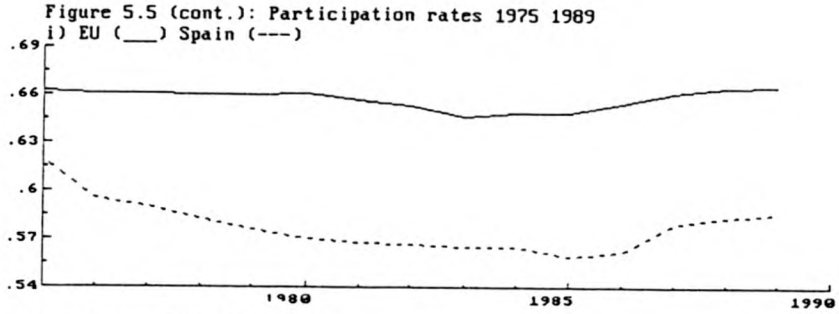


Figure 5.5 (cont.): Participation rates 1975 1989

i) EU (___) Spain (---)



j) EU (___) UK (---)

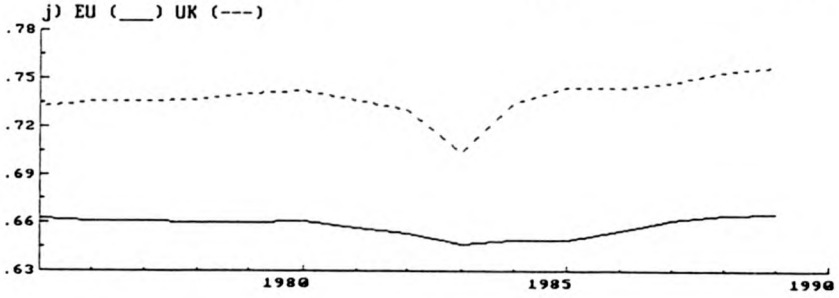


Figure 5.6a: Response of relative employment, USA and EU

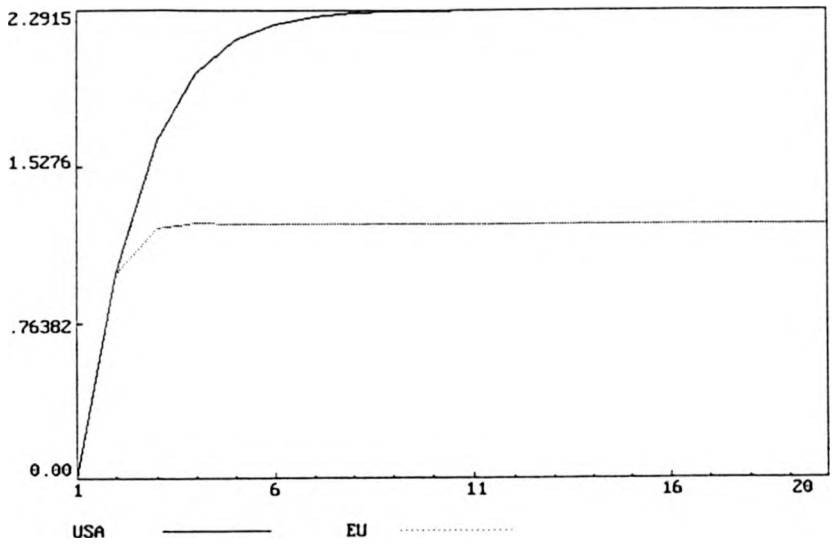


Figure 5.6b: Response of relative employment, Belgium, Denmark and EU

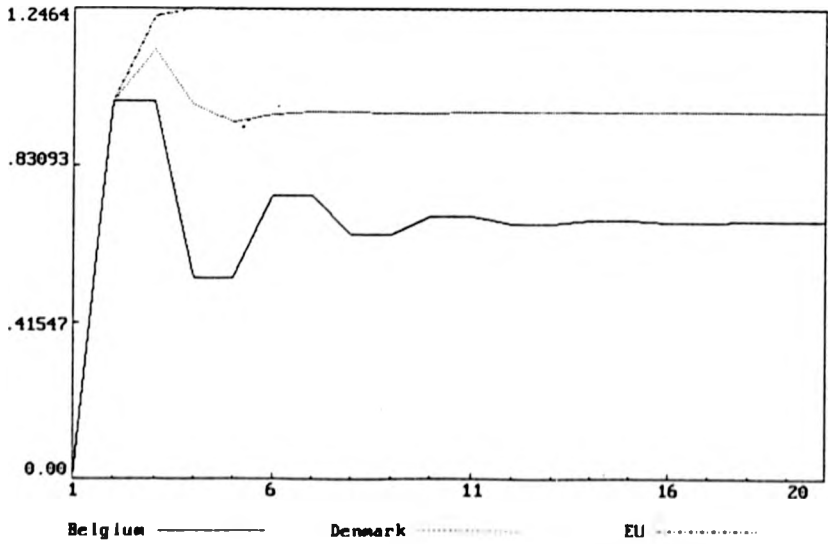


Figure 5.6c: Response for relative employment, France, Germany and EU

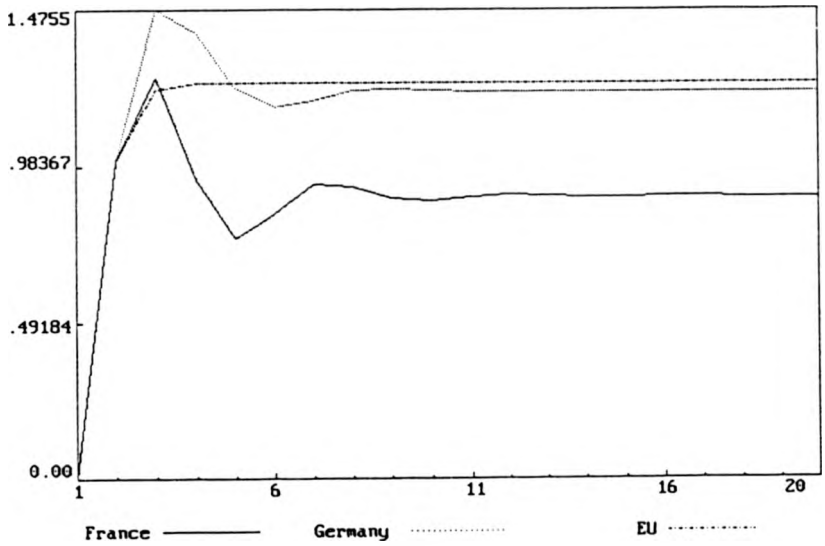


Figure 5.6d: Response of relative employment, Greece, Ireland and EU

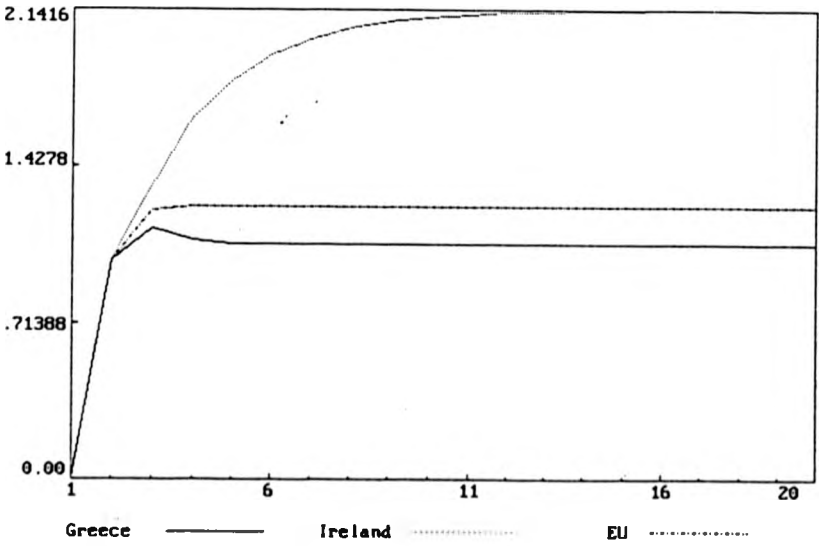


Figure 5.6e: Response of relative employment, Italy, Netherlands, EU

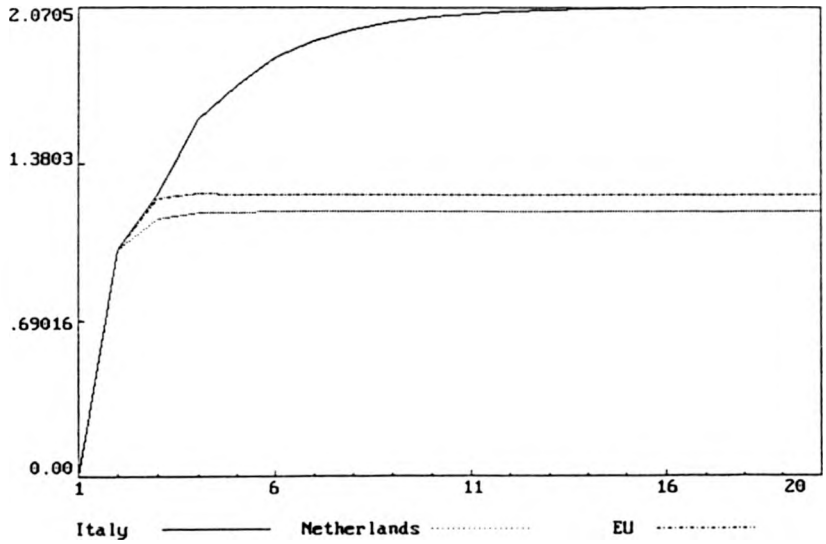


Figure 5.6f: Response of relative employment, Spain, UK and EU

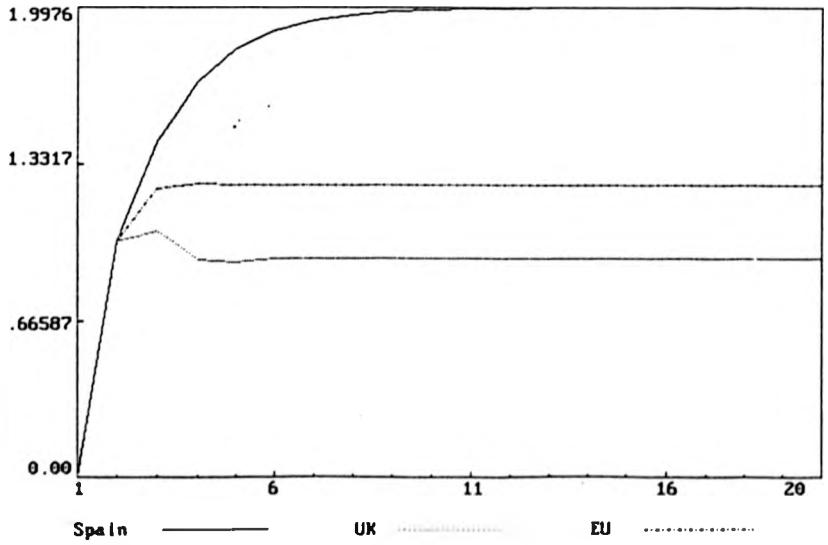


Figure 5.7a: Response of relative unemployment rates, USA and EU

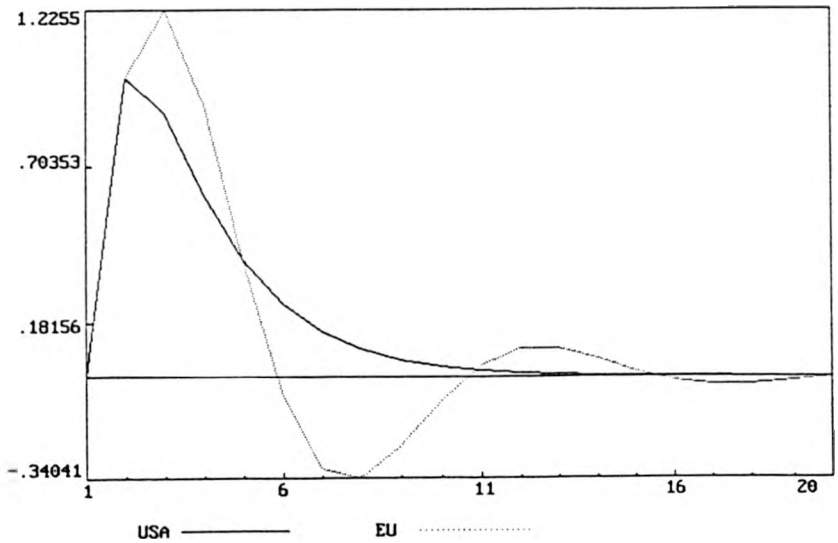


Figure 5.7b: Response of relative unemployment rates, EU (total) and EU

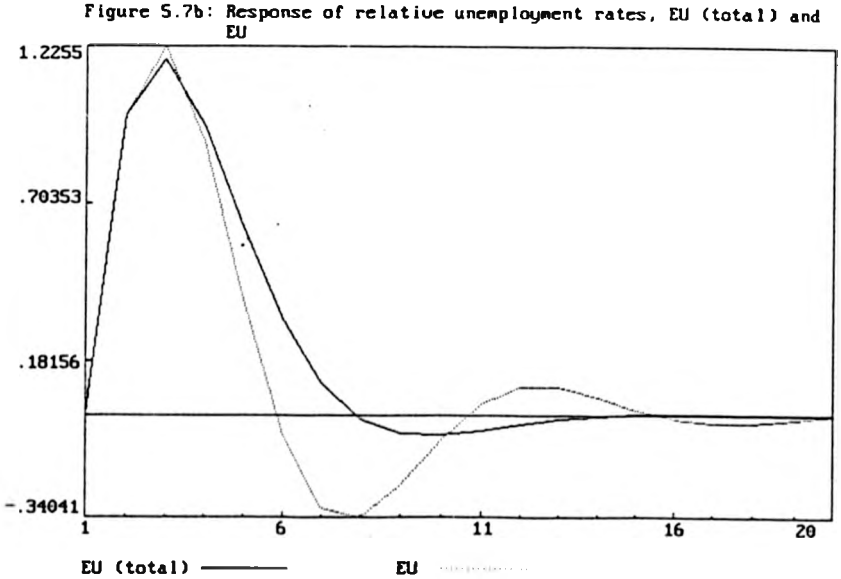


Figure 5.7c: Response of relative unemployment rates, Belgium, France and EU

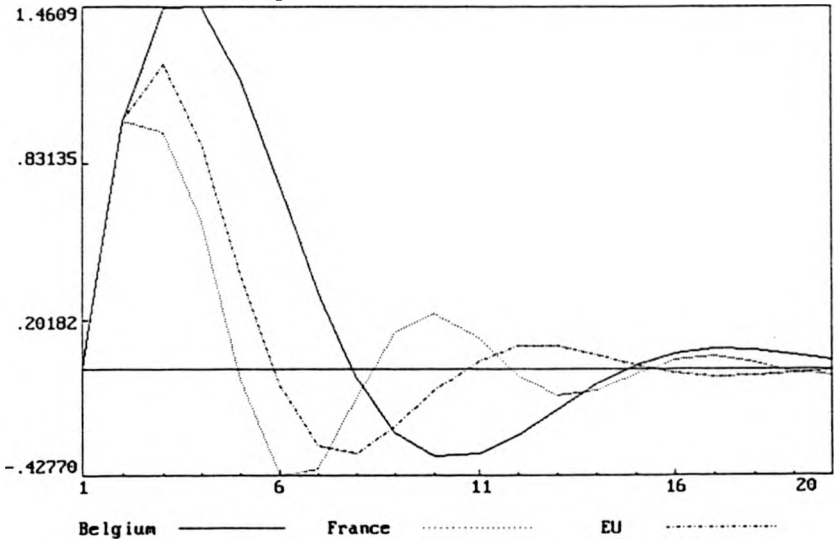


Figure 5.7d: Response of relative unemployment rates, Germany, Italy and EU

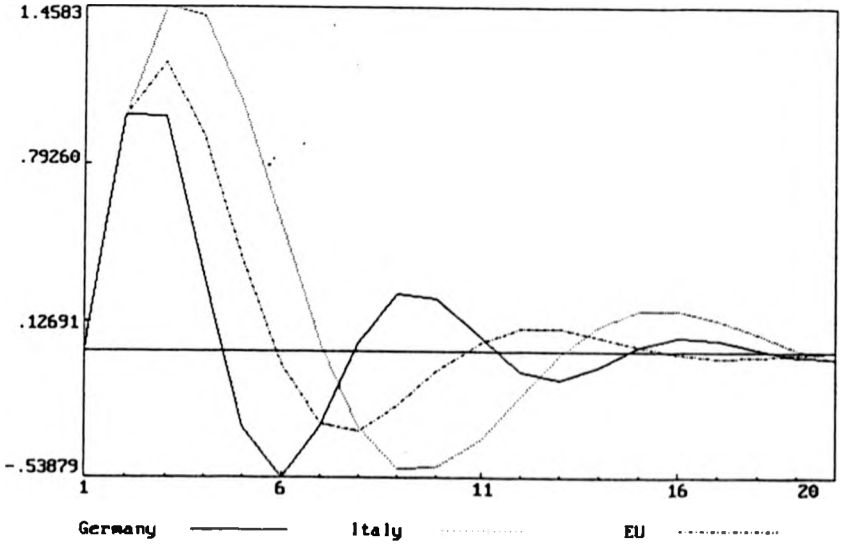


Figure 5.7e: Response of relative unemployment rates, Netherlands, Spain and EU

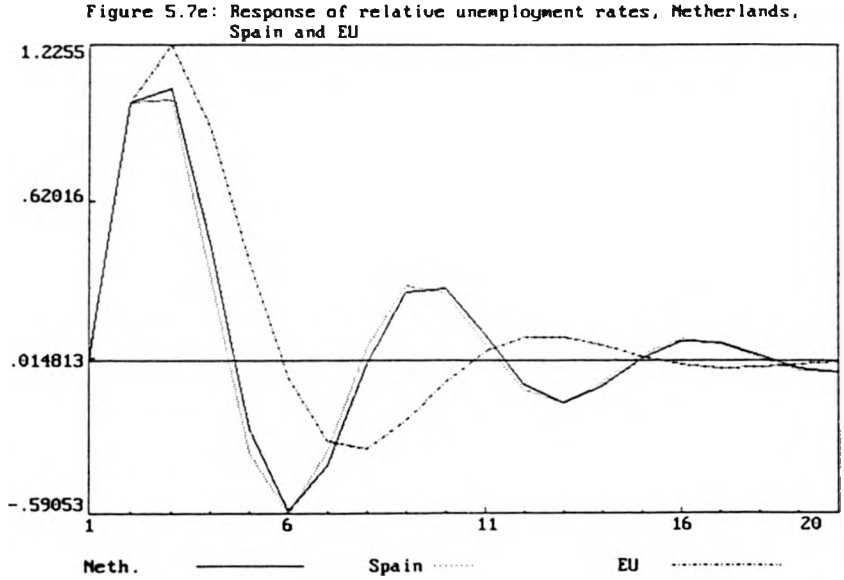


Figure 5.7f: Response of relative unemployment rates. UK and EU

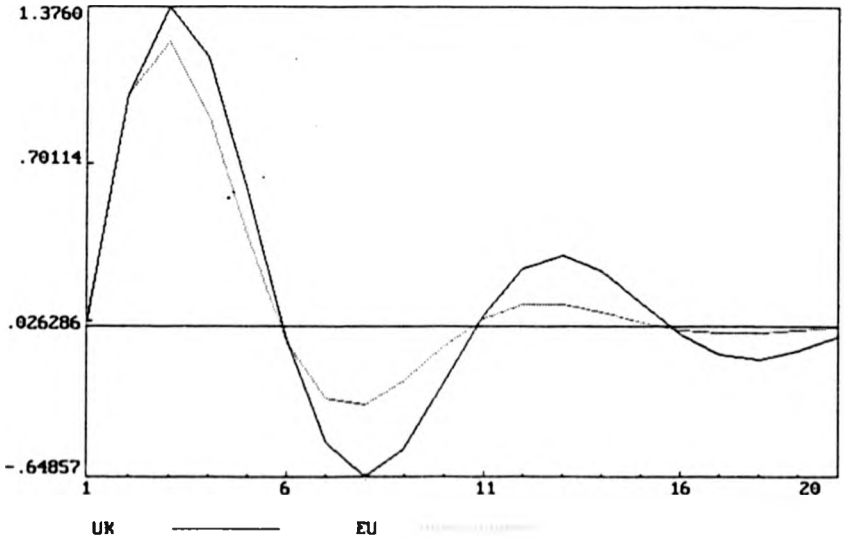


Figure 5.8a: Response of relative participation rates, USA and EU

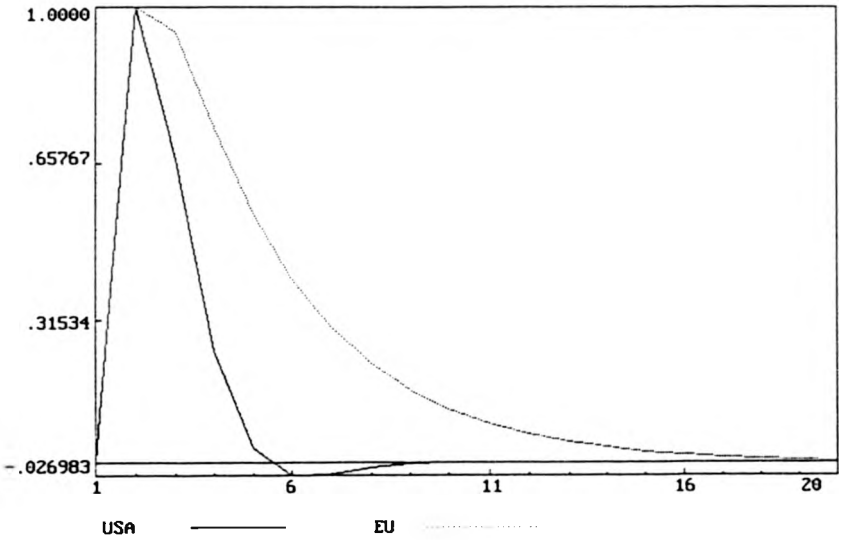


Figure 5.8b: Response of relative participation rates, EU (total) and EU

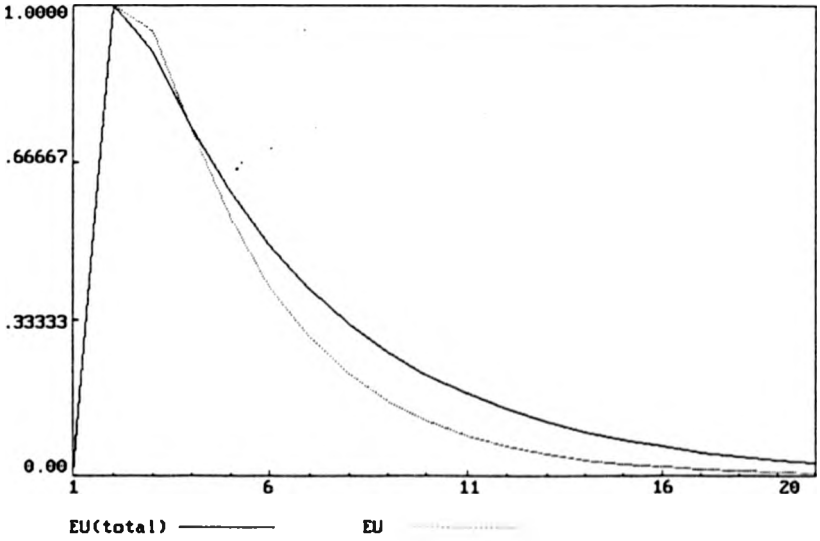


Figure 5.8c: Response of relative participation rates, Belgium, Denmark and EU

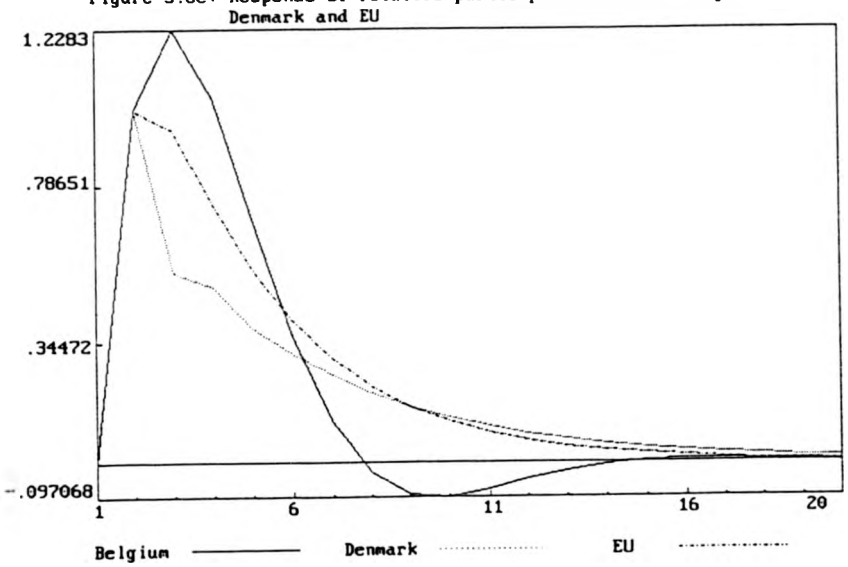


Figure 5.8d: Response of relative participation rates, France, Germany and EU

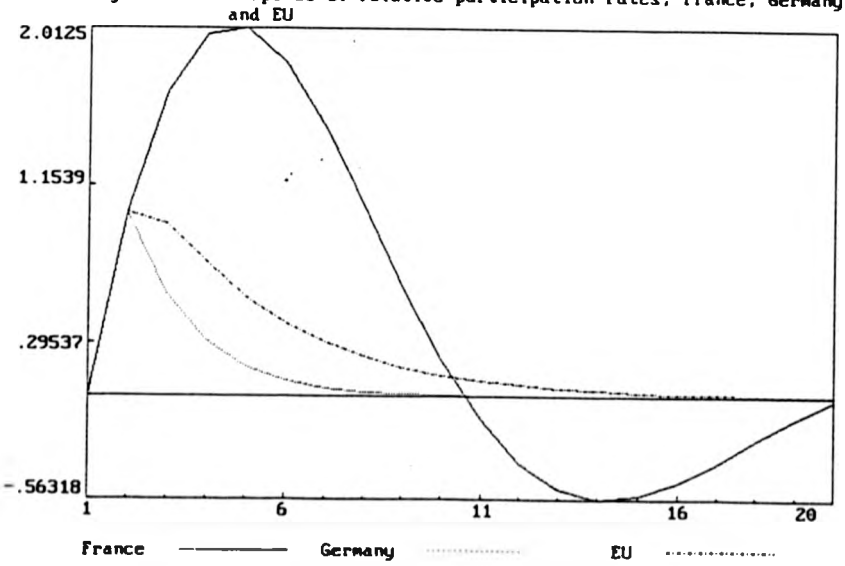


Figure 5.8e: Response or relative participation rates, Greece, Ireland and EU

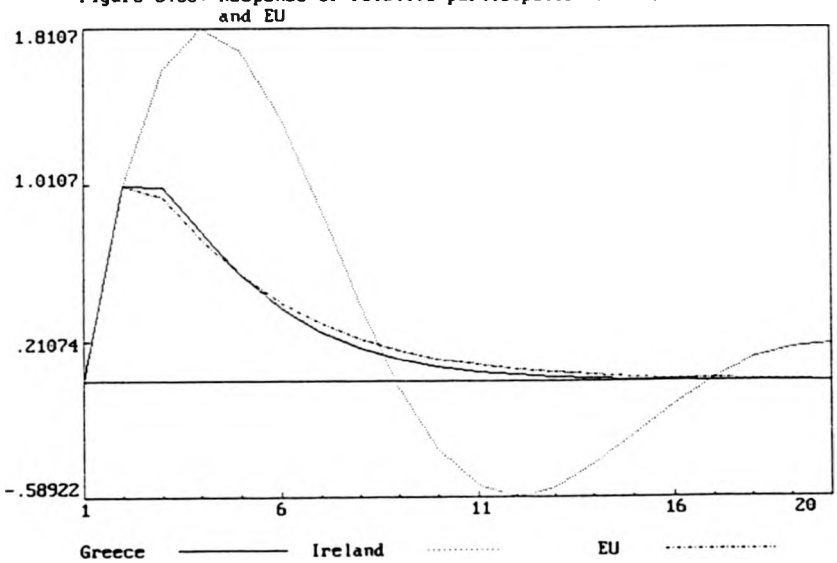


Figure 5.8f: Response of relative participation rates, Italy, Spain and EU

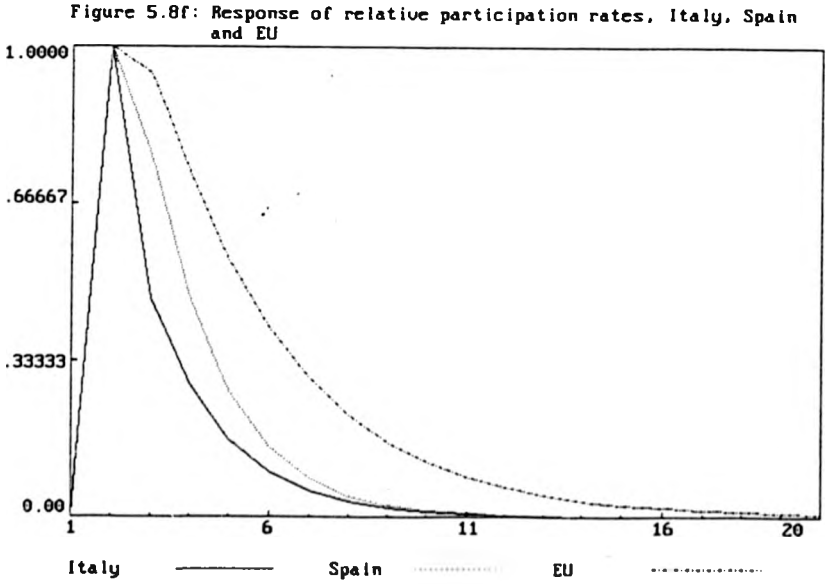


Figure 5.8g: Response of relative participation rates, UK and EU

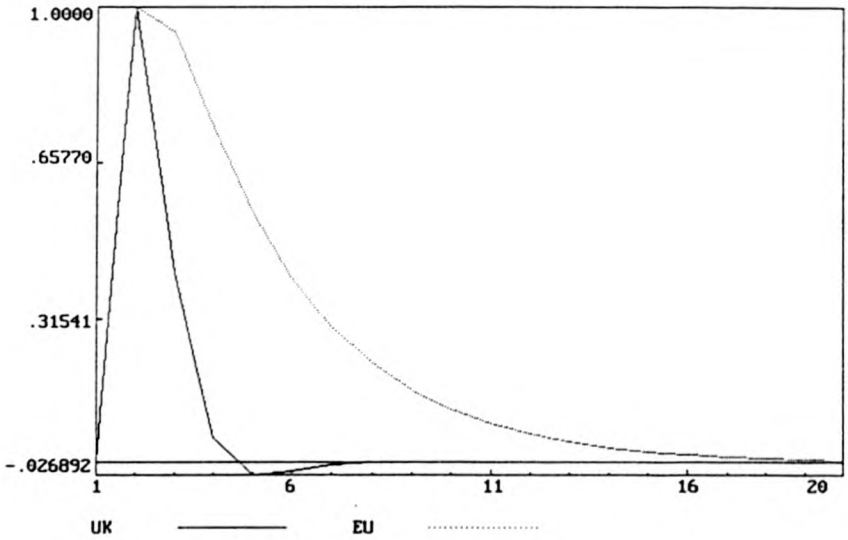


Table 5.1: ADF test for the log of employment

	t-value
EU	- 1.2362
Belgium	- 0.87409
Denmark	- 4.3903 *
France	- 1.3565
Germany	- 1.4782
Greece	- 1.9032
Ireland	- 1.3624
Italy	- 2.0951
Netherlands	- 1.0051
Spain	- 0.49455
United Kingdom	- 0.96241

critical value (constant and trend included) at 5%: -3.712

Table 5.2: Test for the hypothesis $\sum_{l=1}^{2}\alpha_{il}=1$ in equation 1

	t-value
Belgium	- 1.3037
Denmark	0.2284
France	- 4.0381 (*)
Germany	- 2.2192
Greece	- 1.4897
Ireland	- 2.248
Italy	- 2.3862
Netherlands	- 0.53759
Spain	- 1.7368
UK	- 2.2723

(*): significant at 5%

Table 5.3: $\bar{R}^2$ in the equation $\Delta e_{i,t} = k_i + \beta_i \Delta e_{EU,t} + \varepsilon_{i,t}$

	$\bar{R}^2$
Belgium	0.8
Denmark	-0.004
France	0.384
Germany	0.178
Greece	0.0015
Ireland	0.1826
Italy	0.1832
Spain	0.3958
UK	0.3484

Table 5.4: Test for the hypothesis $\beta^*=1$ in equation 4

	β^*	s.e.	t-value
Belgium	0.9183	0.1302	- 0.6275
Denmark	-0.9939	1.057	- 1.8863
France	0.5392	0.1415	- 3.2565 (*)
Germany	0.5001	0.5519	- 0.9057
Greece	-0.1723	0.2576	- 4.3594 (*)
Ireland	1.206	1.251	0.1646
Italy	0.1766	0.1512	- 5.4457 (*)
Netherlands	1.096	1.129	0.0085
Spain	0.6806	2.2226	- 0.1437
UK	0.9108	0.6122	- 0.1457

* : significant at 5% level

Table 5.5: ADF(2) test for unemployment rates

	t-value (constant, no trend)	t-value (constant and trend)
EU	-2.153	-0.90562
Belgium	-2.0245	-0.44975
Denmark	-2.4809	-2.2818
France	-2.0496	-0.51138
Germany	-1.9374	-1.6658
Greece	-1.076	-2.0717
Ireland	-2.0217	-2.1507
Italy	-0.059045	-2.4149
Nehterlands	-1.9606	-0.65904
Spain	-2.0245	-2.7246
UK	-1.9003	-0.65753

- Critical values (Constant, no trend): at 5%: -3.052;
- Critical values (Constant and trend): at 5%: - 3.712;

Table 5.6: long run relationship for unemployment rates

	t-value for the hypothesis $\Sigma\alpha_i = 1$ in equation (5.8)	Johansen's LR test based on maximum eigenvalue
Belgium	- 2.8312	13.7477
Denmark	- 1.4421	4.4039
France	- 3.1638	13.1379
Germany	- 3.7679 (*)	16.6265
Greece	- 1.9464	9.6085
Ireland	0.57667	13.7089
Italy	-1.7415	9.4089
Netherlands	- 5.4506 (*)	22.9497
Spain	- 3.8279 (*)	16.8991
UK	- 2.8296	10.5196

- (*): significant at 5% level
- critical values for Johansen's LR test based on maximum eigenvalue: 14.9 at 5%, 12.912 at 10% significance level

Table 5.7: long run relationship for unemployment rates (as reported directly in Eruostat sources)

	t-value for the hypothesis $\Sigma\alpha_l = 1$ in equation 8	Johansen's LR test based on maximum eigenvalue
Denmark	- 1.5013	7.0429
Ireland	0.32496	5.9482
Italy	-5.3757 (*)	13.2742

(*): significant at 5%

Table 5.8: estimation of the long run parameter for unemployment rates

	Dynamic regression 2.8			Stock and Watson procedure	
	γ^*	s.e. γ^*	speed of adjustment	θ	s.e. θ
Belgium	1.107	0.1132	- 0.38787	1.1566	0.056867
Denmark	0.6121	0.1964	-0.59	0.72748	0.10042
France	0.9168	0.03762	-0.64774	0.92129	0.032324
Germany	0.7372	0.04832	-0.6722	0.67318	0.056867
Greece	0.7372	0.1731	-0.299	0.81265	0.088724
Ireland	0.6627	1.084	0.1967	1.3222	0.081027
Italy	0.9166	0.2121	-0.3959	0.64645	0.046845
Netherlands	0.9223	0.04685	-0.742	0.88724	0.066916
Spain	2.394	0.08835	-0.6428	2.5707	0.088724
UK	1.05	0.08303	-0.5141	1.0911	0.062698

Table 5.9: estimation of AR(2) process for relative employment growth rates

	λ_1	λ_2	σ
EU	0.22524 (0.07955)	-0.29574 (0.08267)	0.016102
Belgium	-0.00022 (0.23749)	-0.46604 (0.23855)	0.00493596
Denmark	0.1357 (0.26692)	-0.16499 (0.30468)	0.0239657
France	0.26233 (0.24515)	-0.38947 (0.23615)	0.0085531
Germany	0.47551 (0.26204)	-0.29702 (0.25897)	0.00130871
Greece	0.1439 (0.26577)	-0.073817 (0.27261)	0.0199551
Ireland	0.33853 (0.29743)	0.19463 (0.30492)	0.01475
Italy	0.24322 (0.26683)	0.27395 (0.28116)	0.00970514
Netherlands	0.13429 (0.26111)	0.0085316 (0.25993)	0.0260798
Spain	0.42487 (0.2625)	0.074542 (0.2815)	0.0179302
UK	0.042626 (0.26397)	-0.11871 (0.27141)	0.0154979

- standard errors in brackets
- σ is the standard error of the regression

Table 10: AR(2) for relative unemployment rates

	φ_1	φ_2	σ
EU	1.1814 (0.06928)	-0.43405 (0.07085)	0.00714
EU (partial)	1.2315 (0.074115)	-0.66212 (0.07787)	0.0054614
Belgium	1.4554 (0.19638)	-0.65732 (0.19946)	0.0042832
Denmark	0.57175 (0.24105)	-0.21481 (0.23498)	0.0111
France	0.95536 (0.24467)	-0.35329 (0.26792)	0.0039
Germany	0.99178 (0.1791)	-0.65563 (0.17335)	0.00362
Greece	1.2059 (0.21451)	-0.4229 (0.19456)	0.00511
Ireland	1.5037 (0.23737)	-0.63216 (0.23737)	0.00987
Italy	1.4583 (0.17746)	-0.7041 (0.18472)	0.00475
Netherlands	1.0565 (0.20122)	-0.60879 (0.28806)	0.005464
Spain	1.0114 (0.19114)	-0.68737 (0.18936)	0.00747
UK	1.376 (0.21724)	-0.7356 (0.29415)	0.0069

- standard errors in brackets
- σ is the standard error of the regression

Table 11: AR(2) for log of participation rates

	η_1	η_2	σ
EU	0.8996 (0.09095)	-0.07005 (0.09424)	0.013273
EU (Neth. excluded)	0.94241 (0.09582)	-0.15361 (0.08795)	0.01
Belgium	1.22 (0.28147)	-0.47303 (0.32645)	0.075715
Denmark	0.53679 (0.32063)	0.21146 (0.27537)	0.011
France	1.6571 (0.27206)	-0.76576 (0.3545)	0.0043
Germany	0.56014 (0.31142)	-0.01212 (0.31055)	0.00362
Greece	0.99795 (0.30953)	-0.22185 (0.30007)	0.019195
Ireland	1.6012 (0.25886)	-0.75319 (0.32163)	0.0782
Italy	0.46171 (0.37833)	0.07127 (0.27458)	0.00643
Netherlands	0.81547 (0.3097)	0.13796 (0.36998)	0.30667
Spain	0.76879 (0.31734)	-0.12149 (0.19172)	0.008
UK	0.41431 (0.31971)	-0.11828 (0.31227)	0.01334

- standard errors in brackets
- σ is the standard error of the regression

CONCLUSIONS

As pointed out in the introduction, the aim of this thesis is to contribute to the debate over the ERM and the creation of a European Monetary Union, both by throwing new light on issues where no agreement has been reached in the literature and by investigating important areas so far overlooked.

In the first chapter we considered the process of disinflation which Europe and the USA experienced in the 1980s and the hypothesis that the ERM membership helped traditionally inflation-prone countries to bring inflation down. We noticed that all the empirical work available tests for the hypothesis of an 'ERM effect' by comparing the period preceding and the one following the creation of the ERM or the period pre and post-1983 with respect to the behaviour of inflation rate or the relationship between inflation and other macroeconomic variables, such as wage inflation and output growth, or the specification of wage equations over the two subperiods. Any parameter non-constancy is attributed to the 'ERM effect', in the light of the Lucas critique, according to which shifts in economic policy (such as the participation in the ERM or the policy turnaround in 1983) should alter those statistical relationships.

The results obtained following the above methodology clearly depend on the choice of a date break, which is chosen ex ante and exogenously by the researcher. But the methodology adopted in the first chapter, proposed by Hamilton, allows us to detect any structural break in an endogenous manner. In research reported in chapter one, we applied the Hamilton filter to the series given by the inflation differentials between each of the initial ERM against Germany for the period 1979-1990; we also considered the differential between the UK and Germany as a control variable, due to the fact that the UK experienced a reduction in inflation as the ERM countries, but outside the System itself. The results show a clear switch in regime from a 'high inflation' to a 'low inflation' state for France and Italy around the mid 1980s; but no clear switch has been detected for the small countries of the ERM, such as Belgium, Denmark and the Netherlands. This does not come at a surprise, given that the latter countries were part

of the 'Snake' and the ERM was seen by them as a natural development of the previous exchange rate arrangement. It is very interesting to note that no regime switch has been detected in the case of the UK either; though this country experienced a reduction of its inflation level, it is not possible to find any structural break in its differential with Germany not to identify one state characterised by high inflation and another characterised by low inflation. This result, together with those obtained for France and Italy, is supportive of the view that the ERM membership helped inflation-prone countries to reduce inflation.

Given the particular interest of the results, we decided to push further this line of research, by analysing more closely the cases of France and Italy. When the sample was extended back to 1975, we still found a switch in regime around 1984, not at the beginning of the ERM in 1979, for both the countries mentioned above. This seems consistent with the theory that the ERM worked as a disciplinary device, but only when the commitment to stable exchange rates became credible.

We subsequently applied the extension to the Hamilton filter suggested by Garcia and Perron (1990): once two highly persistent states are found, this allows one to test for the existence of a third regime. The motivation for this type of analysis was to test for a further break around 1987, when the Basle-Nyborg agreement was signed, and a commitment to stable exchange rates was strengthened further. The results show that neither in the case of France, nor in the case of Italy does a third regime in the time series behaviour of inflation differentials with Germany seem present. This is not, perhaps, surprising for France, since that the mean differential already obtained by 1984 was around 1%, leaving little scope for further convergence. But Italian inflation did not fully converge, with an average differential with Germany of 4% in the period after 1984. While the ERM membership generally helped the inflation-prone countries in the convergence process towards Germany when they first showed their commitment to stable exchange rate (around 1984), we have demonstrated that, at least for countries like Italy, where a substantial positive inflation differential still persisted, (for possibly good economic reasons), no further convergence was achieved

when Banca d'Italia reinforced its commitment to stable exchange rates with the other ERM currencies. It may well be that national differences in fiscal policies holds the key, although this is something we have not specifically investigated.

The presence of a persistent positive inflation differential, coupled with the absence of realignments (with the exception of the Italian lira in 1990) leads to the issue of the credibility of the commitment not to realign the central parities and, in case of imperfect credibility, to the analysis of the realignment expectations. The recent literature has focused on the behaviour of exchange rates under imperfect credibility and the theoretical specification and measurement of expected realignments (Lindberg and Soderlind 1992, Bertola and Caballero 1992, Bertola and Svensson 1994, Tristani 1994). The most successful model is undoubtedly the one suggested by Bertola and Svensson, who model expected devaluations as following a Brownian motion process, or, in discrete time, a random walk. Given that the appeal of their model is the fact that it seems to fits the data, we decided to test directly for the hypothesis of the time series behaviour of expected realignment.

In our analysis we do not need to assume the validity of the Uncovered Interest Parity, but simply that the wedge between expected future exchange rate and interest rate differentials is a stationary process, which is obviously a less stringent assumption; it then follows that the assumption of a I(1) process for expected realignments implies the same order of process for the interest rate differentials.

We analyse weekly interest rate differentials on Eurocurrencies for the currencies of the initial ERM members against the German Mark for the period 1987-1991 and find that, once the presence of a negative trend is taken into account, the hypothesis of the presence of a unit root is rejected, with the exception of the Danish krona. We get the same result when we consider the Swedish krona against the currency basket to which it was pegged until 1991. In our empirical analysis we apply unit root tests, as well the multivariate technique for testing for cointegration proposed by Johansen. The well known low power of unit root tests (i.e. the low probability of rejecting the null hypothesis of the presence of a unit root when this is false), in particular when the

alternative hypothesis is either a stationary process with high persistence or a stationary process around a deterministic trend, does not constitute a problem in our analysis as we are able to reject the null hypothesis of the presence of a unit root in all cases but one.

Of course it is always possible to model the expected realignment so that it fits the data; one simply defines as expected realignment all that cannot be explained in terms of fundamentals. A better approach implies the formulation of an economic theory which clarifies the economic factors which influence expected realignments. We develop this line of thought in the theoretical analysis of the currency crisis of 1992, which led to the exit of the Italian lira and the British Pound from the ERM. Instead of considering the probability of realignment, we propose a model where there is a certain probability of leaving the System altogether. In the model it is assumed that there are two countries, one of which, say Italy, has exhausted its (available) reserves in defending the parity and is living on 'borrowed time'. It is assumed, in particular, that Italy has access to a loan of potentially unlimited amount granted by Germany, but Germany reserves the right to call the loan back at any time; once the loan is called back the target zone becomes unsustainable and a free float will characterise the exchange rate thereafter. In this setting, the expected future exchange rate has two components: the first is due to the expected change of the exchange rate inside the band, the second is due to the probability that the loan is called back times the expected jump in the exchange rate at the time of leaving the System. This model allows us to focus on the role of the stance of the Bundesbank towards the defence of the weak currencies of the System in the dynamics of the crisis and to show how the perceived position of the Bundesbank feeds back into the market expectations.

Note, however, that our model does not cover other significant elements of the crisis, such as the pressure coming from the real exchange rate appreciation and the consequent loss of competitiveness, which hit most notably Italy, and the influence of the increasing unemployment level on the governments' actions. These limits derive from the theoretical framework of our model, given by the monetary model of exchange

rate determination with fully flexible prices, where it is assumed that Purchasing Power Parity holds continuously and that output is fixed at the level corresponding to full employment.

We believe that the merit of the model proposed in chapter three of this thesis lies in the consideration of an important aspect of the 1992 currency crisis unjustifiably overlooked by the theoretical literature on the crisis.

We also provide some empirical support for our model. Contrary to what happens as far as expected realignments are concerned, this model of expected regime switches implies the presence of an I(1) component in the expected future exchange rate and, hence, in the forward exchange rate and the interest rate differential between Italy (UK) and Germany. We test for this hypothesis for forward exchange rates and interest rate differentials at various maturities over the period January 1990-September 1992 for Italy and the UK against the German Mark, with the French Franc also considered as a control variable. The results seem to support the hypothesis that there was an I(1) component for the variables relative to Italy and the UK. We noted above that unit roots tests have low power and so the results are not very strong and need to be taken with caution; in order to get more robust results it could be useful to test for the presence of a break in the series as well as to test for stationarity of forward rates and forward premiums on a sample which excludes the period prior to the crisis. In the first case our model would be supported if a structural break was found; in the second case, we would expect to find a stationary behaviour for the series under scrutiny in the period where no switch of the type described in chapter was expected, such as the one before the summer 1992.

it is reassuring, however, that, despite the low power of the test, our results show that the hypothesis of unit root is rejected for the French Franc, which in the crisis of 1992 received full support by the Bundesbank.

The currency crises of both 1992 and 1993 had several facets and we refer to the literature (Eichengreen and Wyploz 1994, Masson 1994, Ozkan and Sutherland 1994) for the analysis of the other aspects of it.

Given that, despite the foreign exchange turmoil, the prospect of creating EMU by the end of the century is still at the top of the European political agenda, it seems important to investigate whether the EU as a whole has the characteristics necessary for successful currency union. The recent literature has revived the theory of optimum currency areas (OCA), originally proposed by Mundell (1961). According to this theory, the cost of giving up monetary autonomy and the possibility to adjust exchange rates will be negligible if the disturbances affecting the economies of the member countries are symmetric or if there is high factor mobility among the countries. A very detailed study of the post-war experience of the states of the USA (Blanchard and Katz 1992) shows that, given the impossibility to respond by changing exchange rates, adjustments to adverse shocks to state economies come mainly from migration of the labour force, and to a lesser extent through wage flexibility. The current situation in Europe is substantially different: as Eichengreen (1993, 1992 b) points out, not only is migration low among the EU countries, but also within these countries; it is quite unlikely that the situation will change radically in the near future, although some factors, such as the possibility to transfer pension schemes across countries, will ease labour mobility. Given this situation it is important to examine how employment shocks spread in Europe and how individual countries respond to them. This is the goal of the analysis contained in the final chapter of the thesis.

The results show that employment shocks in Europe tend to be idiosyncratic in nature, far more so than in the US. This type of shock tends to have persistent effects both in the EU and in the US, even if less in Europe than in the US; the lower degree of persistence of idiosyncratic employment shocks experienced in Europe is probably due to the role played in the adjustment process by changes in relative prices (Bayoumi and Prasad 1995) or by devaluation. With the loss of the exchange rate instrument and in presence of wage stickiness, however, it will be difficult to rely on such changes in relative prices, so it can realistically be expected that persistence of employment shocks will increase. This, and the result that in Europe the percentage of idiosyncratic shocks is far higher than in the US, points to clear difficulties in the adjustment

process, once EMU starts. The results have to be evaluated with caution, as the total employment series for the Netherlands is affected by a structural break due to a change of its definition, which has not been accounted for; although the break carries over the corresponding EU employment series, the distortion is limited by the fact that this variable is defined as a weighted average and the weight corresponding to the Netherlands is relatively small. We therefore believe that for all the EU countries but Netherlands the results would be qualitatively similar if we used a modified series for employment growth which took into account the change in definition above mentioned.

As for unemployment rates, it is well known that they are more persistent in the EU than in the US. What we show, however, is that the deviations of national unemployment rates from the EU average die out more quickly than the analogous variable for the US states; it might be that exchange rates changes plunged a role in dumping the effects of idiosyncratic shocks. Moreover, our results show that movements in participation rates play quite an important role, in the EU, in the adjustment process, although the limited size of our sample induces us to interpret the result with caution.

One strong message coming from this type of the analysis and it refers to a pattern of core-periphery emerging in Europe; Greece, Ireland and Spain seem to have usually larger idiosyncratic shocks and the response to their effect seems slower; it could be possible, therefore that these countries might be in a disadvantageous position if the project of the Monetary Union will go ahead. The situation might worsen once we bear in mind that, as pointed out by Krugman (1993), that the most likely effect of the creation of a fully integrated European market will be an increase in specialisation, which can lead to increasing incidence of asymmetric shocks.

We are not in a position to forecast if the project of EMU will finally go ahead and, in this case, which countries will join. It seemed important however to try and deepen our knowledge on some of the issues which look critical in evaluating the EMU project.

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