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WHO WILL JOIN EMU? IMPACT OF THE MAASTRICHT CONVERGENCE CRITERIA
ON ECONOMIC POLICY CHOICE AND PERFORMANCE

R. Sean Craig

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ABSTRACT

To qualify for European Monetary Union (EMU) countries must meet convergence criteria established in the Maastricht treaty of December 1991. However, an analysis of how difficult it will be to meet the convergence criteria is not sufficient to identify the countries most likely to join EMU in 1999. This paper identifies a number of factors in addition to budget deficit reduction required to qualify for EMU such as; the persistence of inflationary expectations; the variance of output shocks; the inflationary bias to monetary policy; and, the political cost to not joining EMU. Moreover, countries follow a policy rule where a large negative output shocks can cause them to abandon the restrictive policies necessary to qualify for EMU and, instead, use policy for stabilization. Concern about such a policy shift could cause increases in interest rates similar to those observed during ERM crises. Data on the above factors are generally not available, except for budgetary data. However, the model shows that data on long-term interest rate differentials with Germany can serve as a measure of their influence. Two approaches, using implied forward interest rate differentials and econometric analysis, are used to evaluate the usefulness of this measure. Both support the use of long-term interest differentials. Overall, it appears likely that EMU will occur in stages as factors are relatively favorable for EMU in Denmark, France, Ireland and the Netherlands. In contrast, for Italy and Spain EMU appears unlikely.

**Who Will Join EMU? Impact of the Maastricht Convergence Criteria
on Economic Policy Choice and Performance**

R. Sean Craig¹

I. Introduction

European Monetary Union (EMU), scheduled for January 1999, may be close enough to allow a preliminary assessment of which countries are most likely to join EMU. To qualify for EMU countries must meet convergence criteria established in the Maastricht treaty of December 1991. Most countries meet or are close to meeting the inflation and interest rate criteria. In contrast, in many cases large reductions in budget deficits are needed to meet the fiscal criteria. However, an analysis of how difficult it will be to meet these criteria is not sufficient to identify the countries most likely to join EMU as other factors also play a role.

This paper develops a simple model of the decision to join EMU identifying these factor. In the model EMU provides governments with a precommitment mechanism that eliminates the inflationary bias to monetary policy. However, despite this benefit, countries may be unwilling to adopt the more restrictive monetary and fiscal policies necessary to qualify for EMU. Another cost to participating in the Exchange Rate Mechanism (ERM) prior to EMU is that monetary policy cannot be used to stabilize output shocks.

The model shows that countries are less likely to join EMU when the required deficit reduction is relatively large; when inflationary

1. The author is an Economist in the Division of International Finance, at the Board of Governors of the Federal Reserve System. Jay Bryson and Karen Johnson provided helpful comments. This paper represents the views of the author and should not be interpreted as reflecting those of the Board of Governors of the Federal Reserve System or its staff.

expectations are more persistent; when the variance of output shocks is high; and when political cost to not joining is low. They are more likely to join if the inflationary bias to monetary policy is relatively large. Moreover, governments follow a policy rule where the decision to join EMU depends on the realizations of output shocks. A large enough negative output shock (and the accompanying recession) could cause policy to be shifted from the restrictive stance necessary meet the convergence criteria to stabilizing the shock. In general, negative shocks increase concern about a policy shift causing interest rates to rise. This suggests that the interest rates rises observed during ERM crises could reflect output shocks rather than instability in the ERM.

Data on the above factors are generally not available, except for budgetary data, making evaluation of who is more likely to join EMU more difficult. However, the model and open interest rate parity show that data on long-term interest rate differentials with Germany can serve as a measure of the influence of these factors. To establish that this measure will be useful in practice it is necessary to show that it reflect more than just near-term developments. First, this measure can be decomposed into a one-year differential and an implied forward interest rate differential from one to ten years in the future. The latter, which reflects the influence of factors beyond the 1-year horizon (such as concern that budget deficit targets might not be met in 1999), is much more highly correlated with this measure. A second, more formal, test applies the econometric method used in several recent studies of the influence of macroeconomic fundamentals on ERM interest rate differentials. It finds that variables representing short-term developments affect 1-year but not long-term interest rate differentials.

The next section reviews the Maastricht convergence criteria and shows that it will be costly for many countries to meet the budget deficit criteria. The model in Section III shows how other factors influence the decision to join EMU. Section IV considers the extent to which data on interest rate differentials can be used establish how likely a country is to join EMU. Section V shows that use of data on long-term interest differentials and budget deficits together permits a clearer assessment of who is likely to join EMU than is possible using budgetary data alone. The reason is that budget deficits are large in almost all countries. The analysis suggests that EMU will occur in stages. In Denmark, France, Ireland and the Netherlands factors other than budget deficits are relatively favorable for EMU. In contrast, in Italy and Spain EMU appears relatively unlikely.

II. Implications of The EMU Convergence Criteria for Policy

The Maastricht treaty sets four convergence criteria:

- 1) general government budget deficits cannot exceed 3 percent of GDP;
- 2) gross government debt cannot exceed 60 percent of GDP;
- 3) inflation rates must be no more than 1-1/2 percentage points above the average for the three countries with the lowest inflation rates;
- 4) interest rates must be no more than 2 percentage points above the average for the three countries with the lowest interest rates.

In addition, the treaty states that there can be no realignments in the two years prior to EMU. EMU can occur as early as January 1997 if a minimum number of seven countries meet the convergence criteria. If this condition is not satisfied, as is widely expected, it must occur no later than January 1999 and includes only those countries meeting the criteria

at that time². In practice, the treaty allows for some flexibility in the application of the convergence criteria.

Before analyzing how these convergence criteria are likely to influence policy it is useful to briefly consider why they are thought necessary. The fiscal criteria are intended to limit the increase in spillovers from excessive budget deficits in one country that under EMU could increase interest rates for other countries. EMU could increase these spillovers by exacerbating political market failures that cause countries to run excessive budget deficits³. Market mechanisms that help to limit increases in budget deficits by raising the cost of debt issuance might not be as effective under EMU for two reasons: first, since countries can no longer use inflation to reduce the real value of debt there would be no country-specific inflation risk premium. Second, any tendency for the default risk premium to rise is likely to be limited by the perception that the systemic risk to the financial system would make a bail-out necessary in the event of default. Such a bail-out would raise inflation rates or tax burdens throughout the monetary union depending on how it is financed.

2. Under the treaty, ERM countries that qualify for EMU are obligated to participate with the exception of the United Kingdom and Denmark. (Of course, countries have the option of choosing policies that make them ineligible for EMU.) These two countries obtained protocols to the treaty allowing them to put the decision to join EMU to their legislatures. Delay of EMU beyond 1999 could involve an abrogation of the treaty at considerable political cost.

3. Corsetti and Roubini (1993) show that these market failures can result when political parties that alternate in government maximize the welfare of their own constituencies rather than the whole population. Using econometric analysis they find that budget deficits in European countries can be explained by political variables suggesting that market failures exist. In some cases, political parties' concerns about their reputation (which influences the outcome of future elections) can mitigate the tendency to run excessive budget deficits (Rogoff and Sibert (1989)). However, if these reputational effects are not strong enough there is a case for fiscal rules (Buiter, Corsetti and Roubini (1993)).

In contrast to the concern about negative externalities that underlie the two fiscal criteria, the purpose of the inflation and interest rate criteria is to insure the nominal convergence necessary for a smooth transition to EMU. Interest rate differentials should narrow as other criteria are met⁴. Failure to narrow sufficiently to meet the criteria would indicate the persistence of a large risk premium reflecting, in part, continued differences in inflationary expectations.

Charts 1 and 2 illustrate the extent to which countries have or are projected to meet these criteria in 1993 and 1994. Most countries already meet or are close to meeting the inflation and interest rate convergence criteria, as the ERM and recession have contributed to nominal convergence. In contrast, no countries simultaneously meet the government debt or budget deficit criteria⁵.

The magnitude of the shift in budget balances needed to lower debt/GDP ratios to 60 percent is too large to be politically feasible in many highly indebted countries. To show this the government budget constraint, equation 1, can be used to calculate the annual average budget surpluses required to reach the 60 percent limit⁶ by 1999.

4. De Grauwe (1994) argues that the interest rate (and inflation) convergence may be limited by the persistent risk of devaluation. This risk results, in part, from the unstable nature of the ERM which encourages speculative attacks. The widening of the ERM bands in August 1993 was intended to reduce this risk and may have done so.

5. Luxembourg is an exception. However, since it uses the Belgian currency its decision to join EMU will depend on Belgium's decision.

6. This identity shows that the debt/GDP ratio can be reduced either by budget surpluses or as a result of nominal GDP growth (the term in square brackets). Since nominal GDP growth is likely to be limited by low inflation governments will have to rely on budget surpluses to reach the target debt/GDP ratio. The calculation presented in Table 1 assumes nominal GDP growth of 5 percent.

$$1) \quad b_t = [(1+g_t)(1+\pi_t)]^{-1} b_{t-1} + d_t$$

b -- government debt/GDP ratio
d -- government budget deficit/GDP ratio
g -- growth rate of real GDP
 π -- inflation rate

These budget surpluses, reported in Table 1, are very large for Belgium, Ireland and Italy. For Denmark, and the Netherlands, they are probably feasible but would nevertheless require a very large shift in the budget balances from deficit to surplus.

In cases where the 60 percent debt target is not attainable the Maastricht treaty provides a second, less restrictive, debt criteria: that the debt/GDP ratio be stable or declining. In practice, it is this modified debt criteria that is likely to be the relevant one. It is equivalent to setting a minimum threshold for the primary budget surplus. Table 1 reports the threshold primary surpluses that stabilize debt/GDP ratios in 1994. They are calculated by substituting the definition of the primary surplus, Equation 2, into Equation 1.

$$2) \quad s_t = -(d_t - i_t b_{t-1})$$

i -- interest rate on government debt
s -- primary surplus

The deficit/GDP ratios necessary to stabilize debt/GDP ratios can be calculated by adding government interest payments to the threshold primary surpluses. They represent an alternative target to the 60 percent debt criteria. A surprising feature of this alternative target, shown in Table 1 for 1994, is that it is redundant for several countries. For Belgium, Italy, Ireland and Spain the deficit/GDP ratios that stabilize debt/GDP ratios exceed the 3 percent budget deficit criteria.

Only in Denmark and the Netherlands will budget deficits have to be reduced below the 3 percent limit to stabilize debt/GDP ratios.

The above analysis suggests that the primary effect of the convergence criteria will be to make fiscal policy more restrictive. For most EU countries the deficit reduction required to meet the 3 percent budget deficit criteria, although large, is feasible when spread out over four years. Most highly indebted countries will not be able to meet the 60 percent debt criteria. However, they will satisfy the alternative debt criteria if they meet 3 percent deficit criteria. The exception is Denmark and the Netherlands which must reduce their budget deficits below 3 percent of GDP to satisfy this alternative criteria. Finally, the treaty allows some flexibility in the application of the fiscal criteria. Thus, countries with budget deficits that exceed 3 percent by a not too large margin would be allowed to join EMU.

III. The Decision to Join EMU

The model presented below identifies factors in addition to the required deficit reduction that influence the decision to join EMU. It takes into account two sources of uncertainty relevant to any evaluation of who is likely to join EMU. This uncertainty results, first, from the fact that the decision to join EMU depends on future realizations of output shocks; and, second, because the governments' actual political commitment to join EMU is unknown.

The benefit of EMU in the model is that it provides a means to credibly commit to low inflation through the creation of a European Central Bank (ECB). Without EMU the problem of time inconsistency imparts an inflationary bias to monetary policy. Countries with

relatively large inflationary biases need to allow their currencies to depreciate to maintain competitiveness making a floating or adjustable-peg exchange rate regime necessary.

Countries participate in the ERM because the treaty requires it for the two year prior to EMU and because it facilitates inflation convergence⁷. Although both EMU and the ERM are fixed exchange rate regimes there is an important difference: monetary union is irreversible and, hence, fully credible. In contrast, in the ERM the exchange rate peg cannot be fully credible as there is always the option of switching to a more inflationary monetary policy and devaluing. This contributes to persistence of inflationary expectations that tends to depress output and, consequently, raise the cost of EMU.

The simple model of the decision to join EMU presented below is a one-good, two-country, Mundell-Fleming model. It incorporates two alternative exchange rate regimes. In the ERM one country pegs its currency to that of the other country--the anchor country. For convenience, is it assumed that the anchor country can precommit to zero inflation. There is full inflation convergence in the model due to the one-good assumption⁸. However, even though actual inflation is zero inflationary expectations remain positive due to the risk of a switch to

7. Although the ERM was originally conceived of as an adjustable-peg regime with narrow fluctuation bands it has evolved into a vehicle for achieving the nominal convergence necessary for EMU. This new role is inconsistent with periodic realignments which prevent nominal convergence and increase the cost of joining EMU by revealing a relatively weak commitment to EMU. Moreover, countries typically attempt to hold their exchange rate within a band that is much narrower than the official one (this was true before bands were widened in August 1993).

8. The one-good assumption precludes using the model to analyze inflation convergence. However, as noted above, this convergence has largely been achieved, making this assumption more acceptable. Moreover, the realignments since September 1992 have largely corrected the real exchange rate misalignments that had built up (De Grauwe (1994)).

a more inflationary exchange rate regime. Another convent assumption is that the ECB has the same preferences and ability to precommit as the Bundesbank⁹. As a result, inflation is zero in the ERM and under EMU. The second regime is a flexible exchange rate regime in which the inflationary bias to monetary policy determines the inflation rate. The quantity equation is used to represent the monetary sector so that the rate of money supply growth equals the inflation rate. The one-good assumption implies that the rate of exchange rate depreciation equals the inflation differential between countries.

Government macroeconomic policy objectives are represented using a quadratic loss function, equation 3, in which government welfare "W" is reduced by inflation " π " and any deviation of (the log of) output "y" from its target level " y^T ". Moreover, governments are also concerned about present and discounted expected future welfare, as shown in equation 4 where " δ " is the discount rate and "E" the expectations operator.

$$3) \quad W_t = \pi_t^2 + (y_t - y^T)^2 + c,$$

$$4) \quad L = E_t \left\{ \sum_{t=0}^{\infty} \delta^t W_t \right\}$$

The parameter "c" represents the one-time political cost to withdrawing from the ERM. Since "c" cannot be observed there is uncertainty about how committed the government is to EMU. This cost is one reason why countries do not choose to drop out of the ERM and rejoin

9. This assumption, although made to simplify the model, is not unreasonable since the ECB is closely modeled on the Bundesbank.

later. (Another reason, discussed below, is the cost of joining EMU is higher when the commitment to EMU is perceived to be weak.)

Output is derived by assuming that firms maximize profits using the production function (where "n" is the log of employment) in equation 5, which implies that the real wage ("w-p" in logs) equals the marginal product of labor, equation 6.

$$5) \quad y = (1-\omega)n$$

$$6) \quad w - p = -(1/\beta)y, \quad \beta = \omega/(1-\omega)$$

Agents choose a nominal wage " \bar{w} ", so as to set output at its full employment level " \bar{y} "¹⁰. Nominal wage rigidity is introduced by assuming that wages are set before the price level is observed¹¹. This means that agents must use the expected price level " E_p " when choosing the nominal wage, as shown in equation 7. Actual output "y" differs from full employment " \bar{y} ", when actual inflation " π " differs from its expected level " π^e ", as shown in Equation 8 (obtained by subtracting equation 7 from equation 6).

10. For example, by minimizing the squared deviation of employment from its full employment level as in Canzoneri and Henderson (1991).

11. The wage rigidity that generates the output decline in this model is forward-looking. The model does not incorporate the backward-looking wage rigidity found in most macroeconometric models used to calculate the output cost of EMU. The cost associated with this wage rigidity could easily be added to the model. Buiter, Roubini and Cosetti (1993) review results of simulations of EMU from a number of different macroeconometric models and find the adjustment cost to be significant in all cases. Johnson (1994) reports simulations results from the Federal Reserve Board's Multi-Country Model showing that the cumulative reduction in output over six years exceeds 3 percent of GDP in Italy, 1 percent of GDP in France, and 3/4 of a percent in the United Kingdom. The impact on Germany and the United States is negligible.

$$7) \quad \bar{w} - E_p = -(1/\beta)\bar{y}$$

$$8) \quad y - \bar{y} = \beta(\bar{p} - E_p) = \beta(\pi - \pi^e)$$

In equilibrium ex-ante aggregate supply and demand are equal at the full employment output level. However, output can deviate from full employment for two reasons: first, due to an exogenous country-specific shock to aggregate demand represented by the error term " ϵ " (assumed to be "i.i.d.") in equation 9; second, due to uncertainty about the exchange rate regime. As a result of this uncertainty inflation and the stance of fiscal policy can differ from their expected levels, as shown in the first two right hand side terms of Equation 9.

$$9) \quad y - \bar{y} = \beta(\pi - \pi^e) - (x - x^e) + \epsilon, \quad E(\epsilon) = 0, \quad \text{Var}(\epsilon) = \sigma$$

The fiscal contraction " x " equals the difference between the current budget deficit and the 3 percent Maastricht target. It is expected to occur with probability " α "--the probability that the country will join EMU--as shown in Equation 10. If this contraction is actually implemented fiscal policy will be more contractionary than expected. If the country decides not to join EMU, expected with probability " $1-\alpha$ ", the partially anticipated fiscal contraction does not occur.

$$10) \quad x^e = \begin{cases} 0 & \text{with probability } 1-\alpha \\ x & \text{with probability } \alpha \end{cases}$$

Inflationary expectations, shown in equation 11, also reflect the choice of exchange rate regime. The inflation rate if EMU occurs,

expected with probability " α ", is zero due to the assumptions made above¹². In the event of withdrawal from the ERM, expected with probability of " $1-\alpha$ ", agents expect inflation to be " $\tilde{\pi}^e$ ". This specification implies that inflationary expectations will persist even though actual inflation is zero.

$$11) \quad \pi^e = \begin{cases} \tilde{\pi}^e & \text{with probability } 1-\alpha \\ 0 & \text{with probability } \alpha \end{cases}$$

The expected and actual rates of inflation that result when a country withdraws from the ERM and cannot precommit to low (or zero) inflation are shown in Equations 12 and 13. In this exchange rate regime actual inflation differs from its expected level because monetary policy is used to partially offset the impact of the exogenous shock " ϵ ".

$$12) \quad \tilde{\pi}^e = \beta(y^T - \bar{y}) = \beta K, \quad K = (y^T - \bar{y})$$

$$13) \quad \tilde{\pi} = \beta K - \theta \epsilon, \quad \theta = \beta / (1 + \beta^2) < 1.$$

In this solution¹³ the inflation rate is proportional to the difference between the governments target level of output and the lower full-employment level " $(y^T - \bar{y}) = K$ ". This difference is the source of the inflationary bias because it provides governments with an incentive

12. Allowing for positive inflation in the ERM and under EMU would not change any of the results of the model.

13. This solution is obtained by maximizing equation 2 subject to equation 8 with " $x=0$ ". It was originally derived by Barro and Gordon (1983). It differs from the precommitment solution where inflation is zero but output is more variable because monetary policy cannot be used to offset the impact of the shock.

to raise output using a surprise inflation. This inflation is built into inflationary expectations contributing to an equilibrium inflation rate, " $\tilde{\pi}$ ", where the marginal gain in output is exactly offset by the marginal cost of the higher inflation.

Output in countries remaining in the ERM is reduced because actual inflation (at zero) is below expected inflation and the fiscal contraction is larger than expected. That is " $y^E - \bar{y} < 0$ ", as shown in equation 14. In contrast, when there is a switch to the floating regime output increases, as shown in equation 15, due to the positive inflationary surprise. Also, fiscal policy is more expansionary than expected because the partially anticipated fiscal contraction does not occur.

$$14) \quad y^E - \bar{y} = -(1-\alpha)(\beta\tilde{\pi}^e + x) + \epsilon, \quad (\text{EMU occurs})$$

$$15) \quad y^N - \bar{y} = \alpha(\beta\tilde{\pi}^e + x) + (1-\theta)\epsilon, \quad (\text{No EMU occurs})$$

Another important cost to remaining in the ERM, highlighted by a comparison of the error terms in equations 14 and 15, is the loss of the ability to stabilize output shocks. Output shocks have a larger impact in the ERM regime (" $\epsilon > (1-\theta)\epsilon$ ") because monetary policy targets the exchange rate and cannot be used to offset this impact.

The governments decision to join EMU involves comparing costs and benefits across time periods and exchange rate regimes. This complex problem can be simplified by invoking several assumption: first, the infinite decision horizon of governments in equation 4 can be divided into two distinct periods reflected in equation 16: the transition to

EMU, the first term (period "0"); and after EMU occurs when all periods are essentially the same, the second term (period "1"). Finally, note that the expectations operator is applied only to the second term because the decision to withdraw from the ERM is made after the exogenous output shock " ϵ " is observed. This assumption implies that uncertainty as to who will join EMU results because the political cost to withdrawing from the ERM, " c ", is unknown.

$$16) \quad L = \{\pi_0^2 + (Y_0 - Y^T)^2\} + \frac{\delta}{1+\delta} E_1 \{\pi_1^2 + (Y_1 - Y^T)^2\} + c, \quad \text{note } \sum_{j=1}^{\infty} \delta^j = \frac{\delta}{1+\delta}$$

To analyze the decision to join EMU it is necessary to compare government welfare when a country remains in the ERM and joins EMU (" L^E "), equation 17; and when it shifts to a floating exchange rate regimes (" L^N "), equation 18¹⁴. Note that it has been possible to drop time subscripts due to the assumptions, made above, that inflation is zero in the ERM and under EMU or, in the case of withdrawal from the ERM, determined by a constant inflationary bias " βK ".

$$17) \quad L^E = \{-(1-\alpha)(\beta^2 K+x) + \epsilon - K\}^2 + \frac{\delta}{1+\delta} (K^2 + \sigma)$$

$$18) \quad L^N = \{\alpha(\beta^2 K+x) + (1-\theta)\epsilon - K\}^2 + \{\beta K - \theta\epsilon\}^2 + \frac{\delta}{1+\delta} (1+\beta^2) (K^2 + \theta^2 \sigma) + c$$

The costs and benefits of joining EMU are reflected in equations 17 and 18. ERM membership raises the welfare loss because the temporary decline in output increases the first term in equation 17. Note that

14. Equation 17 was obtained by substituting equation 14 into equation 16 and setting " $\pi=0$ ". Equation 18 was obtained by substituting equations 12, 13, and 15, into equation 16.

this cost is larger if inflationary expectations are relatively persistent (which is the case when "1- α " is relatively high). In contrast, withdrawal from the ERM has a positive output effect that decreases welfare loss. This is reflected in a reduction in the first term of equation 18 as output is raised closer to the government's target level. However, this welfare gain is offset by the inflationary bias " βK " and the one-time political cost " c " associated with withdrawing from the ERM reflected in the last three terms of equation 18.

Comparison of Equations 17 and 18 indicate that country-specific output shocks have a larger impact in the ERM because in the ERM stabilization is not possible. This implies that government will follow a partially state-contingent policy rule where they withdraw from the ERM in the event of a sufficiently large output shock. The reason is that as the size of the shock increases the welfare loss in the ERM rises relative to that in the flexible exchange rate regime¹⁵. Thus, for a shock of sufficiently large size the reduction in the welfare loss from using monetary policy for stabilization exceed the benefits from joining EMU, and the country will withdraw from the ERM¹⁶. An implication of this policy rule is that negative output shocks can result in sharp rises in interest rates. These shocks raise the perceived probability that a country will not join EMU increasing the risk premium in interest rate,

15. This is the case because " $\partial^2 L^E / (\partial \epsilon)^2 = 1 > \partial^2 L^N / (\partial \epsilon)^2 = (1-\theta)^2$ ".

16. Model with partially state-contingent policy rules was first analyzed by Isard and Flood (1989). They show that for models of the type developed in this paper this rule can be optimal relative to a regime in which the exchange rate peg is perfectly credible. More recently, Giovannini (1990) and Chen and Giovannini (1993) have used models with this rule to analyze the ERM.

as shown below¹⁷.

A definitive answer to the question of who will join EMU is not possible due to uncertainty about the political cost of withdrawing from the ERM "c". Instead, it may be possible to identify the countries more likely to join EMU. For these countries there is a relatively high probability " ρ ", that the welfare cost of switching to the flexible exchange rate regime " L^N " exceeds that of remaining in the ERM " L^E ", as shown in equation 19.

$$19) \quad \rho = \text{prob}[L^N - L^E \geq 0]$$

$$\text{where} \quad L^N - L^E = -\mu\sigma + \Omega + \theta\alpha + c$$

$$\mu = 2(1-\theta)\theta + \frac{\delta}{1+\delta}(1-\theta^2)$$

$$\Omega = -(\beta^2 K+x)^2 + 2\{\epsilon-K\}(\beta^2 K+x) + \left(\frac{\delta}{1+\delta}+1\right)(\beta K)^2 + 2\beta K\theta\epsilon$$

$$\Phi = 2(1-\theta\epsilon)(\beta^2 K+x)$$

Given that the uncertainty in the model is with respect to "c", the political cost of withdrawing from the ERM, it is possible to rewrite this probability as the probability that "c" exceeds " $\mu\sigma - \Omega - \Phi\alpha$ ", as shown in equation 20.

17. This represent another explanation for the recent crises in the ERM to that advanced in the literature. Portes (1993) and De Grauwe (1994) argue that the crises occurred because the ERM is an inherently unstable system. They argue that the combination of unrestricted capital mobility and imperfectly credible exchange rate bands invite speculative attacks.

$$20) \quad \rho = \text{prob}[c > \mu\sigma - \Omega - \Phi\alpha] = 1 - \text{prob}[c \leq \mu\sigma - \Omega - \Phi\alpha]$$

The probability that a country will join EMU is endogenously determined in the model. The reason is that agents' inflationary expectations, which influences the cost of joining EMU, incorporate an estimate of the probability that a country will join EMU " α ". This estimate is correct on average due to the assumption of rational expectations, implying that the probabilities " ρ " and " α " are equal. Since " α " appears on the right-hand side of equations 19 and 20 it is necessary to solve for it which requires that a specific distribution for " c " be assumed. The uniform distribution, shown in equation 21, is simple enough to allow an analytic solution¹⁸. The uniform distribution implies that " c " falls with equal probability on any point within the range defined by an upper limit " c_u ", and a lower limit " c_l ". Equation 22 shows the solution for " α " using this distribution.

$$21) \quad \rho = \frac{\mu\sigma - \Omega - \Phi\alpha - c_l}{c_u - c_l}$$

$$22) \quad \alpha = \frac{-\mu\sigma + \Omega + c_u}{c_u - c_l - \Phi'} \quad \text{where } \alpha = \rho$$

The influence of different factors on how likely a country is to join EMU, represented by the probability " α ", can be analyzed using equation 22. First, a negative output shock (" $\epsilon < 0$ ") reduces the probability that a country will join EMU, as shown in equation 23. This shock (which could induce a recession) increases the incentive to

18. A similar derivation can be found in the Klein and Marion (1992).

withdraw from the ERM to stabilize output. This result, that output shocks and the probability " α " are positively correlated, has implications for interest rate behavior that are developed below.

$$23) \quad \frac{\partial \alpha}{\partial \epsilon} = \frac{2}{c_u - c_l - \Phi} [(1 - \alpha \theta) (\beta^2 K + x) + \beta K \theta] > 0$$

Second, the probability that a country will join EMU declines as the variance of the output shock rises, as shown in equation 24. The reason is that the more variable is output the greater are the gains from being able to use monetary policy to stabilize output.

$$24) \quad \frac{\partial \alpha}{\partial \sigma} = - \frac{\mu}{c_u - c_l - \Phi} < 0$$

Another implication of the model is that the larger the required deficit reduction the lower the probability that a country will join EMU. The reason is that the fiscal contraction tends to depress output in the ERM thereby increasing the welfare loss (that is " $\partial L^E / \partial x > 0$ "). In contrast, in the event of withdrawal from the ERM fiscal policy is more expansionary than expected. This reduces welfare loss in the floating exchange rate regime by raising output closer to the governments target level (" $\partial L^N / \partial x < 0$ "). Both these effects lower the probability of EMU¹⁹, by increasing the benefits of withdrawing from the ERM, as shown in equation 25.

19. The exception is when there is a very large positive output shock " ϵ " which raises output above the governments target level. In this case, a restrictive fiscal policy reduces the welfare loss by reducing output towards this target level.

$$25) \quad \frac{\partial \alpha}{\partial x} = \frac{2}{c_u - c_l - \Phi} [- (\beta^2 K + x) - K + \alpha + (1 - \theta \epsilon) \alpha]$$

$$= \frac{2}{c_u - c_l - \Phi} \left[\frac{\partial L^N}{\partial x} - \frac{\partial L^E}{\partial x} \right] < 0$$

Finally, it is possible to show that if a country is perceived to be more committed to EMU, represented by a high " c_u ", the probability that it will join EMU " α " will be higher²⁰, as shown in equation 26.

$$26) \quad \frac{\partial \alpha}{\partial c_u} = \frac{1 - \alpha}{c_u - c_l - \Phi} > 0$$

The significance of this result is that the costs incurred during the transition to EMU will be less for countries with "high credibility". The reason is that the persistence of inflationary expectations is lower and fiscal policy is less contractionary as " $1 - \alpha$ " is relatively low²¹.

The model shows that countries are less likely to join EMU when the required deficit reduction is relatively large, when inflationary expectations are more persistent (which is the case when " α " is low), when the variance of output shocks is high, and when the political cost to not joining is low.

20. This result also holds for " c_l " and the mean of " c ".

21. This implies that countries have an incentive to avoid realignments as they increase the cost of joining EMU. A realignment has the effect of revealing " c_u " to be lower than previously thought.

IV. Interest Differentials as a Measure of the Probability of Joining EMU

Data on the above factors are generally not available, except for budgetary data, making it difficult to evaluate who is likely to join EMU. However, open interest rate parity suggests that long-term interest differentials with Germany can serve as a measure of the combined influence of these factors.

Under open interest rate parity, shown in Equation 27, the differential between the interest rate on an "n" period bond in country "j" and in Germany (the ERM anchor country) in period "t" reflects the expected depreciation against the DM between the current period and when the bond matures in period "t+n". A risk premium " ψ " reflects the divergences from open interest parity that are often observed²².

$$27) \quad i_{nt}^j - i_{nt}^G = \frac{1}{n} E_t (e_{t+n}^{jG} - e_t^{jG}) + \psi_t$$

- e_{t+n}^{jG} -- exchange rate between country "j" and Germany in period "n"
- i_{nt}^j -- interest rate on an "n" period bond in country "j"
- ψ_t -- risk premium

In the model presented above exchange rate behavior depended on the exchange rate regime. Specifically, the exchange rate is expected to remain fixed in the ERM with probability " α ", or depreciate at a rate " βK " in the event of a switch to the floating exchange rate regime which is expected with probability " $1-\alpha$ ". These alternative probability weighted paths for the exchange rate can be substituted into the open

22. The unrestricted capital mobility in Europe suggests that open interest rate parity is more likely to hold in Europe than elsewhere.

interest rate parity condition to obtain the implications of the model for interest rate differentials, as shown in equation 28.

$$28) \quad i_{nt}^j - i_{nt}^G = \frac{1}{n}(1-\alpha)\beta K + \psi_t$$

According to the model, interest rate differentials reflect future expected inflation (the inflationary bias " βK ") and the probability of withdrawal from the ERM " $1-\alpha$ ". The model implies that information on interest rate differentials can be used to construct a measure of the probability of EMU, as shown in equation 29.

$$29) \quad \alpha = 1 - n \left\{ \frac{i_{nt}^j - i_{nt}^G}{\beta K} \right\} + n \left\{ \frac{\psi_t}{\beta K} \right\}$$

In practice, the usefulness of long-term interest differentials as a measure of the probability of EMU may be limited because neither the size of the inflationary bias " βK " or the risk premium " ψ " are known. However, to the extent that these two factors are similar across countries interest differentials should serve as an indicator of who is more likely to join EMU.

Another potentially more serious problem is that long-term differentials may largely reflect near-term developments and contain little information on the influence of long-term factors on EMU. This possibility arises because, as the model shows, near-term output shocks raise " α " and, consequently, the long-term differential. This problem is more likely to arise if these shocks are large and frequent and have a large impact on long-term differentials (that is " $\partial\alpha/\partial\epsilon$ " is large).

Evidence that this problem may exist is provided in Chart 3. It shows that one-year interest rate differentials, which largely reflect short-term influences, and 10-year differentials have been correlated in ERM countries in recent years. This suggests that before using long-term interest differentials it is necessary to establish empirically that they do not primarily reflect short-term developments.

One method for determining the importance of near term output shocks is to decompose the ten-year interest rate differential into a one-year differential and an implied forward differential between one-year and ten years in the future. The implied forward differentials should exclude the near-term (1-year) impact of transitory output shocks on the probability of a country joining EMU. Thus, they should reflect the influence of other factors relevant to the decision to join EMU that have their influence mostly beyond the one-year horizon, such as concern that budget targets will not be met.

The implied forward interest rate differential is constructed using yield curve and open interest parity relationships, shown in equation 30. It is conceptually equivalent to the interest rate differential on a 9-year bonds one year from now. In practice, it could be distorted by the term premium in the yield curve, the exchange risk premium, and the differences in risk and tax characteristics between 1-year euromarket bonds and 10-year government bonds.

$$30) \quad f_{9t}^{j,t+1} = \left[\left(\frac{(1+i_{10t}^j)}{(1+i_{10t}^G)} \right)^{10} \left\{ \frac{(1+i_{1t}^G)}{(1+i_{1t}^j)} \right\} \right]^{-10} - 1$$

$f_{9t}^{j,t+1}$ -- implied 9-year forward interest rate differential in one year ("t+1") between country "j" and Germany
 i_{1t}^j -- 1-year interest rate in country "j"

i_{10t}^j -- 10-year interest rate in country "j"

Although implied forward and 10-year interest differentials, plotted in Charts 2-5, are highly correlated there are important differences between countries. In the Netherlands the two differentials are essentially the same suggesting no influence from short-term factors. However, in other countries there are significant divergences-- especially during periods of ERM crisis when output shocks may have been important. In France, the two differentials are usually equal and only diverged around the September 1992 ERM crisis (but not the more recent August 1993 crisis). In Italy and Spain divergences are much larger. Overall, these high correlation suggests that 10-year differentials do provide information on the influence of long-term factors on EMU--except during episodes of crisis.

It is also possible to test using econometric analysis whether 10-year differentials are influenced by output shocks. The test examines whether the variables representing output shocks that were found to influence one-year differentials also influence long-term interest rate differentials. Several recent papers by Rose and Svensson (1994), Thomas (1994), and Chen and Giovannini (1992, 1993) test the extent to which interest rate differentials are influenced by macroeconomic fundamentals. This paper first attempts to reproduce their basic finding--that short-term interest differentials are influenced by macroeconomic variables likely to be correlated with output shocks²³. However, it looks for this relationship over the more recent period from 1987 to 1994 when the ERM

23. Rose and Svensson (1994) do not find much influence.

came to be viewed as the vehicle for achieving EMU²⁴. Then, after confirming that there is a relationship, it tests whether a similar relationship exists for long-term interest differentials.

The test involves regressing the same set of macroeconomic variables, shown in equation 31, on 1-year, 10-year and implied forward interest rate differentials for Belgium, Denmark, France, the Netherlands, Italy, Spain, and the United Kingdom. The variables for each country are relative to the equivalent German variables except for the monthly central government cash budget balance which serves as a imperfect proxy for fiscal policy. In all cases a single lagged dependent variable was sufficient to eliminate serial correlation. In most cases variables were integrated of the same order.

$$31) \quad \left\{ \begin{array}{l} \text{interest rate} \\ \text{differential} \end{array} \right\}_t = \lambda_1 \{ \text{inflation} \}_t + \lambda_2 \left\{ \begin{array}{l} \text{industrial} \\ \text{production} \end{array} \right\}_t + \lambda_3 \left\{ \begin{array}{l} \text{money} \\ \text{supply} \end{array} \right\}_t \\ + \lambda_4 \{ \text{unemployment} \}_t + \lambda_5 \left\{ \begin{array}{l} \text{budget} \\ \text{deficit} \end{array} \right\}_t$$

An F-test is used to test whether there was a statistically significant cumulative impact of each variable on interest rate differentials. Three lags were used for each regressor except when an F-test supported the addition of more lags. Only the cumulative significance levels are reported as this is the statistical information

24. It was not practical to use the standard measure of realignment risk developed by Svensson (1992). The measure cannot be used after July 1993 due to the widening of the ERM bands. This means that the most recent date for which this measure would be available is July 1992 because for 1-year interest rates the measure is constructed using observations from one year ahead. Moreover, most studies show that this measure and actual interest rate differentials are very close, especially at maturities longer than a few months.

necessary to establish whether a relationship exists. Point estimates and t-statistics are not reported as there are a very large number of them and because they are reduced-form estimates and therefore difficult to interpret²⁵.

Tables 2, 3 and 4 report the results of regressions for the 1-year, 10-year and the implied forward interest rate differentials, respectively. Table 2 shows that macroeconomic variables have a significant impact on 1-year interest rate differential in all countries except the Netherlands. In contrast, Table 3 shows that there is no relationship between these variables and 10-year differentials except for unemployment in France and the budget deficit in Belgium. Table 4 shows that these same variables have no impact on the implied forward interest rate differentials in any country.

The empirical analysis in this section indicates that 10-year (and implied forward) interest rate differentials do not primarily reflect the influence of short-term factors. This suggests that they can serve as a measure of the influence of long run factors on how likely a country is to join EMU. Of course, it is impossible to establish in practice how good a measure long-term interest rate differentials are since EMU is a future event and market expectations are unobservable.

V. Conclusion

The model presented above identified a number of factors influencing how likely a country is to join EMU. They include: the size of the deficit reduction required to qualify for EMU; the persistence of inflationary expectations (represented by " $1-\alpha$ "); the variance of output

25. For more detailed estimation results over a longer sample see Chen and Giovannini (1993) and Thomas (1994). These authors also were able to use the Svensson (1992) measure of realignment risk.

shocks; the inflationary bias to monetary policy; and, the political cost to not joining EMU. It also showed that the decision to join EMU depends on the realizations of output shocks.

With the exception of budget deficits these factors are not observable making an assessment of who is most likely to join EMU difficult. However, the paper shows that long-term interest rate differentials can serve as a summary measure capturing the combined influence of these factors. Chart 8 provides, for 1993 and 1994, a cross-plot for each ERM country of the two factors relevant to the decision to join EMU for which data is available--long-term interest differentials and budget deficits²⁶ (also shown is the 3 percent target). Used together, these data make it possible to distinguish more clearly between countries than when using budgetary data alone. The chart shows the positive correlation between 10-year interest differentials and budget deficits predicted by the model. Long-term interest differentials in Denmark, France, and the Netherlands are small despite budget deficits/GDP ratios well above the 3 percent limit. This suggests that factors other than budget deficits are relatively favorable to EMU for these countries. In contrast, in Italy and Spain the combination of large budget deficits and wide interest rate differentials suggest that participation in EMU is relatively unlikely. Belgium and the United Kingdom form an intermediate group. Overall, the results in this paper suggest that EMU is likely to occur in stages.

26. The 1994 chart uses average interest rate for the first half of 1994 and OECD budget deficit estimates from the June 1994 Economic Outlook.

TABLE 1

Fiscal Convergence in EU Countries in 1994
(in percent, or as a percent of GDP)

<u>Country</u>	<u>Debt/GDP</u> *	<u>Deficit/</u> <u>GDP Ratio</u>	<u>Required</u> ¹ <u>Annual</u> <u>Budget</u> <u>Surplus</u>	<u>Target</u> ² <u>Primary</u> <u>Surplus</u>	<u>Target</u> ² <u>Budget</u> <u>Deficit</u>
Belgium	139.1	5.8	14.6	4.2	5.1
Denmark	83.0	4.3	2.2	1.5	1.3
Germany	54.1	2.9	--	1.0	2.8
France	48.8	5.9	--	0.9	2.4
Ireland	96.2	2.5	5.1	--	--
Italy	122.5	9.7	11.0	6.1	4.0
Netherlands	83.3	3.9	2.3	2.6	2.1
Portugal	69.5	7.5	-0.7	--	--
Spain	61.0	7.1	--	2.1	3.1
United Kingdom	52.8	6.4	--	0.8	1.7
<u>Convergence</u> <u>Criteria</u>	60	3.0			

* The general government debt measure is that used by the European commission to determine whether the debt criteria is met. It differs from the OECD measure in that it excludes trade credits and liabilities that correspond to financial assets held elsewhere in the general government sector. The debt projection for 1994 was derived using the increase in government debt projected by the OECD. all other budgetary data is from the OECD.

1 Annual average Budget surplus required to reduce the debt/GDP ratio to 60 percent over a four year period assuming 5 percent nominal GDP growth.

2 Primary surplus and budget deficits required to hold the debt/GDP ratio constant at its 1994 level.

TABLE 2

**Test of the Effect of Macroeconomic Variables
on the One-Year Interest Rate Differential with Germany¹**

(Monthly Data: Sample Period January 1987 - end 1993 except when noted)

<u>Country</u>	<u>Con- stant</u>	<u>Con- sumer Prices</u>	<u>Money</u>	<u>Indus- trial Produc- tion</u>	<u>Unem- ploy- ment</u>	<u>Budget Deficit</u>	<u>Lagged Depen- dent Variable</u>	<u>R²</u>
Belgium	--	--	*	**	**	--	**	.97
Denmark		--	*	--	*	NA	**	.92
France								
3-lags	*	**	--	*	**	**	**	.98
12-lags		*	--	*	--	*	-- ²	.95
Netherlands								
from 87/1	--	--	--	--	NA	--	**	.83
from 88/4	*	--	--	--	--	--	**	.94
Italy	**	*	*	**	--	*	--	.97
Spain								
from 89/1	--	*	--	*	--	NA	**	.95
United Kingdom								
3-lags	**	**	--		**		**	.99
3-lags 90/1				--	*	--	--	.99

1 F-test of the hypothesis of no cumulative effect of variable on interest rate differential.

2 Significant at 10 percent level.

* indicates significance at 5 percent level

** indicates significance at 1 percent level

A standard auto-regressive distributed lag specification with three and 12 lags of the macro variables was adopted. A single lag of the dependent variable was sufficient to eliminate all autocorrelation from the residuals in all cases. Tests were also performed for normality and heteroscedasticity. All variables were found to be integrated of order 1 except when noted. Data is monthly and was obtained from the BIS. All variables except budget deficits are in the form of deviation from German levels. Seasonals were added to all equations.

TABLE 3

**Test of the Effect of Macroeconomic Variables
on the Ten-Year Interest Rate Differential with Germany¹**

(Monthly Data: Sample Period January 1987 - end 1993 except when noted)

<u>Country</u>	<u>Con- stant</u>	<u>Con- sumer Prices</u>	<u>Money</u>	<u>Indus- trial Produc- tion</u>	<u>Unem- ploy- ment</u>	<u>Budget Deficit</u>	<u>Lagged Depen- dent Variable</u>	<u>R²</u>
Belgium		--	--	--	--	*	**	.93
Denmark 1-year		--	--	--	--	NA	**	.97
France 3-lags		--	--	--	*	--	**	.98
Netherlands from 87/1		--	--	--	NA	--	**	.93
from 88/4		--	--	--	--	--	**	.96
Italy from 89/2		--	--	--	--	--	**	.93
Spain from 91/5		--	--	--	*	--	*	.99
United Kingdom		--	--	--	--	--	--	.98

1 F-test of the hypothesis of no cumulative effect of variable on interest rate differential

* indicates significance at 5 percent level

** indicates significance at 1 percent level

A standard auto-regressive distributed lag specification with three and 12 lags of the macro variables was adopted. A single lag of the dependent variable was sufficient to eliminate all autocorrelation from the residuals in all cases. Tests were also performed for normality and heteroscedasticity. All variable were found to be integrated of order 1 except when noted. Data is monthly and was obtained from the BIS. All variables except budget deficits are in the form of deviation from German levels. Seasonals were added to all equations.

TABLE 4

**Test of the Effect of Macroeconomic Variables
on the Implied Forward Interest Rate Differential with Germany¹**

(Monthly Data: Sample Period January 1987 - end 1993 except when noted)

<u>Country</u>	<u>Con- stant</u>	<u>Con- sumer Prices</u>	<u>Money</u>	<u>Indus- trial Produc- tion</u>	<u>Unem- ploy- ment</u>	<u>Budget Deficit</u>	<u>Lagged Deper- dent Variable</u>	<u>R²</u>
Belgium	--	--	--	--	--	--	**	
Denmark	--	--	--	--	--	NA	**	
France								
3-lags	--	--	--	--	--	--	**	.98
12-lags	--	--	--	--	--	--	*	.98
Netherlands								
from 87/1	--	--	--	--	NA	--	**	.96
from 88/4	--	--	--	--	--	--	**	.96
Italy								
from 89/2	*	--	--	--	--	--	**	.94
Spain								
from 91/5	--	--	--	--	--	NA	**	.87
United Kingdom								
3-lags	--	--	--	--	--	--	**	.97
3-lags 90/1	--	--	--	--	--	--	**	.93

1 F-test of the hypothesis of no cumulative effect of variable on interest rate differential

* indicates significance at 5 percent level

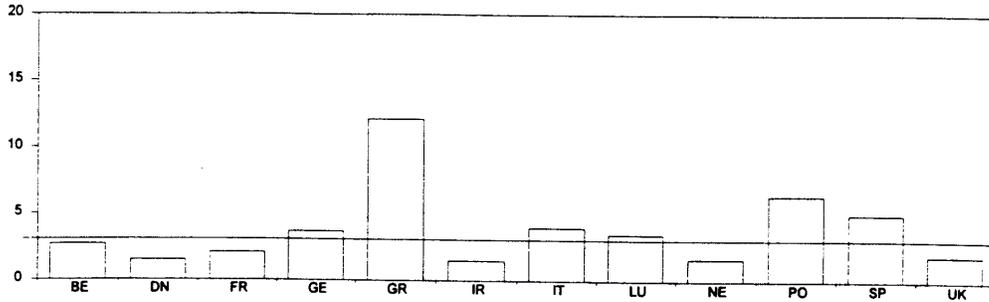
** indicates significance at 1 percent level

A standard auto-regressive distributed lag specification with three and 12 lags of the macro variables was adopted. A single lag of the dependent variable was sufficient to eliminate all autocorrelation from the residuals in all cases. Tests were also performed for normality and heteroscedasticity. All variables were found to be integrated of order 1 except when noted. Data is monthly and was obtained from the BIS. All variables except budget deficits are in the form of deviation from German levels. Seasonals were added to all equations.

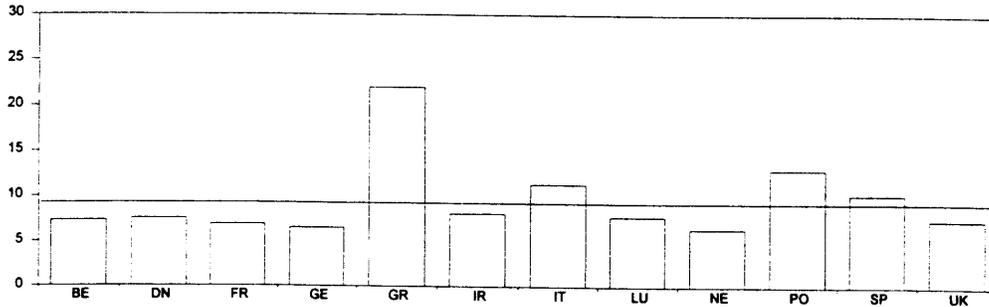
Chart 1

EMU CONVERGENCE CRITERIA AND PERFORMANCE: 1993

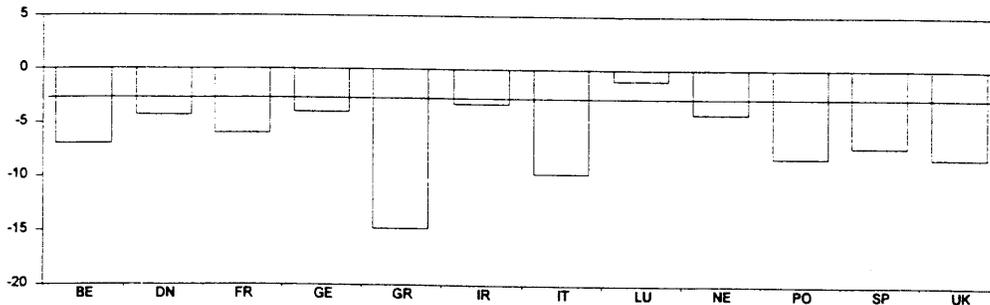
Criteria 1 Inflation over the last year shall be no more than 1.5 percentage points above the average rate in the three countries with the lowest inflation rates.



Criteria 2. The average long-term government bond rate for one year shall not exceed by more than 2 percentage points the average rate in the three countries with the lowest inflation rates.



Criteria 3. The government deficit shall not exceed 3 percent of GDP.



Criteria 4. Government debt shall not exceed 60 percent of GDP.

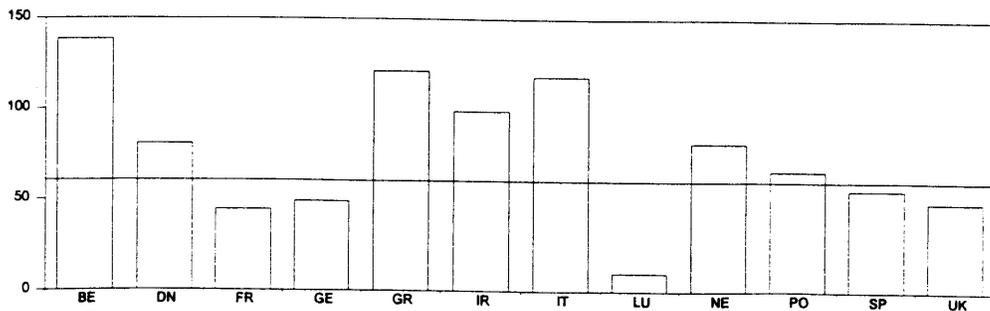
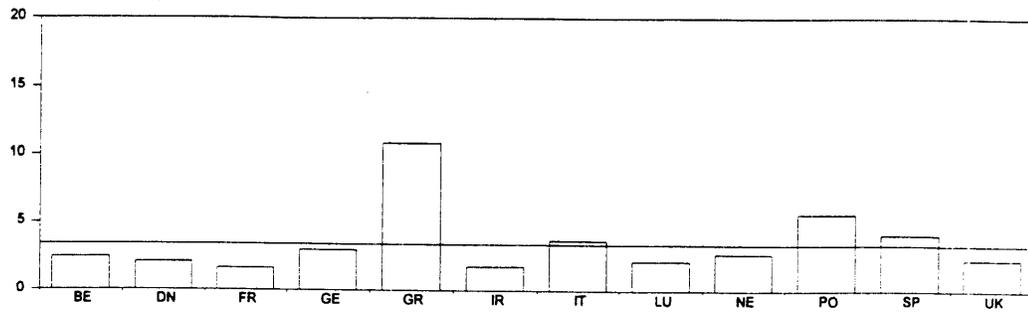


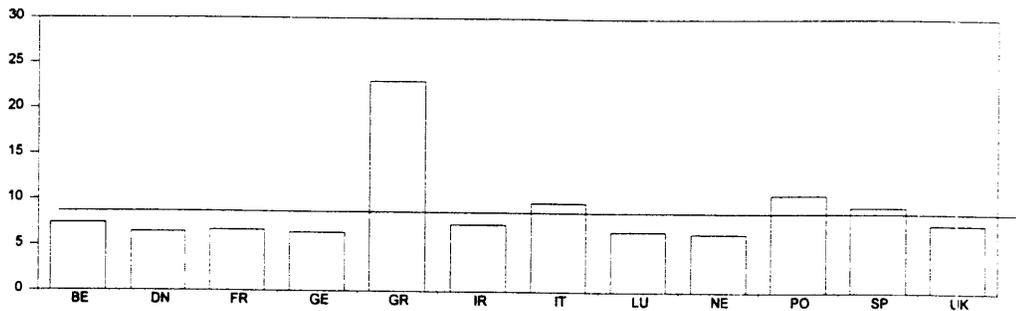
Chart 2

EMU CONVERGENCE CRITERIA AND PERFORMANCE: 1994

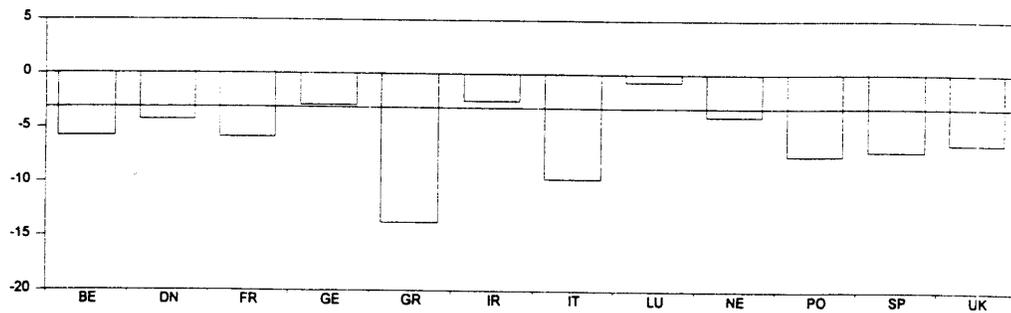
Criteria 1. Inflation over the last year shall be no more than 1.5 percentage points above the average rate in the three countries with the lowest inflation rates.



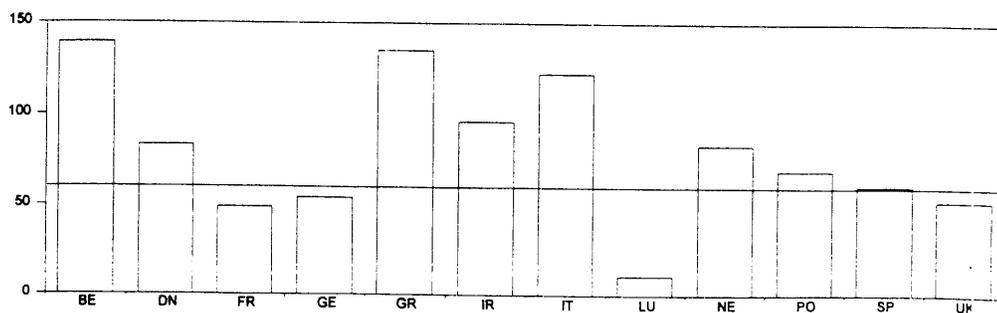
Criteria 2. The average long-term government bond rate for one year shall not exceed by more than 2 percentage points the average rate in the three countries with the lowest inflation rates.



Criteria 3. The government deficit shall not exceed 3 percent of GDP.*



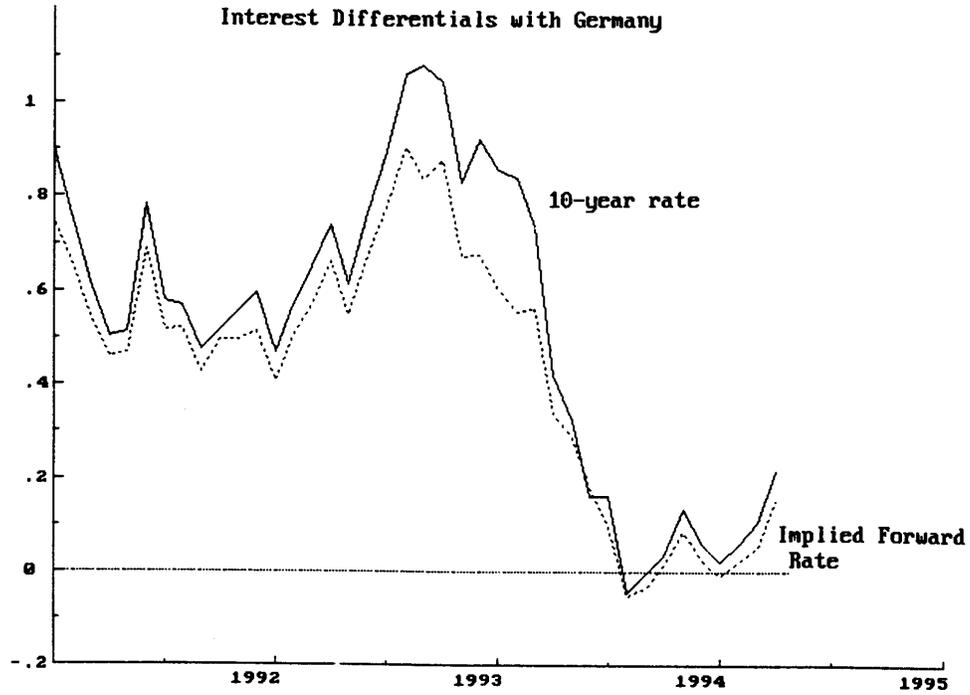
Criteria 4. Government debt shall not exceed 60 percent of GDP.*



* Projections for 1994.

Chart 4

FRANCE



NETHERLANDS

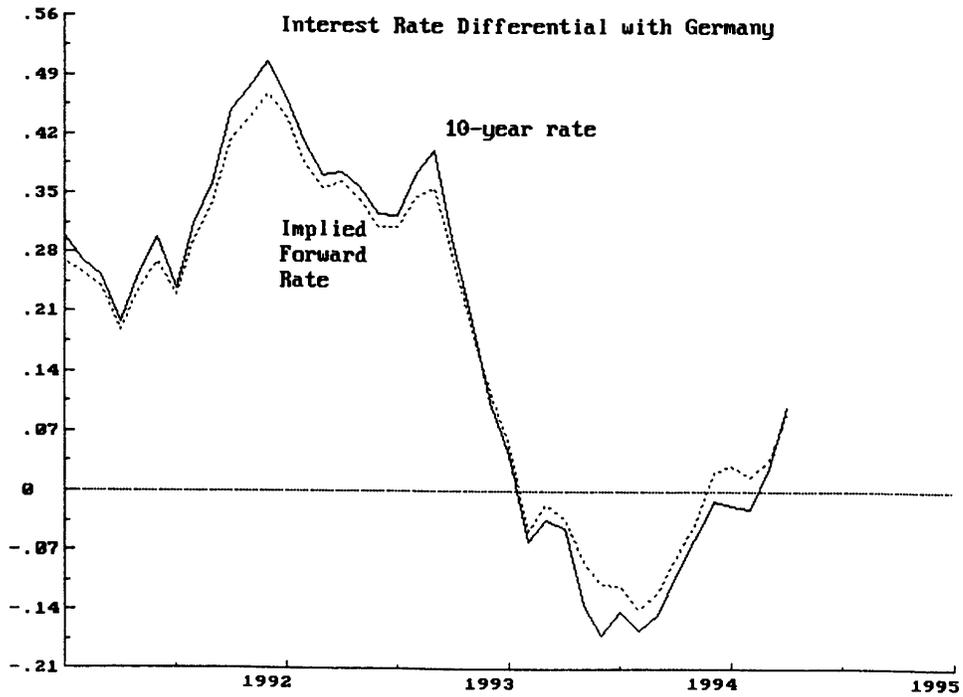


Chart 3

One-Year and Ten-Year Interest
Rate Differentials with Germany
(1991:Q1-1994:Q4)

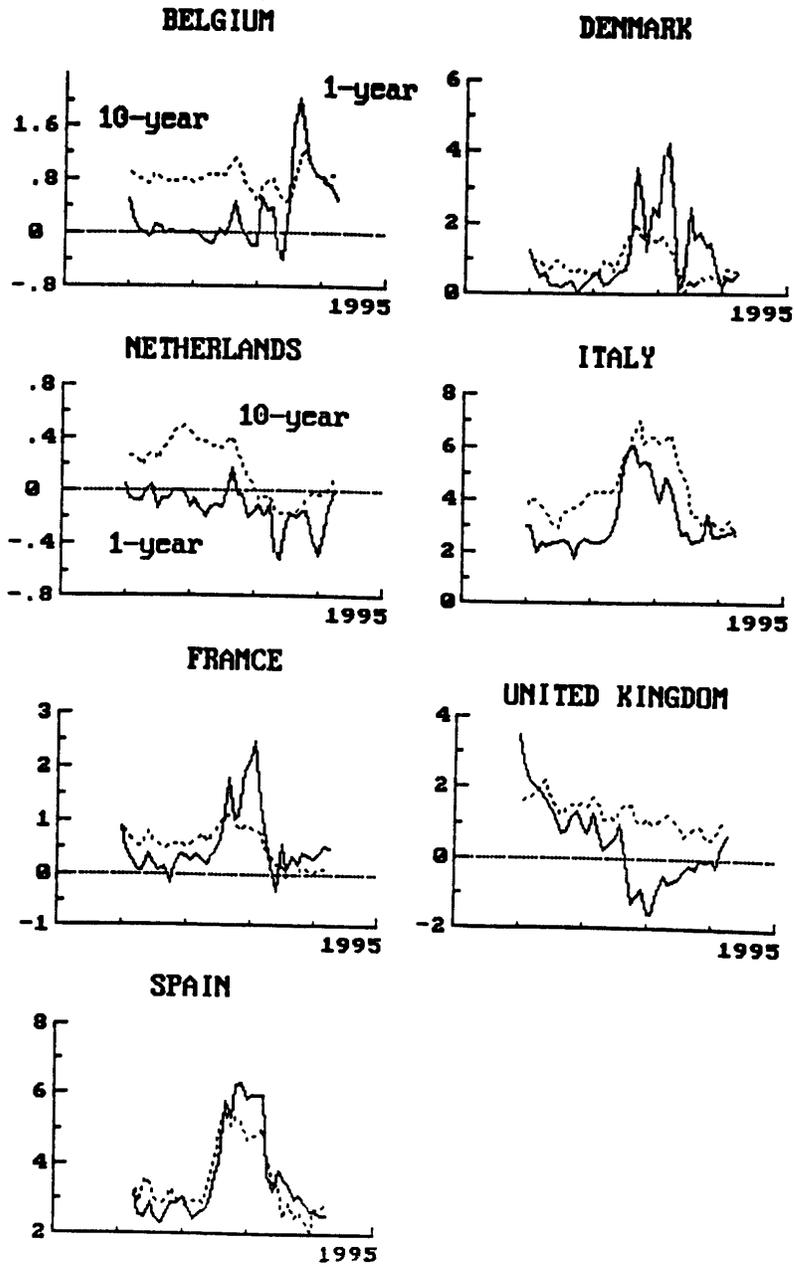
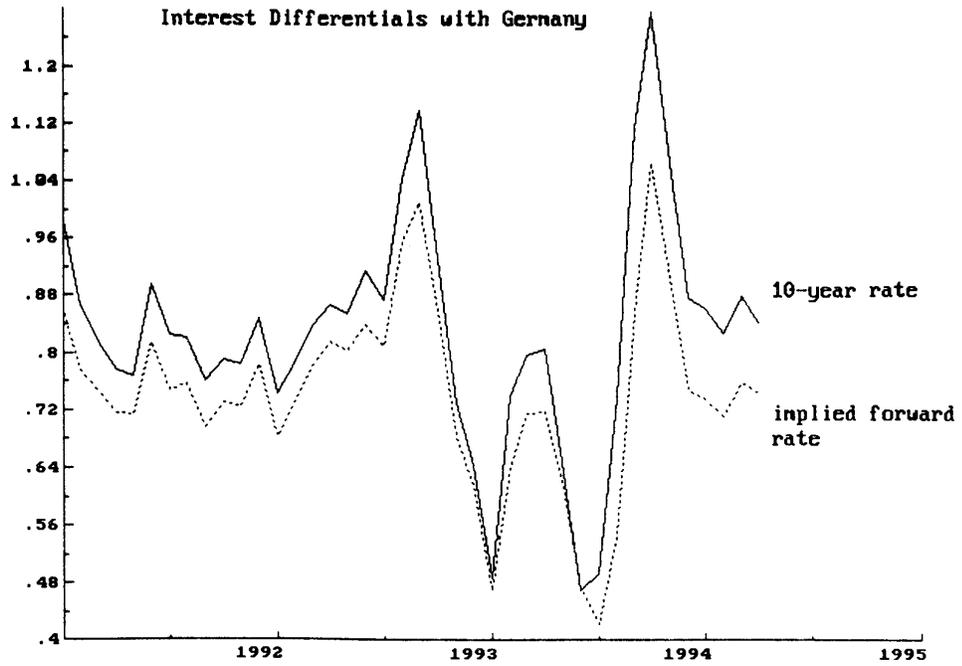


Chart 5

BELGIUM



DENMARK

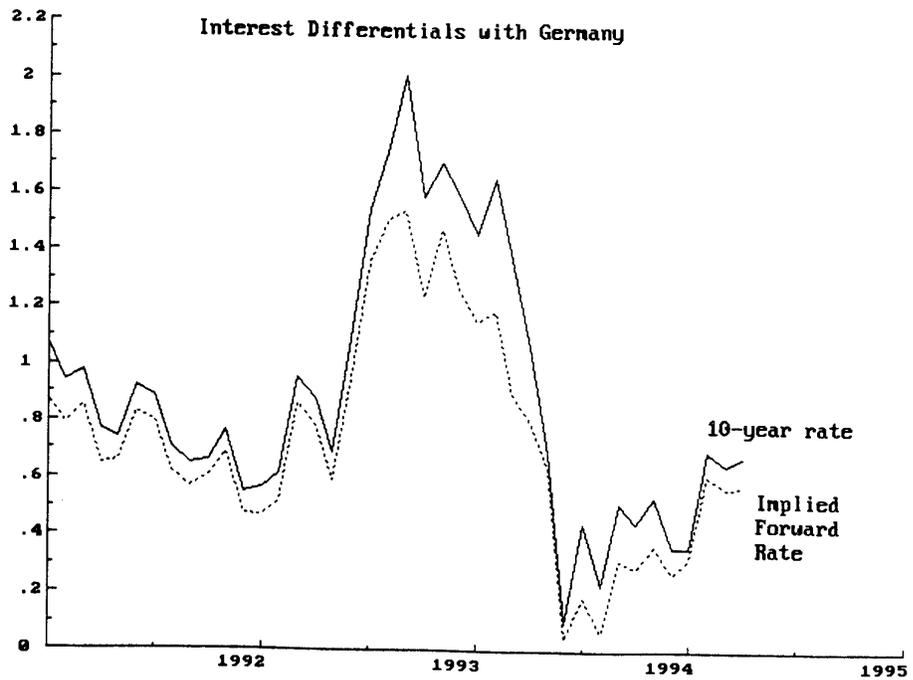


Chart 6

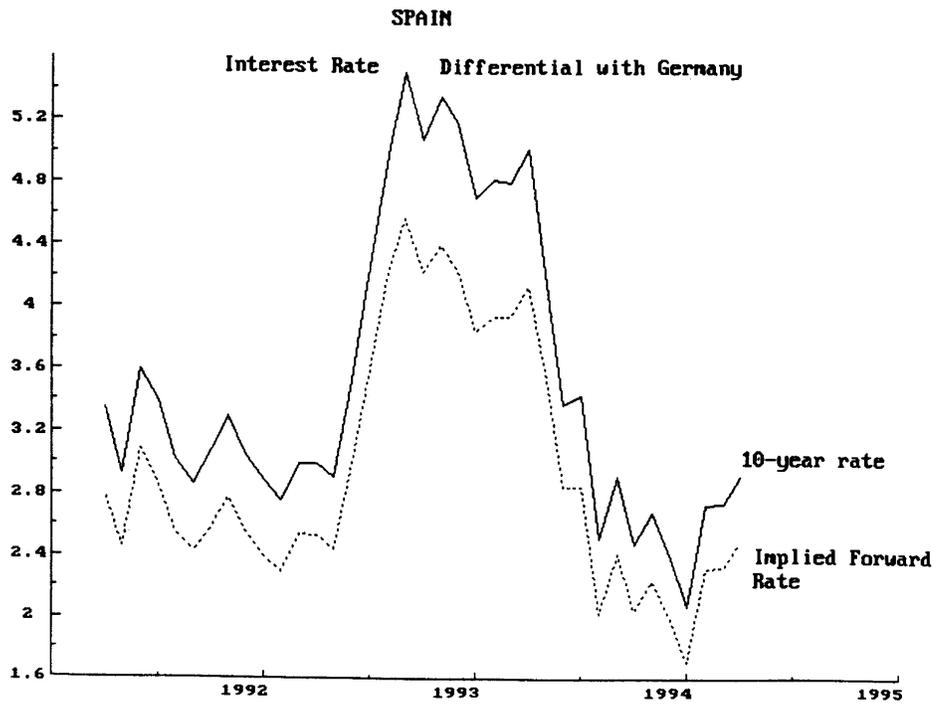
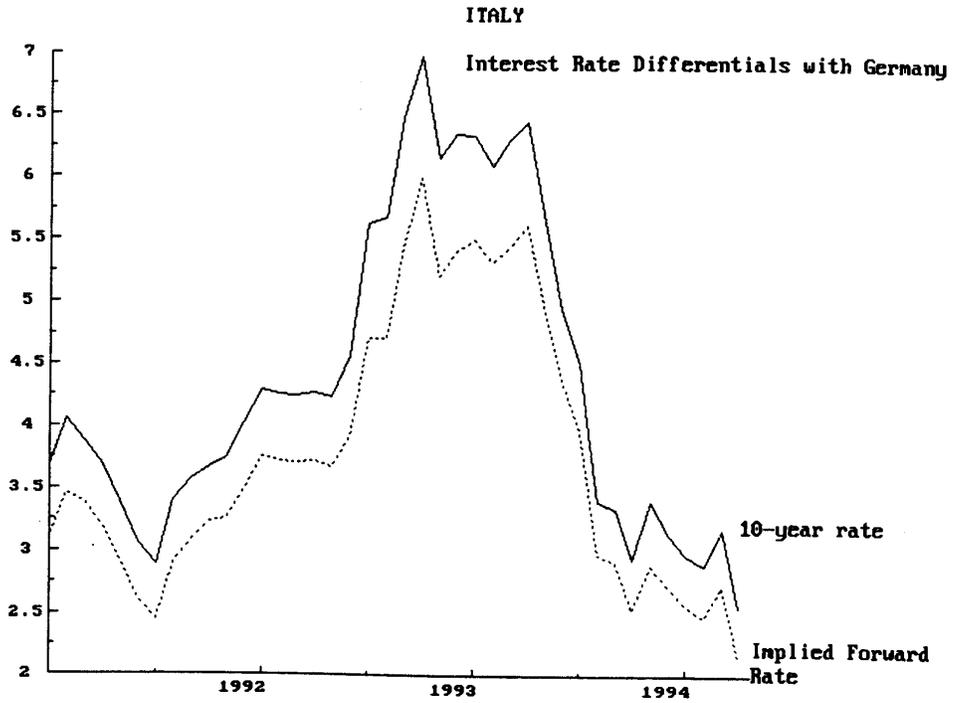


Chart 7

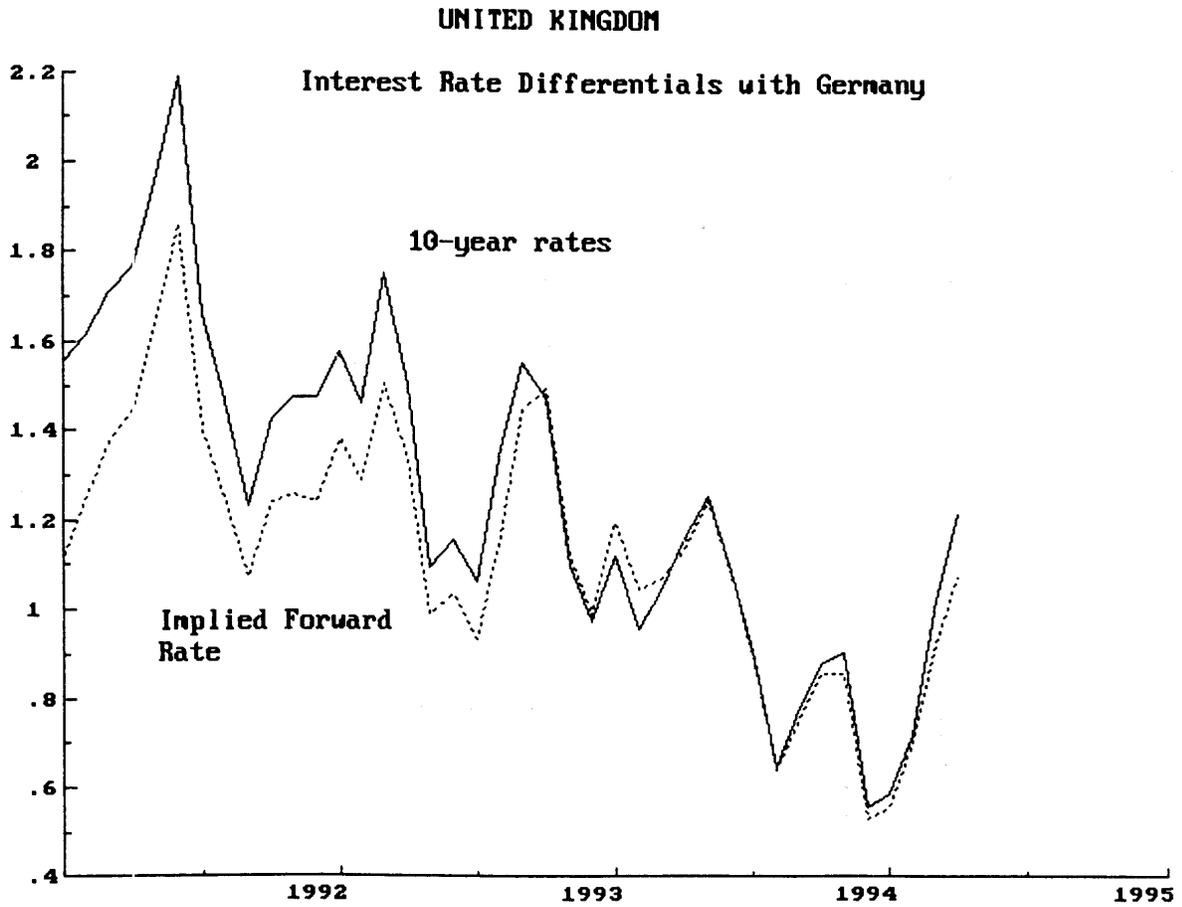
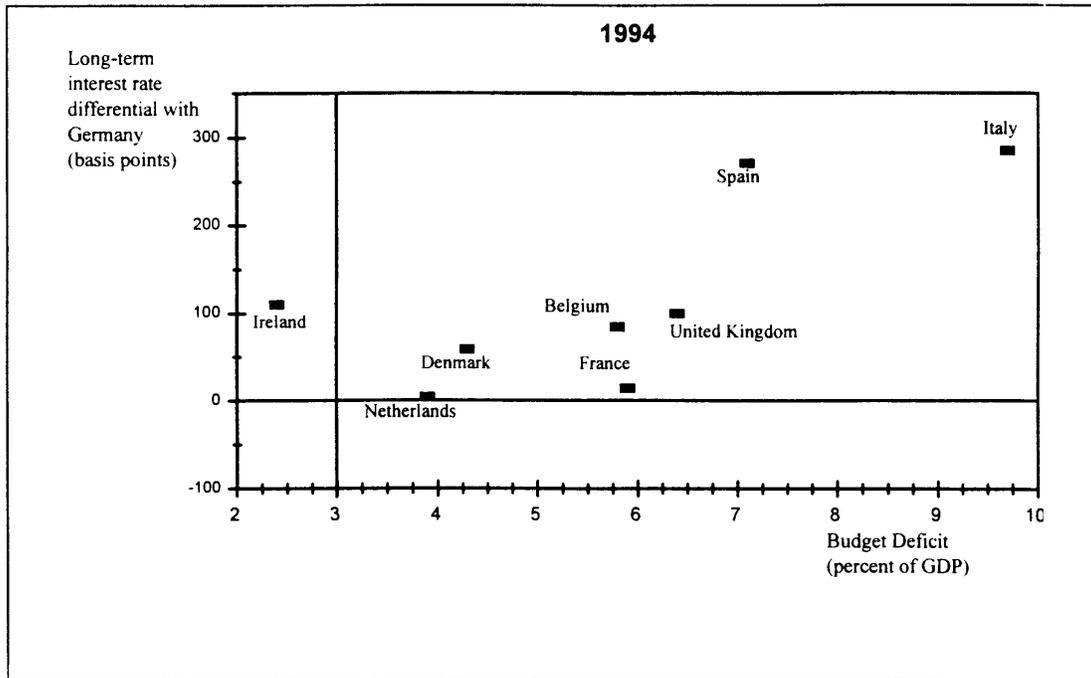
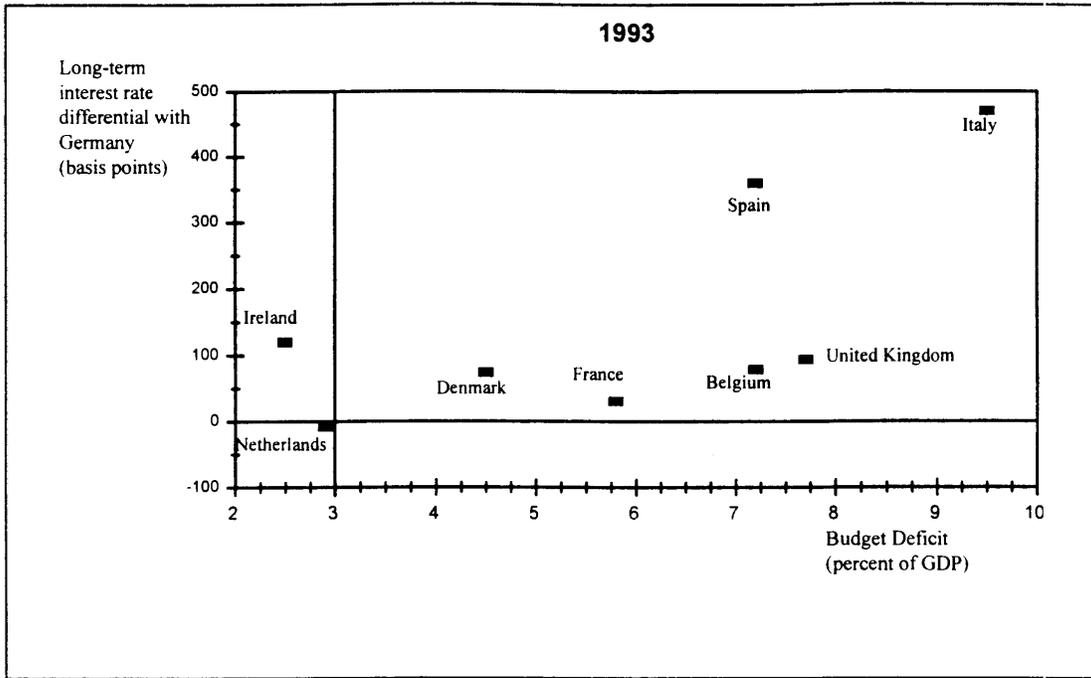


Chart 8

RELATIVE COST OF EMU



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