Monetary Policy on the Road to EMU: The Dominance of External Constraints on Domestic Objectives

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Abstract

We estimate forward-looking interest-rate reaction functions for some EMS countries. We model inflation expectations assuming imperfect information and learning. Reputational factors – the shift to a fiscal dominance regime – and convergence to the German inflation rate are found to be the main policy goals. We cannot detect evidence that the target zone band was exploited to implement countercyclical policies: Krugman's honeymoon effect never materialized for these countries. Thus, their enthusiastic joining of EMU is not particularly surprising. On one hand, the risk of fiscal instability seems definitely staved off. On the other, compared to what *de facto* happened under Bundesbank leadership during the EMS years, ECB policies are more likely to take into account their relative contribution to the European cycle.

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1. Introduction: The Existing Literature and Key Results

Classical target zones models (Krugman, 1991) show that the central bank may exploit the bandwidth to pursue domestic objectives. In this paper we wish to assess how monetary policies in a number of European countries reacted to domestic conditions under the constraints imposed by EMS membership.

In retrospective, the EMS years may be seen, with the notable exceptions of UK and Denmark, as a prolonged period of macroeconomic convergence that eventually led to EMU.

However, the transition to a new regime characterised by low inflation and disciplined fiscal policies was slow and painful. Especially in the countries considered in this paper (France, Italy, Belgium and Ireland) financial markets were sceptical of policymakers' ability to meet their commitments: domestic real interest rates commanded substantial risk premia and inflation expectations remained stubbornly high for a prolonged period. Furthermore, the EMS went through a number of important changes, from the early period, when it resembled a crawling peg, to the "Hard ERM" phase, and later on to the "wide band" arrangements that came into being after the 1992-93 crisis. Thus, any attempt to model monetary policies within the EMS should be conducted on the assumption that agents gradually learned about the actual features of the exchange rate regime. The popular approach based on Vector Autoregressions (VARs) usually requires assuming a time-invariant transmission mechanism and reaction function (see Rudebusch, 1998). We follow an alternative strategy, based on the estimation of structural reaction functions. Basically, the reason for doing so is twofold. First, we are able to test a reaction function that is formally derived from a simple theoretical model of monetary policy design. In contrast, as noted by Christiano *et al.* (1998), VAR modellers usually prefer not to report or to interpret estimated policy rules, because if the actual policy rule is forward-looking, the estimated coefficients of such VAR-estimated 'policy rules' will be difficult to interpret. Second, we use a Kalman filter procedure for the estimation of inflation expectations that is consistent with the hypothesis of gradual learning.

Some recent work on the inflationary consequences of fiscal policies (Canzoneri, Cumby and Diba, 1998) draws a distinction between a regime of central bank dominance (CBD) and one of fiscal dominance (FD). In the latter, primary surpluses are not responsive to the level of public debt, so that the price level and the money stock need to adjust to ensure fiscal solvency. Inflation simply adjusts to the needs of fiscal solvency. Under a CBD regime, instead, primary surpluses systematically react to the level of public debt, and inflation is determined according to central bank's unconstrained optimal feedback rule for money supply and interest rates. Melitz (1997) provides some empirical evidence supporting the view that, over the sample we are studying, substantial complementarities existed between budget and monetary policies in EMS countries. Indeed, a central tenet of our analysis is that the risk of reversal to unsustainable fiscal policies systematically hampered the credibility of the exchange rate commitment. As in Favero, Giavazzi and Spaventa (1997), we assume that the long term interest rate spread *vis à vis* the German bund captures the risk of central par realignments. Moreover, we test whether interest rate policies reacted to such measure of exchange rate risk.

Despite some apparent differences (Italy was forced out of the EMS in 1992, the debt burden was substantially lower in France than in the other countries, etc.), our estimates identify a common policy pattern, based on the dominance of external constraints over domestic objectives. We also find that reputational factors, i.e. exchange rate risk, explain the most salient features of the interest rate policies followed by these countries quite well. Moreover, those interest rate policies appear strikingly consistent throughout the sample period, despite the 1992-93 crisis and the widening of exchange rate bands. Theoretical models of monetary policy design emphasise the role of institutions in shaping expectations.

Popular models of the EMS under Bundesbank leadership have accepted this institutionalist view. The empirical evidence we present here is consistent with a quite different story. Actual policies, as opposed to the announcement of institutional innovations, were essential to achieve macroeconomic convergence. Furthermore, the reform of monetary institutions may turn out to be ineffective without fiscal discipline.

The rest of the paper is organised as follows **Section 2** outlines the benchmark theoretical model used to derive the reaction function subsequently estimated. **Section 3** sets out our estimation methodology. In **Section 4** we briefly examine monetary policy developments in the four countries in our sample, and comment our results. **Section 5** summarizes our main conclusions in the light of the establishment of the Single Currency.

2. Interest Rate Reaction Functions and the Theory of Monetary Policy Design within the ERM

In this section, we show how a forward-looking interest rate reaction function can emerge from a simple Barro-Gordon-type theoretical model of monetary policy design. Consider the following model for current inflation in the presence of costly price-adjustment as in Calvo, (1983) or Rotemberg (1983) (Rotemberg and Woodford, 1999, propose a sticky-price model that has similar implications):

$$p_t = p_t - p_{t-1} = bp^e_{t+1} + j(y_t - y^*) \qquad [1]$$

where current inflation, p_t, depends on inflation expectations and the current output gap, where y^* is potential output. The output gap is given by:

$$y_t - y^* = -d\left[R_t - R^e_t\right] + e_t \qquad [2]$$

Output deviations from the natural rate depend on a supply shock, e_t, and the deviations of the nominal interest rate R_t (which is the policy instrument), from its expected value, R_t^e.

$$R_t^e = r^* + p_{t+1}^e \quad [3]$$

where *r** is the (ex ante) real interest rate.

The next step requires a characterisation of both the institutional setting and the sequence of events. The government is entrusted with fiscal policy and exchange rate parity negotiations. The central bank manages short-term interest rates to keep the exchange rate within the band. Events unfold as follows:

a) *The central parity is announced*.

b) *Inflation expectations are formed*.

c) *An idiosyncratic shock hits the domestic economy*. Conceptually, we can identify two distinct disturbances. The first is a shock e_t. For sake of tractability, we assume that this will never trigger a realignment. The second disturbance is a fiscal shock such that the central bank loses control of the price level in the long run. In line with the so-called “fiscal theory of price level determination” (Canzoneri, Cumby and Diba, 1998; Cochrane, 2000), we label the latter scenario as a switch to a regime of fiscal dominance (FD). In this case, realignment always takes place.

d) *The central bank sets interest rates*. Under FD, the bank will fully accommodate. In the absence of a fiscal shock, i.e. in a regime of central bank dominance (CBD), the bank sticks to the announced exchange rate commitment, and exploits the bandwidth to pursue domestic objectives. Simultaneously, in the financial markets, private agents adjust their portfolios. Their choice is made taking as given the announced parity and the interest rate differential, and conditional upon the expectation of a future realignment.

e) *At the beginning of the following period, this sequence is repeated*. The government chooses a (new) central parity, expectations are formed, and so on. Therefore, realignments can only take place at the start of each period or after a shock.

We now model the exchange rate. Standard models of target zones[1] do not account for policymaker's concern with domestic objectives. Coles and Philippopoulos (1997) allow for within-the-band time-inconsistency in the conduct of monetary policy, but assume that the central parity is fully credible. Moreover, to maintain analytical tractability, their analysis is essentially deterministic. Our story substantially departs from these contributions. Our interest here is not in providing a detailed description of exchange rate dynamics within the band. Instead, we wish to highlight the trade-off faced by a policymaker who is concerned with the conflicting objectives of exchange rate stabilisation and control of domestic objectives. Therefore, we posit that shocks induce no persistence. Consequently, a standard parity condition requires that the current exchange rate react to the current interest rate differential and to the expectation of realignment at the beginning of the following period. In this case, the following holds

$$\begin{aligned} e_t &= (1-q)\left[\overline{e} - s\left(R_t - F_t^G\right)\right] + q\left[e^* - s\left(R_t - F_t^G\right)\right] = \\ &= \overline{e} - s\left(R_t - F_t^G\right) + q\left(e^* - \overline{e}\right) \end{aligned}, \qquad [4]$$

[1] See also Krugman (1991), Miller and Weller (1991), Flood, Rose, and Mathieson (1991), Bertola and Caballero (1992), Delgado and Dumas (1993), Garber and Svensson (1995), Bartolini and Prati (1999), Avesani, Gallo and Salmon (1999).

where F_t^G is Germany's short term interest rate, e_t defines the (log of the) exchange rate, $\bar{e}$ represents the current central parity[2], and e^* is the expected parity in case of realignment. The latter would be announced at the beginning of the following period. Note that in equation [4] q is the probability that financial markets assign to a regime shift, and e^* defines the exchange rate parity consistent with the new FD regime. In what follows, we do not explicitly model fiscal authorities' incentives, and instead focus on the behaviour of the central bank.

Suppose that the monetary policy-maker's loss function is given by:

$$L_t = c\left(p_t - p^G\right)^2 + \left(y_t - \tilde{y}\right)^2 + r_1\left(R_t - E\{R_t\}\right)^2 + r_2\left(e_t\right)^2 + r_3\left(R_t - R_{-1}\right)^2, \qquad [5]$$

where the authorities penalise not only deviations of output from a target $\tilde{y}$, which exceeds the natural level y^* (as in Barro and Gordon, 1983), but also changes in the policy instrument. Moreover, ERM membership entails that the inflation target is given by the German inflation target[3], p^G, and that the central bank dislikes deviations of the exchange rate from the original parity (normalised at zero). Observe that r_2 is a rough-and ready way of characterising the constraint imposed by ERM membership on exchange rate volatility. A relatively large value of r_2 mimics a relatively narrow exchange rate band.

Eq. [5] posits that stabilisation policy via interest rate changes is costly[4], and that for this reason shocks are never fully stabilised in the long run. Svensson's (1997a) model highlights the risk of instability of such anti-inflationary policy by assuming that the

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[2] Henceforth, we assume, for simplicity, that the value of the parity is zero.

[3] This is consistent with traditional models of the ERM. See Giavazzi and Pagano (1988), and Giavazzi and Giovannini (1989)

policymaker penalises deviations of R_t from zero. Instead, the term $r_1\left(R_t - E\{R_t\}\right)$ in equation [5] assumes that the policymaker knows the level of inflation expectations, and consequently chooses R_t. However, in case of shocks hitting the economy, the authority decides whether to deviate from the nominal interest rate implied by the state of inflation expectations.

We assume that the central bank minimises [5] with respect to the nominal interest rate, taking expectations, and the exchange rate, as given. Substituting equations [1], [2], [3] and [4] yields an interest rate reaction function of the form:

$$R_t = q_r r^* - q_{\tilde{y}p^G} + qp^e_{t+1} + q_e e_t + q_R R_{t-1} + q_{e*} + q_F F_t^G \qquad [6]$$

Where

$$\begin{aligned}
q_r &= \frac{d^2 j^2 c + d^2 + r_1}{d^2 j^2 c + d^2 + r_1 + s^2 r_2 + r_3} \\
q_{\tilde{y}p^G} &= \frac{dj\,cp^G + d\left(\tilde{y} - y^*\right)}{d^2 j^2 c + d^2 + r_1 + s^2 r_2 + r_3} \\
q_p &= \frac{\left(b + dj\right) dj\,c + d^2 + r_1}{d^2 j^2 c + d^2 + r_1 + s^2 r_2 + r_3} \\
q_e &= \frac{dj^2 c + d}{d^2 j^2 c + d^2 + r_1 + s^2 r_2 + r_3} \\
q_R &= \frac{r_3}{d^2 j^2 c + d^2 + r_1 + s^2 r_2 + r_3} \\
q_{e*} &= \frac{s r_2 q}{d^2 j^2 c + d^2 + r_1 + s^2 r_2 + r_3} \\
q_F &= \frac{s^2 r_2}{d^2 j^2 c + d^2 + r_1 + s^2 r_2 + r_3}
\end{aligned} \qquad [7]$$

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[4] See Goodhart (1996) for some justification. See also Goodhart (1999) for further discussions.

The model could be solved assuming full information and rational expectations for the current exchange rate, inflation, and output. Here our focus is different, as we are concerned with private agents' learning and policymakers' reputation building. We assume that the policymaker cannot accurately predict the supply shock, but has to forecast it (this forecast being private information). Furthermore, we postulate that

$$q_t = q_{t-1} + w_t , w \sim N\left(0, s_w^2\right) \qquad [8]$$

Wage and price setters learn about the probability of a regime shift by observing exchange rate behaviour. Absent realignments, agents take past within-the-band exchange rate variability as an indicator of policymaker's commitment to a regime of central bank dominance[5]. Similarly, we assume that central bank preferences may vary over time (see Cukierman, 1992):

$$c_t = c_{t-1} + u_t , u_t \sim N\left(0, s_u^2\right) \qquad [9]$$

Therefore, the private sector will update their expectation of q, c, and e each period based on the variances of e, w, and u in a standard signal extraction problem (Cukierman, 1992; Muscatelli, 1999).

The private sector will then perceive the interest rate reaction function as:

$$R_t = b_0 + b_p p_{t+1}^e + b_e e_t^f + b_R R_{t-1} + b_e q_t^e e^{e*} + b_F F_t^G , \qquad [10]$$

[5] As Caballero and Bertola (1992) show, central banks limit within-the-band exchange rate volatility when the central par lacks full credibility.

where the b's are functions of the same parameters presented in [6], but with c^e (the expected value of c) rather than c and where e^f is the forecast of the supply shock, and $q_t^e e^{e*}$ is the expected value of the realignment

In practice, one can estimate a forward-looking reaction function for interest rates along the lines of [10] by constructing a series for expected inflation and the expected supply shock (or equivalently the expected output gap), using an optimal updating scheme, such as the Kalman filter (see section 3.2 below). Obviously, expected exchange rate realignments are not observable. Therefore, one would also need a measure of exchange rate risk. In our model, a shift to a FD regime causes an inflationary surge. As a result, the exchange rate central parity must be revised. The long-term yield spread vis-à-vis Germany,

$$S_t = LR_t - LR_t^G , \qquad [11]$$

should therefore capture the perceived risk of a regime shift.

In this vein, Favero, Giavazzi and Spaventa (1997) study the daily behaviour of the spread on the 10-year benchmark bonds of Italy, Spain, Sweden, and Germany[6]. They identify and measure three components of the spread. The first is directly related to the expectation of debt monetisation. The second is due to differences in tax regimes across countries, whereas the last one reflects the market assessment of default risk. Clearly, both the first and the third component of the spread relate to the risk of exchange rate realignment. However, there is an obvious objection to a straight use of S_t in [10], i.e., collinearity with expected inflation. In a full-information rational expectations world the two variables are inextricably linked. However, in our model the two variables have a different informational content. Inflation expectations are predetermined relative to the shock e and to the policy actions, whereas S_t is not. Therefore, compared to inflation expectations, S_t provides the central bank with useful additional information on how the market evaluates the credibility of the central parity[7]. For our purposes, we assess the additional informational content of the spread. We do so by purging the component of the spread directly associated with expected inflation, obtaining the component of exchange rate risk that is orthogonal to (predetermined) inflation expectations. We perform recursive regressions of the interest spread on expected inflation for each country (see Table 1), and use the residuals from those recursive regressions (*Adjspread*) as regressors in our baseline reaction function, along with expected inflation, the output gap, and other explanatory variables.

It is worth noting that by estimating a simple forward-looking interest rate reaction function such as [10], one is not trying to capture the exact way in which the monetary authorities actually react to the wealth of economic indicators available to them. Instead estimated forward-looking reaction functions based on [10] capture *the implicit way in which central bank's operational rules/decisions translate into a reaction function expressed in terms of expected inflation and output gaps*. Thus, if one finds some instability in the estimated reaction function parameters this may be due either to a change in policy preferences (price stability), or to a shift in the intermediate targets and indicators used by the policy authorities in pursuing their targets[8]. However, in general, major and *permanent* shifts in the estimated parameters will reflect corresponding shifts in policy preferences.

Clearly, estimating reaction functions such as [10] does not allow one to directly analyse the authorities' reactions to a full set of policy indicators. It does, however, allow one to judge whether the operational rules have been stable and whether the reliance on certain

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[6] We calculate the spread on the same category of bonds.
[7] This essentially captures the fact that expectations in financial markets respond more quickly to perceived policy actions and exogenous shocks compared to expectations-formation in the goods and labour markets.
[8] This point is also stressed by Christiano *et al.* (1998) in the context of VAR models.

intermediate targets has been at the expense of meeting final output stabilisation and inflation objectives.

In what follows, we actually estimate reaction functions of the following type:

$$R_t = B + \sum_{i=1}^{k} a_i R_{t-i} + g E_t p_{t+j} + l \left(y_t - y_t^* \right) + g S_t + h F_t^G \qquad [12]$$

Typically we find that a lag length of k = 1 is usually sufficient to capture the degree of interest-rate smoothing. Having estimated the basic reaction function in [12], we then search for the appropriate lead (j) for the inflation-forecast term $E_t p_{t+j}$, based on goodness-of-fit criteria.

As noted in Batini and Haldane (1999), the specification of reaction functions such as [12] allows one to analyse a number of issues. First, the weight the bank puts on expected inflation, and the lead term placed on it, illustrates the responsiveness of the instrument to changes in the forecast and the forward-lookingness of the bank’s horizon. Second, the parameters a_i capture the degree of inertia in the interest rate policy. Third, a value of l different from zero implies that the rule explicitly includes some reaction to deviations of output from potential. Finally, parameters g and h capture the importance of external constraints. i.e. ERM membership, on the conduct of monetary policy. Indeed the main purpose of our exercise is to find out whether central banks have exploited the target zones to pursue domestic objectives or, instead, monetary policy has been geared towards reputation-building.

3. Empirical Issues

3.1 The Context: Existing Literature

There have been a number of recent contributions to the literature on estimated interest rate reaction functions. We begin by distinguishing our study carefully from the contributions of previous authors. In general, three broadly different approaches have been used in modelling monetary policy behaviour. First, a number of researchers have used Vector Autoregressions (VARs) to estimate the way in which policy actions depend on a set of macroeconomic indicators, and how in turn policy actions are transmitted to key macro variables. Bernanke and Blinder (1992) use the Federal Funds rate to analyse the transmission mechanism in the US. Christiano *et al.* (1994), Bernanke and Mihov (1997, 1998) (*inter alia*)[9] have refined this approach by analysing alternative measures of monetary policy and identification mechanisms for the estimated VARs. Second, some researchers have focused on estimating single-equation (structural) reaction functions for monetary policy instruments (see for instance, Groeneveld *et al.*, 1996, Muscatelli and Tirelli, 1996, Clarida and Gertler, 1997, and Clarida *et al.*, 1998, Muscatelli, Tirelli and Trecroci, 2000). Third, Rudebusch (1995, 1998) uses data from forward-looking financial markets to construct measures of unanticipated shocks to monetary policy.

In this paper, we adopt the second of these approaches. The third approach, which uses financial market data, is less useful in detecting major changes in monetary authorities' policy behaviour and the implications of any changes for the stance of monetary policy. The VAR approach has some advantages, in that it allows one to jointly model both the endogenous policy response and the impact it has on key macroeconomic indicators. It does so by making only minimal assumptions about the transmission mechanism and the timing in the authorities' reactions to new macroeconomic data. However, the results from VAR models do seem to depend critically on the assumptions made about which variables to include in the VAR, and on the existence of a time-invariant transmission mechanism and

[9] For an excellent survey, see Christiano *et al.* (1998) who analyse the advantages and pitfalls of the VAR approach to identifying monetary shocks.

reaction function (see Rudebusch, 1998). Given the number of variables (7 or more) one usually includes in a VAR of the transmission mechanism, and the limited number of observations, it becomes difficult to conduct any stability analysis by, say, using 'rolling VARs'. This is especially the case if there have been frequent changes in either the policy regime or in the financial system which might affect the timing of the policy response and the nature of the transmission mechanism[10].

Indeed, as noted by Christiano *et al.* (1998), if the actual policy rule is forward-looking, the interpretation of VAR estimated coefficients in terms of policy coefficients is particularly troublesome. Instead, VAR models are primarily designed to construct measures of monetary policy shocks for use in analysing the transmission of monetary shocks[11]. Overall, it does seem that VARs are less useful in undertaking an empirical analysis of regime changes in the conduct of monetary policy. One possible exception to this is the use of procedures aiming at obtaining time-varying VAR coefficients. For instance, Muscatelli and Trecroci (2000) follow a Bayesian approach to VAR estimation, which allows the parameters of the VAR to evolve as more observations are added. This has intuitive appeal in modelling a situation where monetary policy changes occurred, as regime changes in this area are likely to involve a gradual evolution of responses.

Our focus here, as in Clarida and Gertler (1997) and Clarida *et al.* (1998), is on single-equation (forward-looking) structural reaction functions that allow us to analyse shifts in monetary policy regimes using recursive estimation techniques. In this respect, Clarida *et al*. (1998) find that actual interest policies in France and Italy, even prior to the "hard ERM" phase, were markedly tighter than those implied by domestic inflation/output conditions. The authors estimate reaction functions for these countries plus Britain, employing observations

[10] Although Bernanke and Mihov (1998) do allow for a limited amount of time variation in their VAR model.

[11] See e.g. Eichenbaum and Evans (1995). Note, however, that there are contrasting views as to the robustness and usefulness of monetary policy shock measures obtained from VARs; see Rudebusch (1998) Bagliano and Favero (1998) Christiano *et al.* (1998).

for “soft ERM” as the basis for mapping inflation forecast and average real interest rates into the subsequent hard ERM sample. This amounts to assuming that entry into the “hard ERM” coincided unequivocally with a change in policy regime in all countries, and that expectational variables were consistently generated according to a fixed full information scheme over the whole sample.

Clarida *et al*. (1998) thus provide some evidence in support of the view that the French authorities most closely followed the Bundesbank’s policy stance, while Italy appears to have shadowed German policies more loosely, particularly before1992. This scenario is certainly realistic and appealing. However, the empirical evidence provided does allow us to interpret the nature of the differences between the two cases. For instance, it does not allow one to attribute Italy’s apparent lack of exchange rate credibility to cyclical conditions, or to the monetary and/or fiscal authorities’ observed behaviour. Finally, the authors’ use of fixed break-points in the policy regime, and ad hoc full-sample measures for the expectational variables, makes it impossible to account for periods of partial credibility and regime change.

We extend these earlier studies in the following ways. First, by presenting recursive estimates of these reaction functions, we can detect marked changes in the way monetary policy has been conducted over the last two decades. Second, compared to Clarida *et al.*, we use alternative methods to estimate our measures of expected inflation and potential output. Our approach is based on the assumption that the private sector is imperfectly informed about the central bank preferences, whereas the central bank is imperfectly informed about the permanent and cyclical components of output growth (see Orphanides, 1999). Another difference between our approach in this paper and Clarida *et al*. is that we do not take for granted, or assume, any structural break in the behaviour of the monetary authorities. In addition, we have not imposed any particular structure for any shifts in monetary policy. This is because we want to test whether any change can be detected in correspondence to announced regime shifts. For this purpose, we conduct a recursive analysis of the regression parameters. Using structural stability tests we were then able to detect major breaks in interest rates policy.

3.2 The Monetary Policy Instrument Variables

As in other recent papers on reaction functions (see Clarida *et al.*, 1998), we focus on short-term money market rates as the policy instrument[12]. Clearly, there are difficulties in identifying a single interest rate measure as *the* monetary policy instrument for the whole of our sample period (see Bernanke and Mihov, 1997). One might want to use different interest rate measures as the policy instrument at different times (e.g. discount rates in the early part of the sample and repo or call money rates towards the end of the sample period). However, such fine distinctions would inevitably be arbitrary, and in any case short-term money market rates will largely reflect the authorities' monetary policy stance under different operating procedures.

3.3 Measuring Inflation Expectations and the Output Gap

There are different methods to obtain measures of inflation expectations and the output gap[13]. Clarida *et al.* (1998) use a quadratic trend to obtain a measure of potential output and hence deviations of actual output from this trend. In order to obtain a measure of inflation expectations, Clarida *et al.* (1998) use the errors-in-variables approach to modelling rational expectations whereby future actual values are used as regressors instead of the expected values, and instrumental variable estimation is used to take account of the presence of forecast errors.

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[12] See the Data Appendix for details on the interest rates employed.

[13] An interesting attempt in this sense, involving EMU-wide measures of output gaps, can be found in Gerlach and Smets (1999). Gerlach and Schnabel (1999) instead perform a brief exercise aimed at estimating a Taylor rule for the EMU area centred on the latter part of our sample.

Turning first to the output gap, any use of a trend filter (linear or not) involves the use of full sample information, and hence implicitly assuming that the policymaker has information on the future path of output in evaluating the potential output trend. Rational expectations models of inflation expectations that use the full sample similarly do not make allowances for gradual learning by the economic agent, as might be plausible in a situation where the monetary regime is not always constant over the sample period (see Cuthbertson *et al*., 1992).

Instead we employ the Structural Time Series (STS) approach proposed by Harvey (1989) to generate series for the output gap and expected inflation. There are several advantages in using this approach. The first is that it provides a useful and intuitive way of decomposing a series into trend and cyclical components, which is particularly useful when one tries to estimate a series for an unobservable trend such as potential output. Second, the modelling approach lends itself readily to using a Kalman Filter estimation procedure, which allows one to proxy the learning process by policymakers and economic agents. Third, the structural time series models are parsimonious models that have reasonably rich ARIMA processes as their reduced forms.

Essentially, we estimate models for real GDP and inflation for each country, seeking to disentangle the trend, cycle and irregular components[14]. In the case of GDP, a convenient decomposition of the series was made possible by applying the Kalman filter on the trend component. Subsequently, the latter was computed based on one-step-ahead predictions of the state vector. This way, estimates of potential output are obtained using only past information, rather than the full sample.

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[14] The STAMP 5.0 software was used to estimate the STS models. Output and inflation were found to be I(1), and to have a significant cyclical component. The estimates STS models are available on request from the authors. For a similar approach to forecasting inflation in the presence of potential structural breaks, see Stock and Watson (1999). Gerlach and Smets (1999) employ an unobservable component method to estimate the impact of changes in the output gap on short-term interest rates in an aggregate sub-sample of euro area countries.

In the case of inflation, we simply computed one-step-ahead prediction errors from a univariate STS model to obtain a measure of expected and unanticipated inflation. Again, the model parameters are updated only as new data is added. In both cases, the STS methodology assumes that agents make the best use of all available knowledge in a regime of imperfect information. In contrast using a non-recursive estimation approach, such as IV errors-in-variables, has the defect of using information from the whole sample, thus ignoring policy regime shifts.

4. Estimating Policy Rules

Before we comment on the estimates[15], we present a brief narrative description of institutional and policy innovations in each country. This shows that a) the fiscal stance was a key factor in determining the credibility of the central parity; b) several modifications in the ERM rules of the game did in fact occur, *de iure* or *de facto*, and each time the private sector had to adjust to the new scenario. Finally, we provide a justification for the inclusion in our estimates of additional regressors, such as monetary aggregates that were often cited in official documents as intermediate targets for monetary policy.

During the first four years since ERM inception in 1979, the EMS more closely resembled a crawling peg rather than a fixed exchange rate regime: seven realignments (out of a total of twelve) took place during these first years[16]. Over time the system evolved towards a more rigid regime, and the years between 1987 and the 1992-93 crises (the so-called "hard ERM" phase) witnessed no adjustment[17] at all. Italy and the UK left the ERM in September 1992 following a speculative attack on their currencies. From 2 August 1993, the bilateral

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[15] We estimated interest rate reaction functions using quarterly data for each country. In each case the policy instrument has been chosen following widespread consensus in the literature on the transmission of monetary policy impulses, and in all cases but Italy coincides with the call money rate. Further details on the single series are contained in the Data Appendix. The sample chosen is 1980/1-1997/2 for all countries.

[16] See Fratianni and von Hagen (1992), amongst others.

[17] Aside from the narrowing of Italian lira's band, in 1990.

margins around the exchange rate parities were widened from ±2.25% to ± 15% in response to the 1993 crisis involving the remaining ERM currencies.

The Banque de France has repeatedly argued that since late ‘70s its policy had relied on two fundamental intermediate objectives: strict adherence to the ERM, and money supply growth (Fratianni and Salvatore, 1993; OECD, 1999c). Since 1977, the Bank has set targets for monetary growth: M2, from 1988 to 1990, and M3 thereafter. During the first years of French participation to the EMS, the commitment to the exchange rate target seemed a relatively loose one, and capital controls were heavily used to shield domestic money markets from “undesirable” fluctuations. Furthermore, in the early eighties the French government engaged in a unilateral fiscal expansion aiming to boost output and employment. The ensuing inflation outburst and the speculative attacks against the franc forced a quick policy reversal. Since then French policies, both fiscal and monetary, were geared towards reputation building. In fact the spread with German rates remained stubbornly high despite the relatively rapid convergence of inflation towards German levels. The 1993 currency turmoil forced the Banque de France[18] to accept a “wide” target zone. Despite that, the exchange rate was steered within a much narrower band and the central par was never revised. According to Bartolini and Prati (1999), the policy of (potentially) tolerating short-lived fluctuations of the DM/FF rate, while still maintaining a strong commitment to longer-term exchange rate parity, narrowed the scope for short-run speculation[19]. The fiscal stance, which was consistent with the pursuit of a rigid exchange rate in the long run, probably helped in stabilising inflationary expectations. However, as pointed out above, it took a rather long time before the long-term spread narrowed.

[18] It is important to note that the Bank was granted full legal independence in 1993.

[19] Anthony and MacDonald (1999) find some empirical evidence supporting this view. Their work shows that the mean-reverting properties of various ERM exchange rates were essentially the same with the broad band as with the narrow band.

The Bank of Italy gained some degree of formal independence in 1981. In 1984, the Bank announced the first M2 official target[20]. A loose fiscal policy stance and the mounting public debt, however, cast a recurrent shadow on the ability of Italian monetary authorities to control inflation[21]. During the "hard EMS" period the bank managed to defend the parity, but there was growing scepticism concerning the long term compatibility of the public finances with the Maastricht Treaty provisions[22]. The dramatic exit of the lira from the ERM in 1992 was probably a direct consequence of these concerns. Meanwhile, successful agreements on labour costs in 1992-93 had contributed to ease the pressure on inflation expectations. However, the flight to foreign currency-denominated assets that accompanied the currency crisis was halted only when decisive steps towards a badly needed fiscal correction were finally undertaken in the second half of the '90s. By then, a more optimistic outlook for public finances probably contributed to lower the risk premium on lira-denominated assets. In November 1996, Italy rejoined the ERM, and in 1998 the Bank of Italy became one the 11 founding Members of the ECB.

The Belgian monetary authorities have always argued (National Bank of Belgium, various years) that in a small open economy the relationship between the exchange rate and inflation was far more stable and reliable than the growth of monetary aggregates. Consequently, since the collapse of Bretton Woods, Belgium (along with the Netherlands) has joined various exchange rate arrangements in the attempt to provide a nominal anchor to its economy[23]. After the 8.25% devaluation in February 1982, monetary policy was essentially designed to maintain stable exchange rates between the franc and the ECU. In 1990, the monetary authorities eventually declared their intention to peg the currency to the D-mark. As

[20] The official intermediate objective of the Bank had previously been total domestic credit. This, as discussed in Spinelli and Tirelli (1993), and Fratianni and Spinelli (1997), entailed large crowding-out of private-sector credit and lack of control on monetary aggregates, in presence of large government budget deficits.
[21] For an effective assessment of the effects of these considerations on currency markets, see Giorgianni (1997).
[22] Between 1981 and 1991 the ratio of central government deficit to nominal national income almost doubled (Fratianni and Spinelli, 1997).

in Italy, the very high debt-to-GDP ratio generated relatively high real interest rates throughout the ERM period. However, a medium-term strategy of fiscal consolidation while progressively boosting confidence in the currency and overall policy credibility, narrowed the scope for speculative attacks (see IMF, 1998; Perotti, Strauch and von Hagen, 1998). Moreover, the exchange rate peg managed to curb inflation towards German levels already since mid-eighties. That strongly contributed to the decline of interest rate differentials *vis-à-vis* Germany.

Until 1979, Irish monetary policy was closely tied to the UK, as Ireland had adopted a currency board based on Sterling. This resulted, amongst other things, in a significant depreciation of the Irish punt against many "snake's" currencies. The entry of Ireland in the EMS in 1979, however, did not result in an immediate convergence of domestic inflation to German levels. The strong trade links with the UK meant that the domestic price level was still strongly dependent upon British domestic developments. Moreover, substantial budget imbalances recurrently put the currency at risk of speculative attacks. However, the severe macroeconomic adjustment carried out since 1984 did start to produce some effects in the second part of the decade. In fact, between 1987 and 1989 the differential with German long-term interest rates dropped, as the main consequence of a more optimistic economic outlook and increased credibility of the fiscal stance on asset markets. Subsequently, a mix of tax cuts, parity realignments, and wage moderation boosted competitiveness, stimulating a further economic expansion from 1994 onwards. Ireland is seen as one of the few cases of "expansionary fiscal retrenchment" in the recent literature on budget consolidation (see Alesina and Perotti, 1997; Giavazzi, Jappelli and Pagano, 2000)[24]. The monetary authorities then allowed the punt to significantly appreciate vis-à-vis the D-mark: in 1998, a 3% revaluation of the punt was the last official realignment in ERM history.

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[23] See National Bank of Belgium (1998) for a summary of the history of Belgian franc.
[24] For a short but effective account of those Irish events, see Obstfeld (1998).

We now turn to our results. **Tables 2** and **3** display the solved long-run static reaction functions, while the recursive graphs in **Figures 1-4** show the estimated coefficients and the 2-standard error bands[25]– and Chow's tests of structural stability. The study of single recursive coefficients' path over time can provide a useful description of possible shifts in the monetary authorities' preferences. However, the relevance of these changes can be fully gauged only with reference to historical events, and their impact on the estimated reaction function as a whole.

As one could obviously expect, for each equation the 1-step Chow tests detect a break in 1992. However, with the notable exception of Italy, the recursive graphs suggest that the 1992 crisis was just an episode. In fact, the central banks of the other countries broadly reverted to the pre-1992 interest rate rules as soon as speculative pressures faded. This common pattern clearly emerges for France, Belgium and Ireland (ERM continuers henceforth), whereas the Bank of Italy seems to have followed a somewhat different policy rule after the 1992 ERM exit. However, some striking similarities remain, even after the 1992 break-up, between Italy and the other countries. In fact, the coefficient on the domestic output gap is never significant, whereas in all countries the coefficients attached to inflation expectations and to the German interest rate are significant and positive. The coefficient on the long-term spread is also significant and positive. This result deserves more detailed discussion.

As pointed out above, our estimates have been computed inserting the spread component that is orthogonal to inflation expectations into our baseline specification. Figures 5 and 6 show, along with our calculated measure of *ex ante* real interest rates, that the generated *adjspread* series is persistently negative, especially over the latter part of the

[25] Recursive estimates are obtained with a GAUSS code, and plotted using GiveWin. Stability tests are from PcGive 9.1.

sample. Taking into account that these negative values are obtained in a period of falling inflation expectations, growing fiscal discipline and convergence to German levels, this result implies that some latent factor systematically depressed the spread. This finding is best explained by a combination of a more credible fiscal stance (which lowered the exchange rate risk), and relatively favourable cyclical conditions (which delayed the fall of inflation expectations). To confirm this interpretation, note that in Ireland *adjspread* becomes systematically negative after the mid-eighties fiscal adjustment, which also triggered a long-term economic upswing. In France and in Belgium one gets negative values from the start of the nineties when, after a prolonged period of fiscal discipline, a number of commentators begun to describe French policy as “competitive deflation” *vis à vis* Germany.

The case of Italy, where the persistence of negative values for *adjspread* is certainly weaker, indirectly confirms this interpretation. In fact, the cyclical behaviour of the series is clear, with the local peaks centred around the timing of devaluations or periods when narrative accounts signal that speculative pressures mounted. In contrast with the cases of France and Belgium, *adjspread* returns to positive values in 1992, just before and in coincidence with the ERM crisis, and later in 1996. This is consistent with the recurrent waves of scepticism concerning the ability of policymakers to discipline the fiscal stance after 1992 and to meet the Maastricht convergence criteria.

Turning back to our estimates, the ERM continuers are characterised by a steadily growing weight of the coefficient related to the German interest rate. By contrast, in these countries we observe a decrease in the coefficients attached to expected domestic inflation and to the spread. This is broadly consistent with a scenario where macroeconomic indicators signal increasing convergence with Germany and the central parity gains credibility.

Our estimates for Italy present a substantially different picture. First of all, we detect signs of instability already in the early eighties. Second, recursive estimates signal a marked policy shift post 1992. The coefficient on the German interest rate falls, whereas that on inflation expectations increases. Third, in contrast with the ERM continuers, the strength of the coefficient attached to the spread steadily increases throughout the period. Fourth, a money supply aggregate enters the reaction function. Recursive graphs suggest that interest rates reacted to monetary aggregates during the final part of the eighties and after 1992. This finding is broadly consistent with narrative accounts of monetary policy in Italy (Fratianni and Spinelli, 1997). In fact, the Bank of Italy relied on credit ceilings and other administrative controls until 1984. Subsequently, the targeting of monetary aggregates was made possible by the survival of restrictions to capital movements. The latter were lifted at the beginning of the 1990, precisely at the time when our estimates show that the coefficient on the monetary aggregate loses significance. After 1992, the Bank of Italy was freed from the constraints imposed by ERM membership, and the money supply indicator becomes significant once more.

Despite some apparent differences outlined above, there is one common theme underlying the interest rate policies of these four countries: the dominance of external constraints over domestic objectives. Central banks did not exploit the exchange rate target zone to implement countercyclical policies: Figure 7 shows that after 1992 the coefficients on output gap are all very small, insignificant and in two cases have the wrong sign. By contrast, the observed targeting of domestic inflation expectations may be seen as a means to force convergence to German levels. The emphasis on the long spread suggests that reputational factors posed a decisive constraint on the ability to pursue domestic objectives: Krugman's "honeymoon" effect never materialised for these countries. This conclusion is even more striking bearing in mind that after the 1993 target-zone widening both the ERM continuers and the Bank of Italy were *de facto* freed from the obligation to defend the exchange rate parity. Nevertheless, the continuers insisted in mimicking a narrow-band regime. A further confirmation of this is that for all countries foreign reserves significantly enter our estimated reactions functions throughout the sample period. This closely resembles central bank behaviour in a textbook fixed exchange rate regime, whereas under credible target zones monetary policy action is called for only when the exchange rate hits the margin of the band.

5. Conclusions

Both the theoretical model and the econometric methodology presented in this paper are based on the assumption that asymmetric information and gradual learning permeate the relationship between the central bank and the private sector. Moreover, we have assumed that the risk of a fiscal regime shift puts an additional constraint on the monetary policies of former EMS countries. Our empirical results seem consistent with both assumptions.

Target zones model based on full credibility show that the central bank might exploit the bandwidth to pursue domestic objectives. However, the same models show that, when realignments are possible, reputational factors impose a tighter discipline on the Central Bank. Our results confirm former empirical analyses of the EMS, where it is shown that such reputational factors where indeed important (Gerlach and Schnabel, 1999; Favero, Giavazzi and Spaventa, 1997). Our contribution to this literature is twofold. First, we present evidence that the risk of a shift to a regime of fiscal dominance was at the root of the central banks' credibility problems. Second, our results suggest that inflation convergence was the other main objective driving central bank policies. As a result, very little room was left for countercyclical policies: the honeymoon effect never really materialised for these ERM countries. Not surprisingly, all these countries were affected by the contractionary monetary policies in Germany in 1990-91.

These results may help to understand why these countries turned out to be enthusiastic supporters of EMU and of the Stability and Growth Pact that came with it, whereas other EU members such as the UK manifested stiff opposition. In fact, empirical evidence shows that in the UK external constraints and the danger of fiscal imbalances were never overwhelming, and the domestic stabilisation objective remained important throughout 1980s and 1990s. (see for instance Muscatelli Trecroci and Tirelli, 2000, or Clarida, Gali and Gertler, 1998). It is therefore understandable why EMU membership implies an effective loss of national sovereignty for UK policymakers. By contrast, our results suggest that EMU should unambiguously benefit the group of EMS countries whose monetary policies have been analysed in this paper. On the one hand, the risk of going back to a FD regime seems definitely staved off. On the other, compared to what *de facto* happened under Bundesbank's leadership during the EMS years, ECB policies are more likely to take into account their relative importance in the European cycle.

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Data Appendix

Variables were taken from OECD Main Economic Indicators and IMF International Financial Statistics. In most cases, we were able to employ seasonally adjusted data. For each country we measured real output using the GDP at constant price series. The inflation series were defined as simple 4-quarter log-differences in the all-items CPI. Below we briefly list the short-term interest rates we chose as policy indicators, and the definition of variables in the graphs contained in the Data Appendix. Rates are generally converted from monthly series.

Country	***Modelled Interest Rate Variable***
FRANCE	Call Money Rate
ITALY	3-Month Interbank Deposits (Overnight)
BELGIUM	Call Money Rate
IRELAND	Call Money Rate

Variable	***Definition***
EXPINF	Expected inflation, as described in the main text
ADJSPREAD	Adjusted spread, as described in the main text
GERFIBOR	3-month German Fibor
RESERVES	4-quarter log-difference in official reserves excluding gold
M1(3)GROWTH	4-quarter log-difference in M1(M3) Growth

	Constant	*Coefficient*	R^2
France	*0.025337* *(0.0028092)*	*0.65963* *(0.174470)*	*0.171613*
Italy	*0.030986* *(0.0039753)*	*0.40003* *(0.047464)*	*0.510899*
Belgium	*0.0067862* *(0.0023722)*	*0.39122* *(0.056233)*	*0.41227*
Ireland	*0.032671* *(0.0030398)*	*0.39169* *(0.10448)*	*0.169222*

Table 1. Preliminary regressions. France, Italy, Belgium, Ireland, 1980Q1-1997Q2.
Results are from RLS regressions of the spread between the yields on national long-term bonds and that on analogous German Bunds on expected inflation (standard errors in parentheses).

Country/Regressor	***France***	***Italy***
Constant	*0.0324* *(0.004901)*	*0.06893* *(0.007694)*
Expected Inflation	*0.5583* *(0.115)*	*0.7067* *(0.07481)*
Output Gap	*0.152* *(0.1331)*	*-0.1584* *(0.3602)*
GerFibor	*0.8559* *(0.06993)*	*0.2047* *(0.1252)*
AdjSpread	*0.8625* *(0.07898)*	*0.9645* *(0.1467)*
Variable Addition Tests	*M3 Growth* *0.08616 (0.06205)* *DReserves* *-0.01434 (0.0072)*	*M1 Growth* *0.1347 (0.05864)* *DReserves* *-0.0151 (0.00875)*
Summary Statistics	R^2 *0.918652* *s* *0.0101441* *DW* *1.81* *AR 1- 5 F(5, 60)* *0.53061 [0.7522]* *ARCH 4 F(4, 57)* *3.5159 [0.0124]* *Normality* c^2 *23.248 [0.0000]* *RESET* *1.7875 [0.1860]*	R^2 *0.953379* *s* *0.00831553* *DW* *1.45* *AR 1- 5 F(5, 60)* *1.7068 [0.1469]* *ARCH 4 F(4, 57)* *0.81201 [0.5227]* *Normality* c^2 *16.113 [0.0003]* *RESET* *7.646 [0.0074]*

Table 2. Estimated interest rate reaction functions. France and Italy, 1980Q1-1997Q2. Static Long-Run Solutions.

All results are obtained from Recursive Least Squares regressions of the monetary instrument on a constant, the indicated regressors, and one lag of the dependent variable. Regressors are defined in the main text. Asymptotic standard errors in parentheses. We tested for the addition of other regressors. Zero restrictions on lagged money growth and the 4-quarter change in the (log of) official reserves of foreign currency were tested by including them in the baseline regression. Asymptotic standard errors are in parentheses. AR is a LM test for the hypothesis of no serial correlation; ARCH checks whether residuals have an ARCH structure, with no ARCH as the null; Normality tests the normality of residuals; RESET tests the null of no functional mis-specification. P-values in brackets.

Country/Regressor	***Belgium***		***Ireland***	
Constant	0.01362 (0.003863)		0.04562 (0.01502)	
Expected Inflation	0.1441 (0.06617)		0.5312 (0.1864)	
Output Gap	-0.02964 (0.05137)		0.1962 (0.2266)	
GerFibor	0.877 (0.06842)		0.9121 (0.2122)	
AdjSpread	0.8809 (0.1076)		1.074 (0.2172)	
Variable Addition Tests	*M3 Growth* *DReserves*	*0.02811 (0.02532)* *-0.01522 (0.00650)*	*M3 Growth* *DReserves*	*-0.005084 (0.05689)* *-0.07666 (0.02123)*
Summary Statistics	R^2 *s* *DW* *AR 1- 5 F(5, 60)* *ARCH 4 F(4, 57)* *Normality* c^2 *RESET*	*0.942585* *0.00641402* *2.09* *0.54562 [0.7409]* *0.30798 [0.8715]* *21.288 [0.0000]* *3.7747 [0.0565]*	R^2 *s* *DW* *AR 1- 5 F(5, 60)* *ARCH 4 F(4, 57)* *Normality* c^2 *RESET*	*0.670091* *0.0303122* *1.92* *0.53245 [0.7508]* *0.064094 [0.9922]* *128.99 [0.0000]* *2.1777 [0.1449]*

Table 3. Estimated interest rate reaction functions. Ireland and Belgium, 1980Q1-1997Q2. Static Long-Run Solutions.

All results are obtained from Recursive Least Squares regressions of the monetary instrument on a constant, the indicated regressors, and one lag of the dependent variable. Regressors are defined in the main text. Asymptotic standard errors in parentheses. We tested for the addition of other regressors. Zero restrictions on lagged money growth and the 4-quarter change in the (log of) official reserves of foreign currency were tested by including them in the baseline regression. Asymptotic standard errors are in parentheses. AR is a LM test for the hypothesis of no serial correlation; ARCH checks whether residuals have an ARCH structure, with no ARCH as the null; Normality tests the normality of residuals; RESET tests the null of no functional mis-specification. P-values in brackets.

Recursive Graphs and Stability Tests

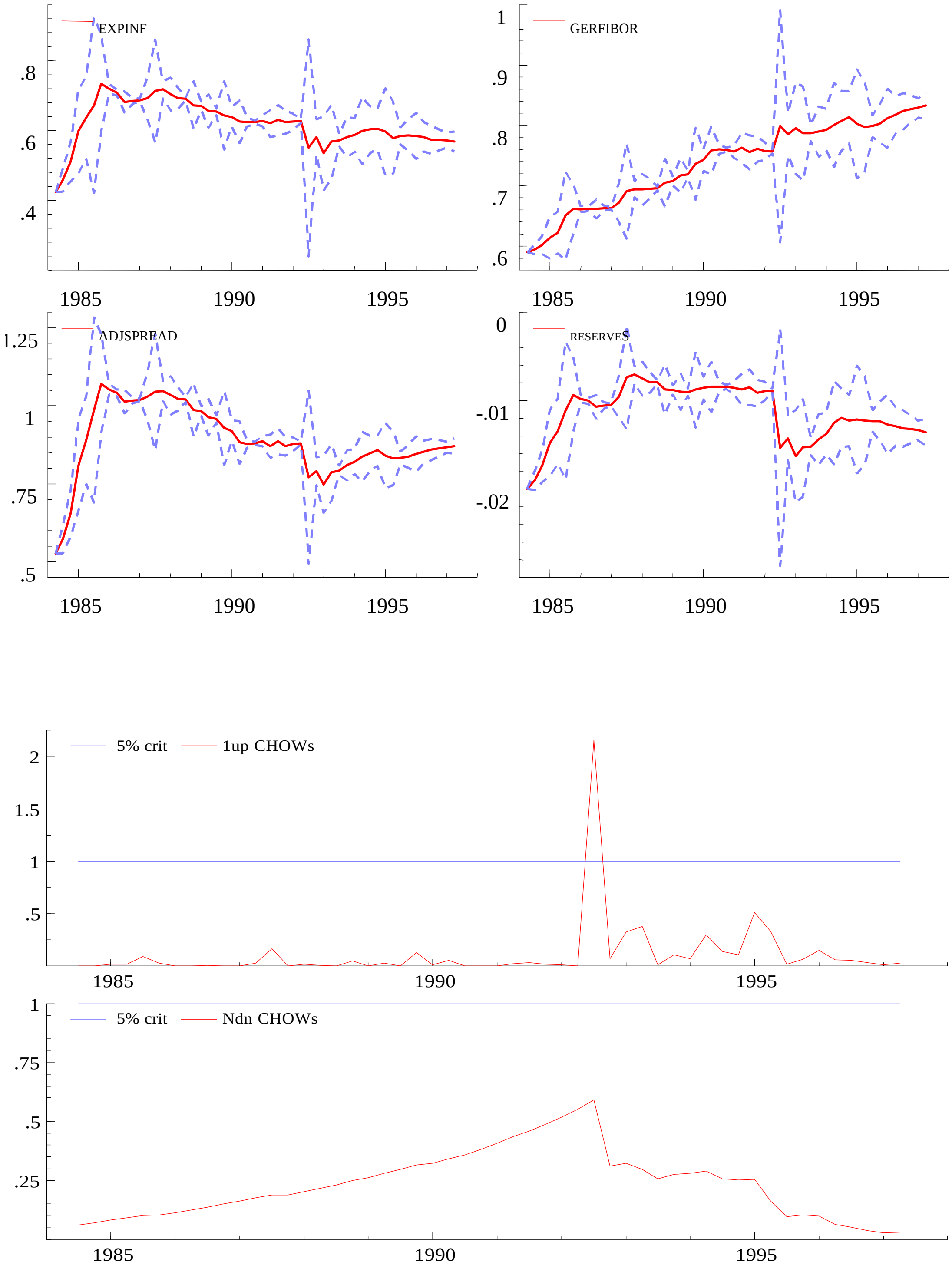


Figure 1. France, 1980Q1-1997Q2. Recursive coefficients between ± 2 standard-error bands; 1-step up and N-step down Chow tests (5%).

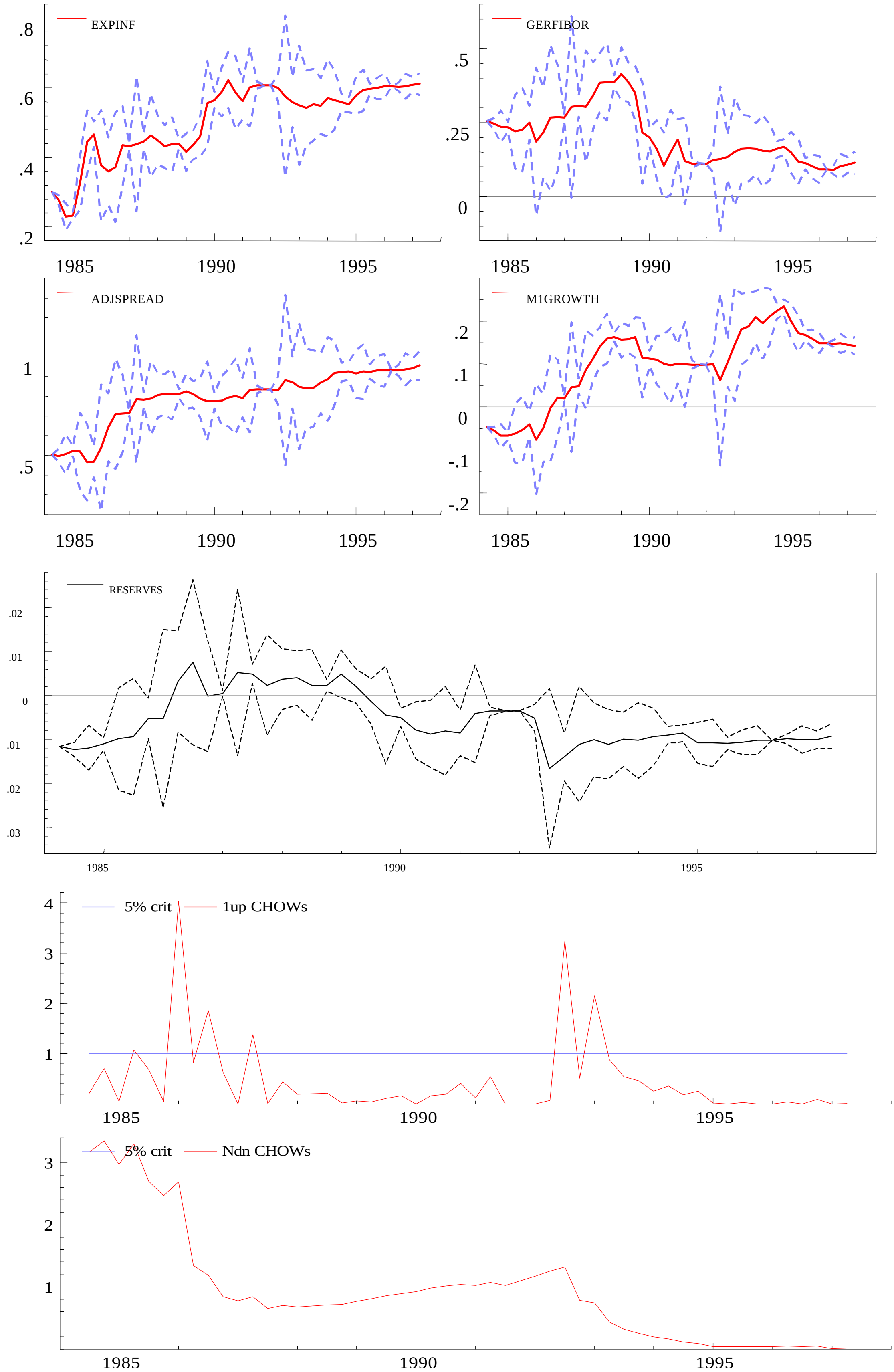


Figure 2. Italy, 1980Q1-1997Q2. Recursive coefficients between ± 2 standard-error bands; 1-step up and N-step down Chow tests (5%).

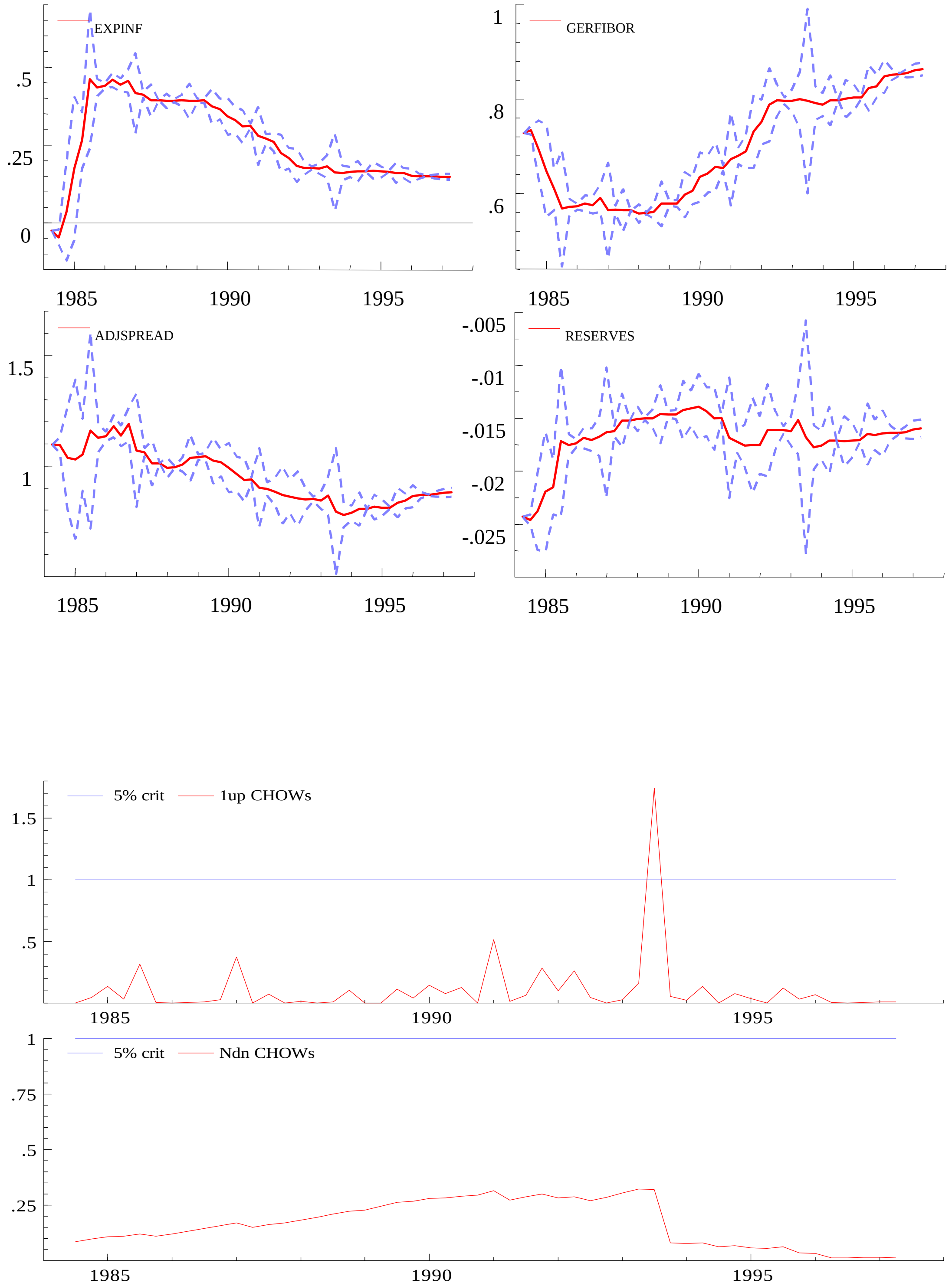


Figure 3. Belgium, 1980Q1-1997Q2. Recursive coefficients between ± 2 standard-error bands; 1-step up and N-step down Chow tests (5%).

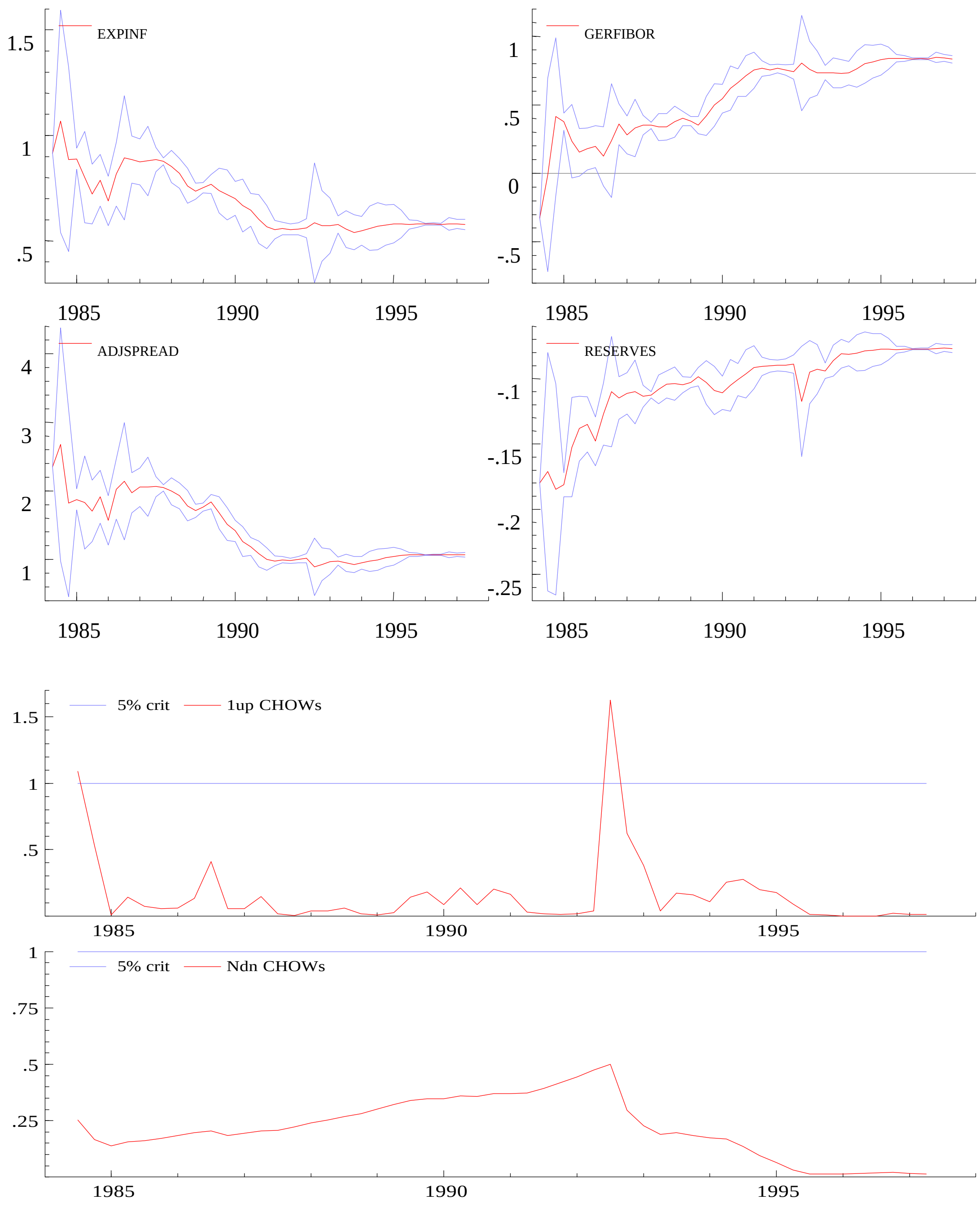
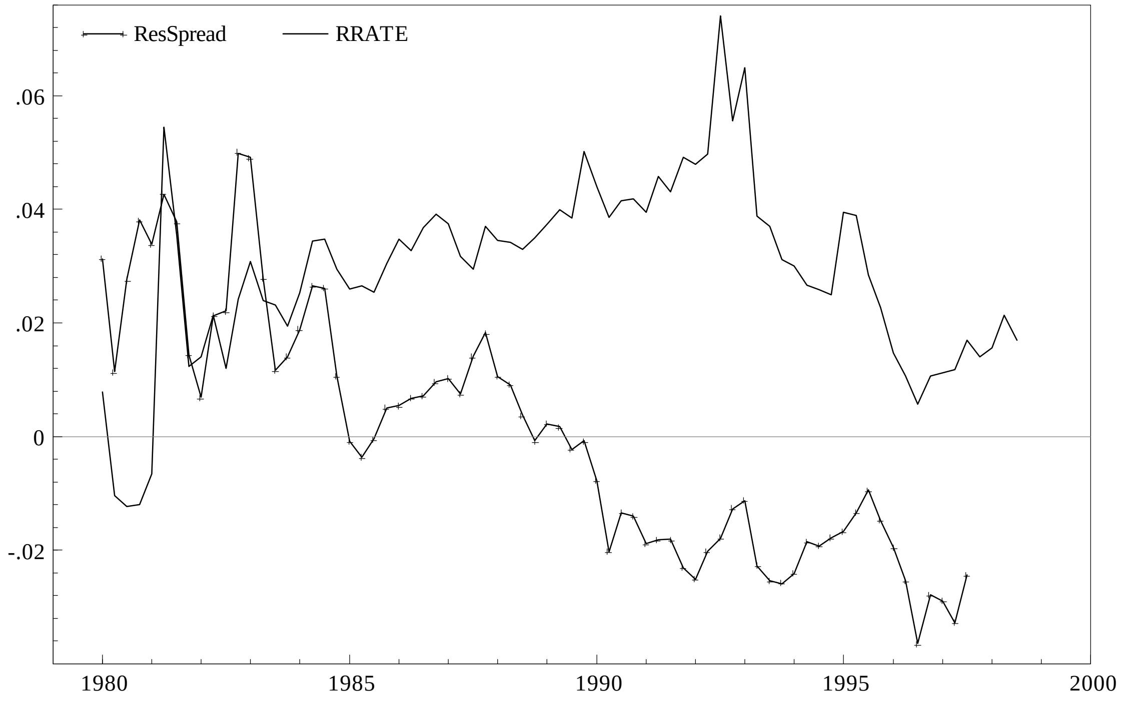
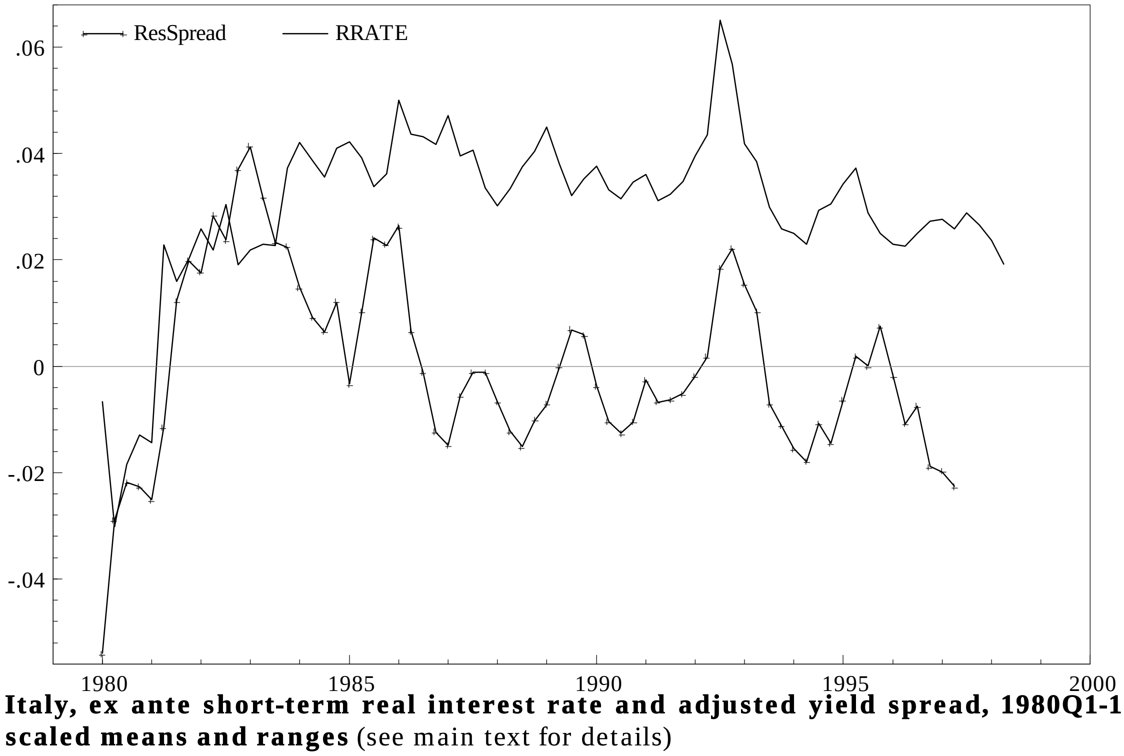


Figure 4. Ireland, 1980Q1-1997Q2. Recursive coefficients between ± 2 standard-error bands; 1-step up and N-step down Chow tests (5%).

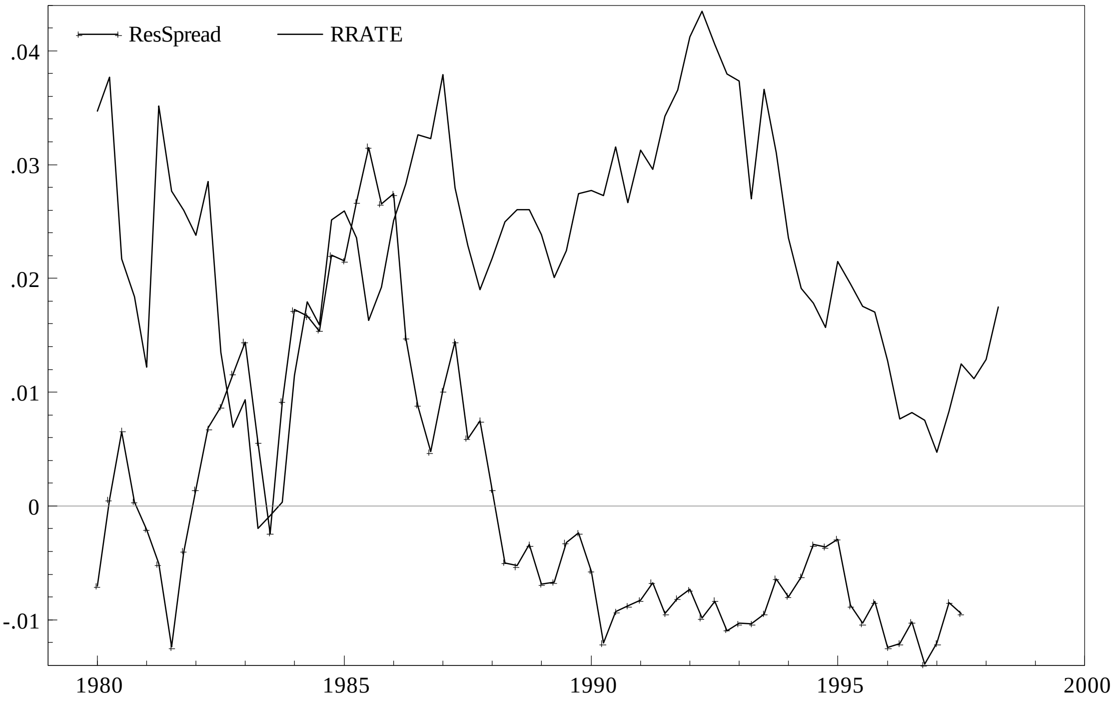


France, *ex ante* short-term real interest rate and adjusted yield spread, 1980Q1-1997Q2, scaled means and ranges (see main text for details)

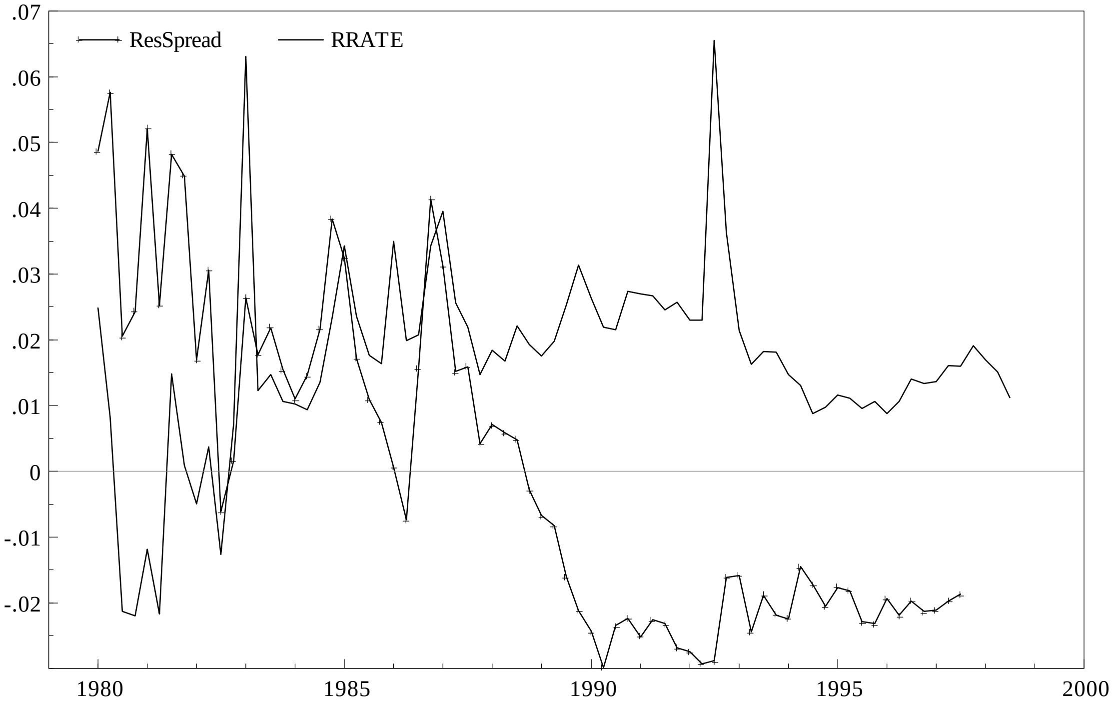


Italy, ex ante short-term real interest rate and adjusted yield spread, 1980Q1-1997Q2, scaled means and ranges (see main text for details)

Figure 5



Belgium, ex ante short-term real interest rate and adjusted yield spread, 1980Q1-1997Q2, scaled means and ranges (see main text for details)



Ireland, ex ante short-term real interest rate and adjusted yield spread, 1980Q1-1997Q2, scaled means and ranges (see main text for details)

Figure 6

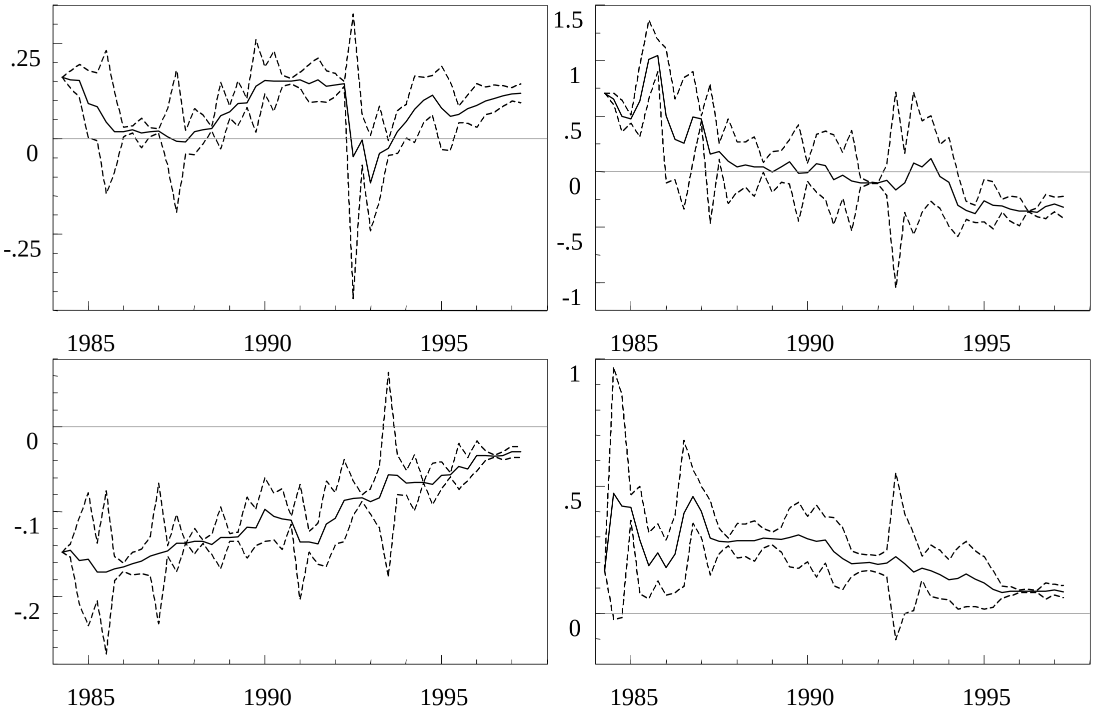


Figure 7. Estimated long-run recursive coefficients on output gaps. France (top left), Italy (top right), Belgium (bottom left), Ireland (bottom right).