

THE EURO AND INFLATION UNCERTAINTY IN THE EMU

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October 2005

Abstract

In this paper, we investigate empirically the relationship between inflation and inflation uncertainty in twelve EMU countries. We estimate a time-varying parameter model with a GARCH specification for the conditional volatility of inflation in order to distinguish between short-run (structural and impulse) and steady-state uncertainty. We then introduce a dummy variable to model the policy regime shift which occurred in 1999 with the introduction of the Euro, and its effects on the links between inflation and inflation uncertainty. We find that the EMU countries have had rather different experiences, and that in the post-Euro period monetary policy might have become less effective in lowering inflation uncertainty, in the sense that a monetary tightening on the part of the ECB might in result in higher uncertainty. This suggests the need for improvements in the ECB's analytical framework.

JEL classification: E31; E52; C22

Keywords: Inflation, Inflation Uncertainty, GARCH models, ECB, EMU

We are grateful to Zubeyir Kilinc for providing the Matlab routines for the estimation.

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1. Introduction

The introduction of the euro and of a common monetary policy in 1999 undoubtedly represented a major policy regime shift for the member countries of the European Monetary Union (EMU). This could have affected both inflation expectations and inflation uncertainty, as, at least initially, agents might not have been certain of the objective function and the policy preferences of the European Central Bank (ECB), and of how they might compare to those of the national central banks previously in charge of monetary policy (for instance, the ECB might have been perceived as less credible than the Bundesbank, which had an established anti-inflation reputation). Uncertainty about the policy preferences of the new monetary authorities might also result in higher inflation forecast errors. According to the Maastricht Treaty, although the primary objective of the ECB is price stability (which the ECB has interpreted as an annual Euro area inflation rate below, but close to, 2% in the medium run), it should also be concerned about output and employment (albeit without prejudicing its main objective). The monetary policy framework adopted by the ECB to fulfil these tasks is based on two analytical perspectives or two “pillars”, namely economic analysis and monetary analysis¹, and the ECB has repeatedly stated that achieving price stability is the most effective way to contribute to output and employment growth (see, e.g. *Monetary Policy Strategy*, 1999), but nevertheless higher uncertainty might have characterised the new economic environment.

Analysing survey data, Heinemann and Ullrich (2004) do not find significant differences in the inflationary credibility of the ECB compared to the Bundesbank, and hence no permanent change in inflation expectations. However, their analysis suggests that the higher uncertainty characterising the period leading up to EMU led to a temporary change in expectation formation, with agents relying more heavily on backward-looking expectations, before reverting to the normal mechanisms once the ECB had established its inflation credibility.

¹ Economic analysis aims at assessing the short- to medium-term determinants of price developments focusing on real activity and financial conditions in the economy. Monetary analysis focuses on a longer-term horizon taking into account the long-run relationship between money and prices. A reference value of 4.5% for the growth rate of broad money (M3) that is compatible with price stability has been calculated using the quantity theory equation. The ECB has stated, though, that “monetary policy does not react mechanically to deviations of M3 growth from the reference value” (see *The Monetary Policy of the ECB*, 2004). As Rudebusch and Svensson (1999, p.1) point out, the ECB strategy “appears to be a combination of a weak type of monetary targeting and an implicit form of inflation targeting”.

As for inflation uncertainty, in a recent review of the performance of the ECB in the first few years of the new regime, its President, Jean-Claude Trichet, has expressed the view that "... the ECB has, despite substantial adverse price shocks, successfully kept inflation and inflation expectations at low levels by historical standards. The single monetary policy and its clear focus on the maintenance of price stability have helped to anchor inflation expectations in the euro area over the medium and the long term. This has facilitated a reduction of inflation uncertainty and the associated risk premia" (see Trichet, 2004).

In this paper, we aim to analyse empirically how the new policy regime with the ECB setting a common interest rate for the EMU countries has in fact affected inflation uncertainty and, consequently, inflation itself in the Euro area adopting an appropriate econometric framework. Specifically, we use a time-varying model with a GARCH specification for the conditional volatility of inflation, as in Evans (1991). This enables us to distinguish between different types of inflation uncertainty which can affect the inflation process. The focus of our analysis is on the policy regime shift which occurred in 1999, and whether this has resulted in a permanent shift in inflation uncertainty and inflation, or whether these have only been temporarily affected. This policy change is modelled by introducing a step dummy corresponding to the introduction of the Euro in the estimated model. The analysis is carried out for twelve EMU countries, over the period 1973-2004, using monthly data.

The layout of the paper is the following. Section 2 reviews the relevant literature. Section 3 outlines the empirical framework and presents the empirical results. Section 4 summarises the main findings and discusses their policy implications.

2. A Brief Literature Review

The relationship between inflation and inflation uncertainty has received increased attention in recent years. Friedman (1977) first argued that higher average inflation would result in more inflation uncertainty. This idea was developed by Ball (1992): in his model, in the presence of two types of policymakers with different preferences who stochastically alternate in power, higher inflation generates higher inflation uncertainty, as agents do not know when monetary authorities with a tougher stance on inflation will replace the current ones. Causality in the opposite direction, namely from inflation uncertainty to inflation, is instead a property of

models based on the Barro-Gordon set up, such as the one due to Cukierman and Meltzer (1986), in which there is an incentive for policymakers to create inflation surprises to raise output growth.

A number of empirical studies have investigated this relationship, normally adopting an econometric framework of the GARCH type (see Engle, 1982), and providing mixed evidence (see Davis and Kanago, 2000 for a survey). For instance, Grier and Perry (1998) estimate GARCH models to generate a measure of inflation uncertainty, and then carry out Granger causality tests. Using data for the G7 countries, they find strong evidence of causality running from inflation uncertainty to inflation, but less empirical support for causality in the opposite direction (see also Baillie et al, 1996). Various studies focus on the US, again with mixed results. Brunner and Hess (1993), and Grier and Perry (1998, 2000), *inter alia*, find evidence of a Friedman effect, with Baillie et al (1996) reporting the opposite. More recently, the impact of inflation targeting on this relationship has been analysed. Kntonikas (2004) reports that the adoption of an explicit target in the UK has resulted in lower inflation persistence and long-run uncertainty. Fountas et al (2004) argue that in the context of EMU the linkages between inflation, inflation uncertainty and output growth have even more important implications for monetary policy, since price stability becomes an even more crucial policy objective for the ECB if inflation is found to affect inflation uncertainty. Further, asymmetries in the effects of inflation uncertainty on output across member countries could make a common monetary policy a less effective stabilisation tool. In fact their empirical analysis, based on EGARCH models, provides evidence supporting the Friedman hypothesis and the presence of asymmetric real effects. However, their sample period is 1960-1999, and hence does not include the new monetary policy setting resulting from the introduction of the euro, whose effects on inflation we wish to examine. Further, their analysis does not distinguish between different types of inflation uncertainty, whilst the approach taken in the present study, as explained below, enables us to measure separately the impact of short-run (structural and impulse) and long-run uncertainty.

3. Econometric Framework

According to Pagan (1984), simultaneous conditional mean and variance estimation as in a GARCH-in-mean (GARCH-M) model is more efficient than a

two-step approach where the conditional variance is estimated first using a GARCH specification, and then included in the conditional mean equation to carry out causality tests. For this reason, a GARCH-M model is estimated by Kontonikas (2004). However, as pointed out by Grier and Perry (1998) and Fountas et al (2004), this approach has the drawback that it does not allow the testing of possible lagged effects of inflation uncertainty on inflation, which might exist at the monthly or quarterly frequency; for this reason, these authors use two-step procedures instead.²

It should also be noted that conventional GARCH models impose a symmetry restriction on the conditional variance. As highlighted by Brunner and Hess (1993), this is inconsistent with the Friedman hypothesis, which implies that new information leading to a downward revision of inflation expectations should also lower inflation uncertainty. Models allowing for an asymmetric impact of news on inflation uncertainty include the EGARCH model of Nelson (1991), which, in contrast to standard GARCH specifications, does not impose non-negativity constraints on the parameter space (this approach is taken by Fountas et al, 2004); the Threshold GARCH (TGARCH) model of Zakoian (1994) and Glosten et al (1993), and the component GARCH (CGARCH) model of Engle and Lee (1993) (both these models are estimated by Grier and Perry, 1998, and Kontonikas, 2004). The CGARCH model has the additional advantage of decomposing inflation uncertainty into a short-run and a long-run component by permitting transitory deviations of the conditional volatility around a time-varying trend.

All the methods discussed above have the drawback that they do not take into consideration the fact that uncertainty about the long- and short-term prospects for inflation might differ significantly and affect inflation expectations in different ways. As emphasised by Evans (1991), agents' temporal decisions are more likely to be affected by the conditional variance of short-run movements in inflation, whilst intertemporal decisions might be based mainly on changes in the conditional variance of long-term inflation. Moreover, one should distinguish between "structural uncertainty" (associated with the randomness in the time-varying parameters, and representing the propagation mechanism), which might originate, for instance, from unanticipated monetary policy changes, and "impulse uncertainty" (associated with the shocks hitting the conditional variance, which are propagated through the parameters of the inflation process), reflecting, for example, changes in

² Fountas et al (2004) also report the estimation results of an EGARCH-M model, which confirm the

the variance of structural disturbances such as price shocks (see Berument et al, 2005).

The econometric framework suggested by Evans (1991), and also adopted by Berument et al (2005) in their analysis of the linkages between inflation uncertainty and interest rates, has the advantage over alternative approaches of yielding estimates of the various types of uncertainty discussed above. Following these authors, in the present study we also utilise a GARCH model with time-varying parameters, which are estimated using Kalman filtering. More specifically, inflation is specified as a k -th order autoregressive process, $AR(k)$, with time-varying parameters, the residuals of this equation following a $GARCH(p,q)$ process. The model is the following:

$$\pi_{t+1} = \mathbf{X}_t \boldsymbol{\beta}_{t+1} + e_{t+1} \quad \text{where} \quad e_{t+1} \sim N(0, h_t) \quad \text{and} \quad \mathbf{X}_t = [1, \pi_t, \dots, \pi_{t-k}] \quad (1)$$

$$h_t = h + \sum_{i=1}^q a_i e_{t-i}^2 + \sum_{j=1}^p \lambda_j h_{t-j} \quad (2)$$

$$\boldsymbol{\beta}_{t+1} = \boldsymbol{\beta}_t + \mathbf{V}_{t+1} \quad \text{where} \quad \mathbf{V}_{t+1} \sim N(\mathbf{0}, \mathbf{Q}) \quad (3)$$

where π_{t+1} denotes the rate of inflation between t and $t+1$; \mathbf{X}_t is a vector of explanatory variables known at time t ; e_{t+1} describes the shocks to the inflation process that cannot be forecast with information known at time t ; e_{t+1} is assumed to be normally distributed with a time-varying conditional variance h_t . The conditional variance is specified as a $GARCH(p,q)$ process, that is, as a linear function of past squared forecast errors, e_{t-i}^2 , and past variances, h_{t-j} . Further, $\boldsymbol{\beta}_{t+1} = [\beta_{0,t+1}, \beta_{1,t+1}, \dots, \beta_{k,t+1}]'$ denotes the time-varying parameter vector, and \mathbf{V}_{t+1} is a vector of shocks to $\boldsymbol{\beta}_{t+1}$, assumed to be normally distributed with a homoscedastic covariance matrix \mathbf{Q} . The updating equations for the Kalman filter are:

$$\pi_{t+1} = \mathbf{X}_t E_t \boldsymbol{\beta}_{t+1} + \varepsilon_{t+1} \quad (4)$$

$$H_t = \mathbf{X}_t \boldsymbol{\Omega}_{t+1|t} \mathbf{X}_t' + h_t \quad (5)$$

$$E_{t+1} \boldsymbol{\beta}_{t+2} = E_t \boldsymbol{\beta}_{t+1} + [\boldsymbol{\Omega}_{t+1|t} \mathbf{X}_t' H_{t-1}] \varepsilon_{t+1} \quad (6)$$

$$\boldsymbol{\Omega}_{t+2|t+1} = [\mathbf{I} - \boldsymbol{\Omega}_{t+1|t} \mathbf{X}_t' H_{t-1} \mathbf{X}_t] \boldsymbol{\Omega}_{t+1|t} + \mathbf{Q} \quad (7)$$

fact that a simultaneous approach does not detect the causal effect of inflation uncertainty on inflation.

where $\mathbf{\Omega}_{t+1|t}$ is the conditional covariance matrix of $\boldsymbol{\beta}_{t+1}$ given the information set at time t , representing uncertainty about the structure of the inflation process.

As Eq. (5) indicates, the conditional variance of inflation (short-run uncertainty), H_t , can be decomposed into: (i) the uncertainty due to randomness in the inflation shocks e_{t+1} , measured by their conditional volatility h_t (impulse uncertainty); (ii) the uncertainty due to unanticipated changes in the structure of inflation \mathbf{V}_{t+1} , measured by the conditional variance of $\mathbf{X}_t\boldsymbol{\beta}_{t+1}$, which is $\mathbf{X}_t\mathbf{\Omega}_{t+1|t}\mathbf{X}_t' = S_t$ (structural uncertainty). The standard GARCH model can be obtained as a special case of our model if there is no uncertainty about $\boldsymbol{\beta}_{t+1}$, so that $\mathbf{\Omega}_{t+1|t} = \mathbf{0}$. In this case, the conditional variance of inflation depends solely on impulse uncertainty³. Eqs. (6) and (7) capture the updating of the conditional distribution of $\boldsymbol{\beta}_{t+1}$ over time in response to new information about realised inflation. As indicated by Eq. (6), inflation innovations, defined as ε_{t+1} in Eq. (4), are used to update the estimates of $\boldsymbol{\beta}_{t+1}$. These estimates are then used to forecast future inflation.

If there are no inflation shocks or parameter shocks, so that $\pi_{t+1} = \pi_t = \dots = \pi_{t-k}$ for all t , we can calculate the steady-state rate of inflation, π_{t+1}^* , as:

$$\pi_{t+1}^* = \beta_{0,t+1} \left[1 - \sum_{i=1}^k \beta_{i,t+1} \right]^{-1} \quad (8)$$

The conditional variance of steady-state inflation is then given by:

$$\sigma_t^2(\pi_{t+1}^*) = \nabla E_t \boldsymbol{\beta}_{t+1} \mathbf{\Omega}_{t+1|t} \nabla E_t \boldsymbol{\beta}_{t+1}' \quad (9)$$

³ As Evans (1991) argues, if there is uncertainty about $\boldsymbol{\beta}_{t+1}$, h_t will tend to understate the true conditional variance since $S_t > 0$.

$$\text{where } \nabla E_t \boldsymbol{\beta}'_{t+1} = \begin{bmatrix} \left(1 - \sum_{i=1}^k E_t \beta_{i,t+1}\right)^{-1} \\ E_t \beta_{0,t+1} \left(1 - \sum_{i=1}^k E_t \beta_{i,t+1}\right)^{-2} \\ \dots \\ E_t \beta_{0,t+1} \left(1 - \sum_{i=1}^k E_t \beta_{i,t+1}\right)^{-2} \end{bmatrix} \text{ is a } (k+1 \times 1) \text{ vector.} \quad (10)$$

Having computed short-run and steady-state uncertainty measures for each country, we then proceed, in the second part of our empirical investigation, to analyse the links between the various types of inflation uncertainty and the level of inflation, as well as examine the impact of the Euro. Specifically, we regress month-to-month changes in the two uncertainty measures against changes in past inflation⁴. Moreover, we include a dummy variable to allow for possible intercept and slope changes in the underlying relationship between inflation uncertainty and past inflation reflecting the introduction of the Euro. The estimated model is the following:

$$\Delta unc_{t+1} = \gamma_0 + \gamma_1 D_{t+1} + (\gamma_2 + \gamma_3 D_{t+1}) \Delta \pi_t + \theta_{t+1} \quad (11)$$

where unc_{t+1} represents in turn steady-state uncertainty (i.e. $\sigma_t^2(\pi_{t+1}^*)$) and short-run uncertainty (i.e., H_t), and D_{t+1} is a dummy variable equal to zero during the pre-Euro period and one during the post-Euro period⁵.

4. Empirical Analysis

Inflation is measured as the first difference of the logarithm of the seasonally adjusted consumer price index (CPI), $\pi_{t+1} = 100 * (\ln CPI_{t+1} - \ln CPI_t)$, using monthly data for twelve EMU countries (Germany, France, Italy, Spain, Portugal, Greece, Ireland, Finland, Belgium, Netherlands, Luxembourg, Austria) over the period 1973-2004. Six years of the Euro period are included in our sample⁶, allowing us to study

⁴ As Evans (1991, p. 180) notes, “the regressions use the month-to-month changes in the variances and inflation because inflation has a unit root and all three variances are complicated functions of past inflation”.

⁵ In the case of Finland, where inflation targeting was adopted over the period 1993-1998, we also included intercept and level dummies for this policy change, but these turned out not to be statistically significant.

⁶ As Greece adopted the Euro only in January 2001, the corresponding sub-sample is four years.

the effects of the 1999 policy regime shift on inflation uncertainty over a reasonably long horizon. The data are obtained from OECD's *Main Economic Indicators: Historical Statistics*.

Table 1 reports the results from ADF (see Dickey and Fuller, 1979, 1981) and KPSS (see Kwiatkowski, Phillips, Schmidt, and Shin, 1992) unit root tests with an intercept and a deterministic linear trend. Overall, the results suggest that inflation in our sample countries has a unit root, which can justify our choice of a random walk model for the time varying parameters of the inflation process (see Evans, 1991).

[Table 1 about here]

[Figure 1 about here]

Figure 1 plots actual inflation and steady-state inflation over the period 1980.01-2004.11. Average monthly inflation rates vary considerably across the countries in our sample, ranging from 0.2% in Germany to 1% in Greece. Similarly to the former country, mean monthly inflation rates in the Benelux countries (Belgium, Netherlands, Luxembourg) and Austria were low: 0.26%, 0.21%, 0.26% and 0.23%, respectively. Steady-state inflation follows similar patterns, with Greece exhibiting the worst performance, with an annualised steady-state inflation rate of 12%, while in Germany the corresponding value was 2.5%. The presence of such inflation differentials is not surprising, as it is a normal feature of a monetary union. The ECB itself admits that “monetary policy can only influence the price level of the Euro area as a whole and cannot affect inflation differentials across regions” (see *The Monetary Policy of the ECB*, 2004). Nevertheless, from the viewpoint of monetary policy effectiveness in stimulating economic growth, inflation rates in EMU countries should converge in order for changes in the Euro-wide nominal interest rate to be translated into similar real interest rate changes across member countries.

[Figure 2 about here]

Figure 2 plots short-run uncertainty and steady-state uncertainty. The former appears to have decreased over time along with average inflation in Portugal and Greece, while in France it has increased. In Italy, Spain, Ireland and Finland one can

identify large increases in short-run uncertainty in the first part of the 1980s followed by a relatively stable period. In Germany a large temporary increase in short-run uncertainty can be noticed around the time of the re-unification in the early 1990s. Short-run uncertainty in the Netherlands and Austria is relatively stable, apart from occasional temporary shocks. The same applies to Luxembourg, with the exception of a large temporary jump in 1999. It should be pointed out that some short-term volatility in inflation is inevitable given the fact that monetary policy can only affect prices with long and uncertain lags - hence the focus of the ECB on medium-term price stabilisation.⁷

Regarding the uncertainty associated with long-run inflation, it appears again that a uniform experience did not occur, since steady-state uncertainty seems to increase towards the end of the sample period in Germany, Italy, Spain, Portugal, Luxembourg and Austria, while in France, Ireland, Finland and Belgium it declines over time. Only in the Greek case does the uncertainty associated with steady-state inflation increase steadily throughout the sample period. Clearly, the presence of such significant differentials across the countries of the Euro area in terms of long-run (as opposed to short-run) uncertainty has more important policy implications, given the focus of the ECB on maintaining price stability in the Euro area over longer periods of time.

[Figure 3 about here]

Figure 3 plots inflation persistence (the sum of the estimated autoregressive coefficients in the inflation specification) and the trend component of inflation (the estimated constant in the inflation process). The former increases over time in Germany, Italy, Spain and Austria. In some cases (Finland, Belgium, Netherlands, Luxembourg) it becomes negative. This can be interpreted in terms of an error-correction mechanism in inflation: as inflation grows large, the central bank adopts tougher anti-inflationary policies. Trend inflation decreases over time in the majority of the sample countries, reflecting the general move towards lower inflation after the highly inflationary 1970s.

⁷ In the early years of the new monetary regime the Euro area was affected by a variety of price shocks such as the tripling of oil prices between early 1999 and mid-2000, the depreciation of the

[Table 2 about here]

Table 2 reports robust estimates of the parameters of Eq. (11) (see Newey and West, 1994). Consistently with the hypothesis put forward by Friedman (1977) and formalised by Ball (1992), the coefficient of past inflation, γ_2 , is positive and significant in six out of our twelve sample countries in the steady-state uncertainty regressions, i.e. in the case of France, Italy, Portugal, Belgium, Luxembourg and Austria. When the change in short-run uncertainty is employed as a dependent variable, γ_2 is significantly positive in five instances, i.e. in Germany, France, Portugal, Greece and Ireland⁸. This suggests that, by lowering average inflation, monetary authorities can reduce the negative consequences of inflation uncertainty.

As for the impact of the Euro and common monetary policy on inflation uncertainty, we find that the coefficient of the level dummy, γ_1 , is positive and statistically significant for Italy and Austria in the steady-state regressions, indicating that post-Euro, steady-state uncertainty has increased in these countries. The coefficient of the slope dummy, γ_3 , is negative and statistically significant in eight countries (Germany, France, Italy, Spain, Greece, Belgium, Luxembourg, Austria) in the steady-state regressions and in three countries (Germany, Greece, Ireland) in the short-run regressions. This indicates an important change in the underlying relationship between inflation and uncertainty occurring in these countries as a result of the introduction of the Euro, since a negative and significant γ_3 implies that post-Euro further reductions in average inflation increase, rather than reduce, uncertainty. The Wald F-statistic for the null hypothesis: $\gamma_2 + \gamma_3 = 0$, indicates that post-Euro the relationship between past inflation and current short-run uncertainty breaks down in the case of Germany, Greece, Ireland, while in the steady-state regressions the null hypothesis is not rejected in the case of Luxembourg and Austria. Thus, in many instances, the Friedman-Ball link that calls for policies aiming at low inflation in order to reduce the corresponding uncertainty appears not to exist in the post-Euro period. This finding may reflect the fact that inflation has been relatively low in all advanced economies since the 1990s, irrespective of whether or not an explicit inflation target was in place. Therefore, there might not be room for further reductions in average inflation, with the associated risk of generating deflationary

common currency over this period, and finally, in 2001, significant increases in food prices, due to a series of livestock epidemics.

⁸ This is in line with previous evidence for the UK (see Kontonikas, 2004).

pressures, and policies aimed at achieving even lower inflation may paradoxically result into higher uncertainty.

6. Conclusions

In this paper, we have investigated empirically the relationship between inflation and inflation uncertainty in twelve EMU countries. Following Evans (1991) and Berument et al (2005), we have adopted a time-varying GARCH specification to model the conditional volatility of inflation in order to be able to distinguish between short-run (structural and impulse) and steady-state uncertainty. We have also analysed the impact on the links between inflation and inflation uncertainty of the policy regime shift which occurred in 1999, when the Euro was introduced and the ECB was given the task of setting a common monetary policy for all EMU countries.

Our empirical findings can be summarised as follows. The inflation performance of the EMU member states has been very different over the whole period starting at the beginning of the 1980s, in terms of both actual and steady-state inflation. Similarly, no consistent pattern can be found for the degree of persistence of inflation. By contrast, as one would expect given the less inflationary environment prevailing after the inflation hike of the 1970s, trend inflation has generally become much lower. Concerning short-run and steady-state uncertainty, again the EMU countries appear to have had rather different experiences, with no clear picture emerging. Most interestingly and perhaps controversially, it appears that in many cases the introduction of the Euro has not been beneficial from the viewpoint of inflation uncertainty. In Austria and Italy, for example, we find a step increase in post-Euro steady-state uncertainty. Moreover, in these and other six countries, i.e. Germany, Greece, France, Spain, Belgium and Luxembourg, it would seem that the pursuit of anti-inflationary policies by the ECB is counterproductive, in the sense that lower inflation might lead to higher steady-state uncertainty. The same applies to short-run uncertainty in the case of Germany, Greece and Ireland, where the Friedman-Ball link between inflation and inflation uncertainty is not found in the post-Euro period.

On the whole, one could conclude that the monetary policy of the ECB has not been an unqualified success as suggested by its President, Mr. Trichet. Although it is true that inflation has been relatively low in the EMU countries under the new

regime, this also applies to all other OECD economies over the same period, and cannot obviously be attributed to the policy actions of the ECB. Moreover, it is not clear that inflation uncertainty has been reduced by the introduction of the Euro as claimed. By contrast, it seems that in the new economic environment monetary policy might have become less effective in lowering inflation uncertainty, in the sense that a monetary tightening on the part of the ECB might result in higher uncertainty. A higher level of long-run inflation uncertainty may be the result of conflicting economic and monetary signals, and lack of transparency in the two-pillar strategy employed by the ECB. As Bofinger (2002, p.11) argues, “In sum, while the first pillar is too narrowly focused on the money stock M3...the second pillar is much too broad to provide any guidance for the ECB’s internal decisions or its dialogue with public”. Rudebusch and Svensson (1999) also point out that emphasis on using movements in the stock of money as a rationale for policy is undesirable since it may result in higher inflation and output variability. Hence, although it should be kept in mind that the ECB is concerned with price stability of the Euro area as a whole, it appears that improvements could be made to its analytical framework with a view to lowering the estimated long-run uncertainty in individual member countries - for instance, a more explicit focus on the inflation forecast might be useful in this respect.

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TABLES AND FIGURES

Table 1: Unit Root Tests

Countries	ADF test statistic		KPSS test statistic	
	Constant	Constant and Trend	Constant	Constant and Trend
Germany	-2.319	-2.605	2.235 ***	0.244 ***
Italy	-1.144	-3.375 *	1.999 ***	0.273 ***
France	-1.461	2.896	1.646 ***	0.385 ***
Spain	-1.006	-2.751	3.222 ***	0.451 ***
Portugal	-1.579	-3.568 **	2.634 ***	0.277 ***
Greece	-2.006	-2.704	1.845 ***	0.34 ***
Ireland	-1.595	-2.539	2.232 ***	0.262 ***
Finland	-1.181	-3.132	2.037 ***	0.222 ***
Belgium	-1.929	-2.765	2.121 ***	0.265 ***
Netherlands	-1.787	-1.965	2.578 ***	0.864 ***
Luxembourg	-2.438	-2.523	3.195 ***	0.304 ***
Austria	-2.369	-2.684	3.282 ***	0.301 ***

Note:

- (a) The number of lagged difference terms in the regressions was chosen by the modified Akaike criterion in the ADF regressions. The Andrews bandwidth was used in the KPSS regressions.
- (b) The reported ADF statistics test the null hypothesis that inflation contains a unit root. The reported KPSS statistics test the null hypothesis that inflation is stationary.
- (c) ***, **, * indicate rejection of the null hypothesis at 1, 5, 10 % level of significance.

Table 2: Robust estimates of Eq. (11), 1980-2004

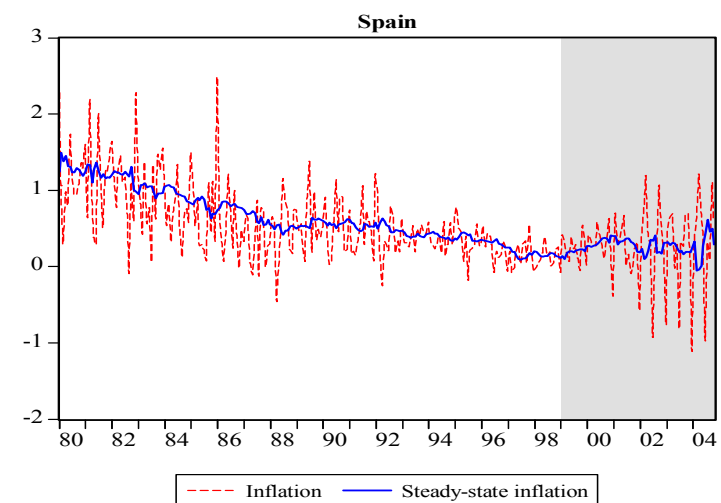
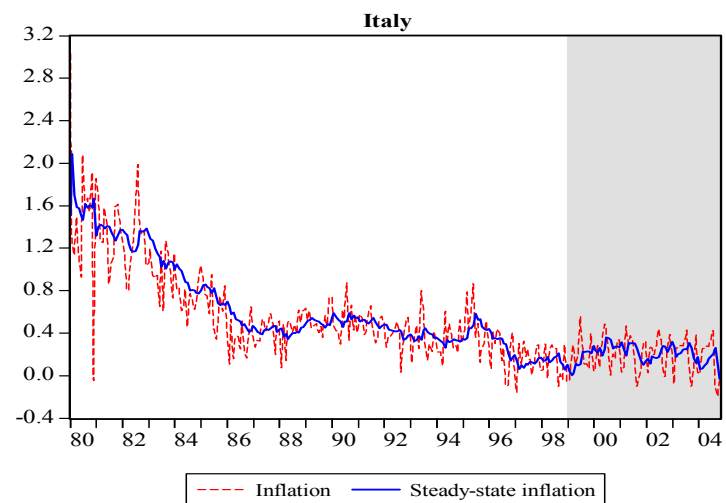
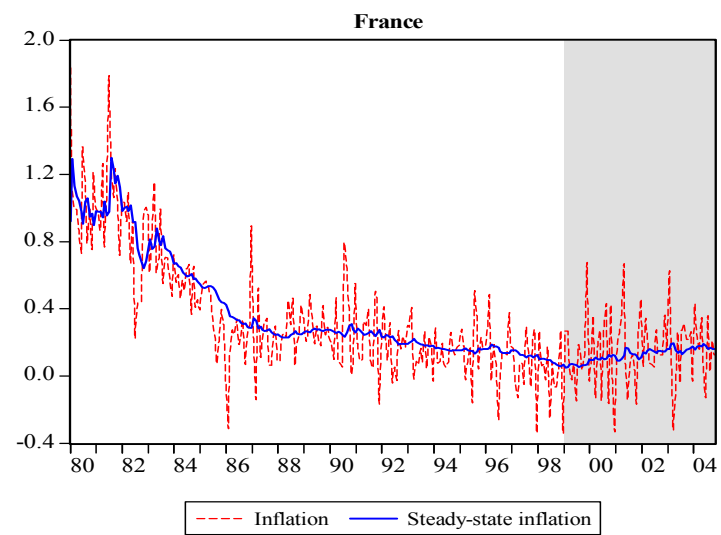
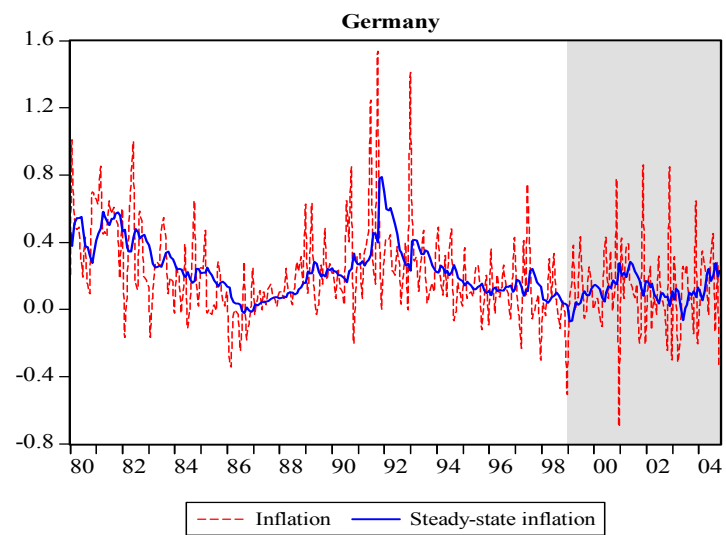
	Germany		France		Italy		Spain	
	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t
γ_0	-0.001	0.0002	-0.0004	0.008	0.002	-0.003	0.004 *	-0.001
γ_1	0.002	-0.00006	0.001	-0.020	0.031 *	0.003	0.130	0.003
γ_2	0.009	0.1 ***	0.049 **	0.329 *	0.099 *	-0.039	-0.004	0.029
γ_3	-0.015 *	-0.106 **	-0.045 **	0.047	-0.235 **	0.041	-1.187 ***	-0.037
R^2	0.044	0.225	0.215	0.084	0.165	0.052	0.22	0.032
σ_θ	0.013	0.05	0.021	0.317	0.078	0.049	0.674	0.076
Wald F-stat $\gamma_2 + \gamma_3 = 0$	-	0.053	10.352 ***	-	3.306 *	-	-	-

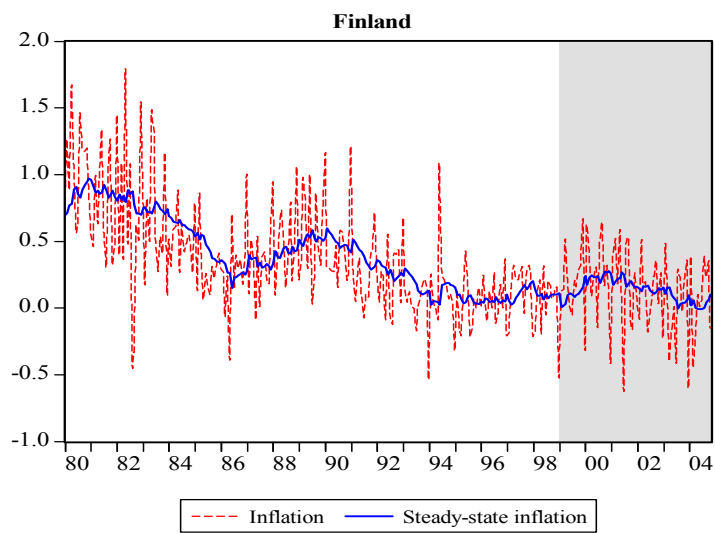
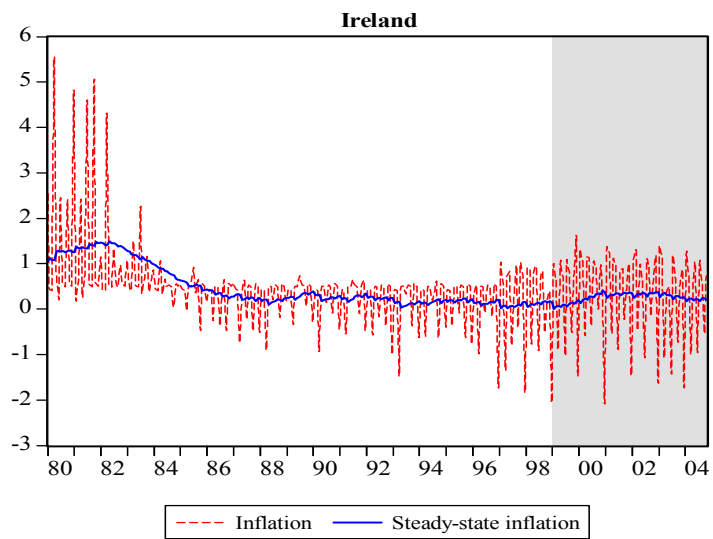
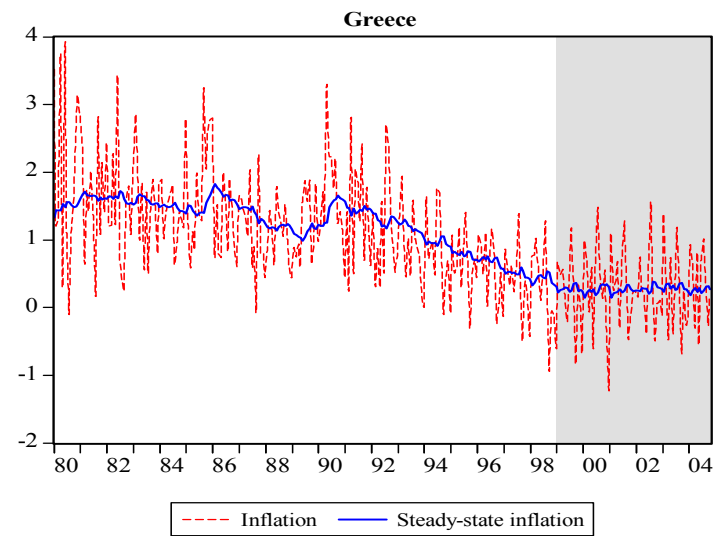
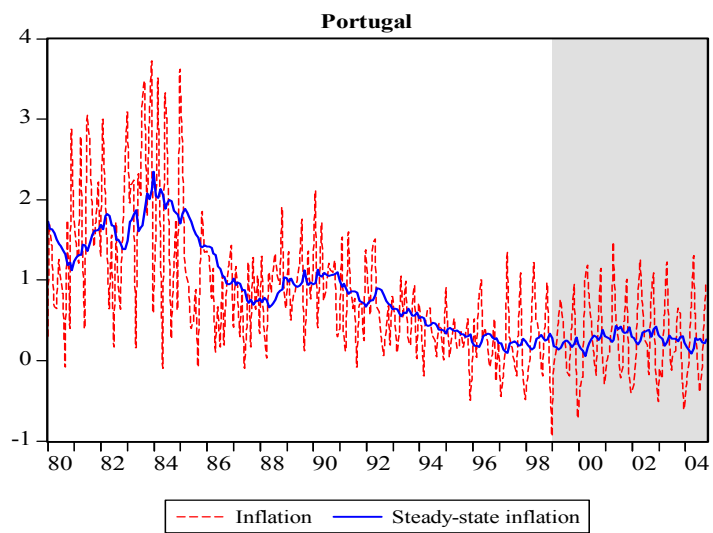
	Portugal		Greece		Ireland		Finland	
	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t
γ_0	0.0001	-0.007	0.001	-0.009	-0.0001	-0.005	-0.0003	-0.002
γ_1	0.002	0.004	-0.001	0.009	0.0001	0.008	0.0001	0.004
γ_2	0.023 ***	0.052 *	-0.0004	0.038 *	-0.00002	0.109 **	0.0025	0.001
γ_3	0.005	-0.028	-0.005 ***	-0.036 *	0.0007 ***	-0.107 **	0.0012	-0.011
R^2	0.177	0.054	0.076	0.092	0.101	0.115	0.028	0.019
σ_θ	0.042	0.169	0.007	0.106	0.002	0.338	0.007	0.026
Wald F-stat $\gamma_2 + \gamma_3 = 0$	-	-	-	0.049	-	0.02	-	-

	Belgium		Netherlands		Luxembourg		Austria	
	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t	$\sigma_t^2(\pi_{t+1}^*)$	H_t
γ_0	-0.0003	-0.0004	0.0005	-0.00001	0.00007	-0.002	0.0005	0.0002
γ_1	0.001	0.001	0.0002	0.0002	0.002	0.002	0.002 **	0.0001
γ_2	0.013 ***	-0.011	-0.024	-0.03	0.025 *	0.001	0.004 ***	0.002
γ_3	-0.01 ***	0.008	0.020	0.066	-0.026 *	-0.002	-0.004 **	-0.0002
R^2	0.136	0.03	0.033	0.071	0.033	0.001	0.133	0.005
σ_θ	0.01	0.02	0.041	0.045	0.048	0.037	0.004	0.014
Wald F-stat $\gamma_2 + \gamma_3 = 0$	34.313 ***	-	-	-	0.188	-	0.002	-

Note: σ_θ represents the standard deviation of the regression's residuals.

Figure 1: Actual inflation and steady-state inflation, 1980-2004.





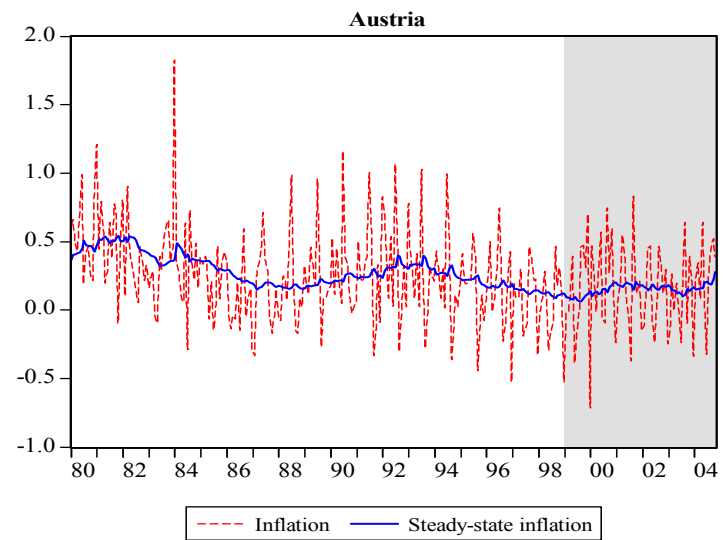
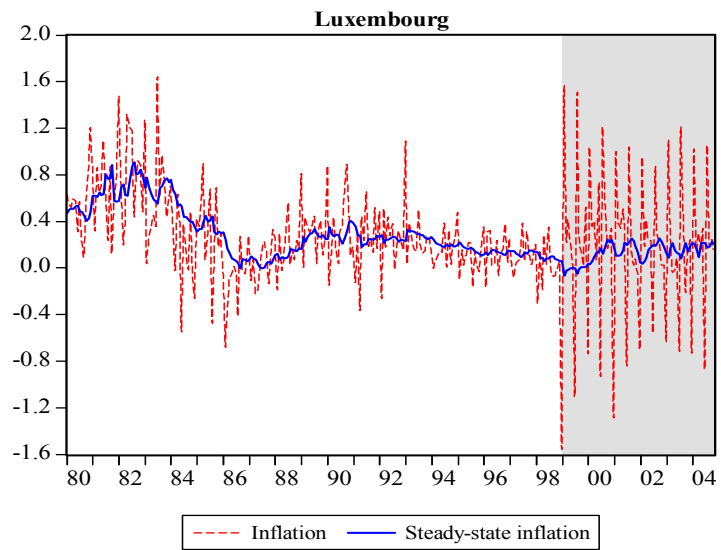
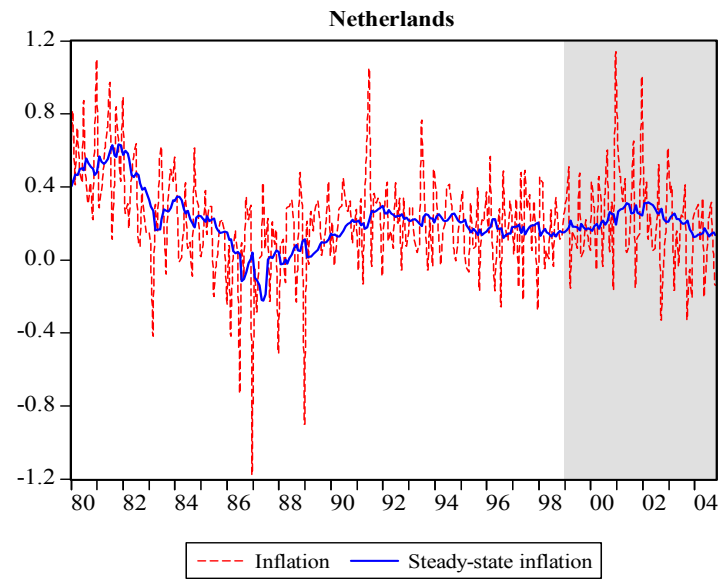
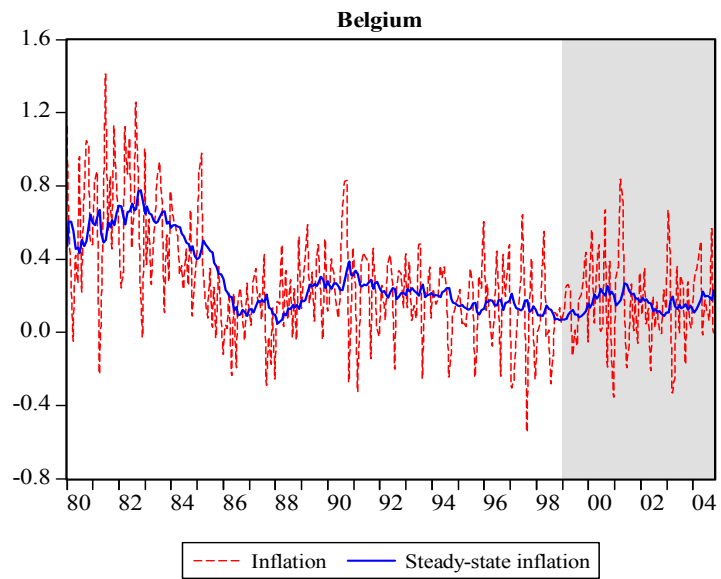
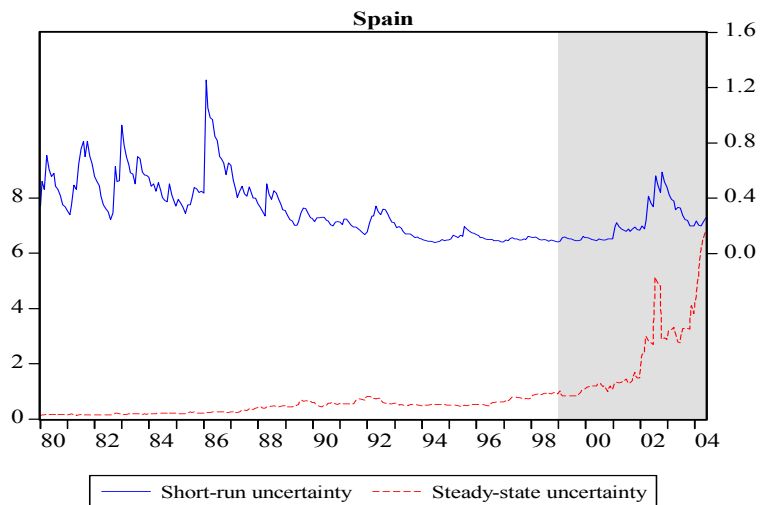
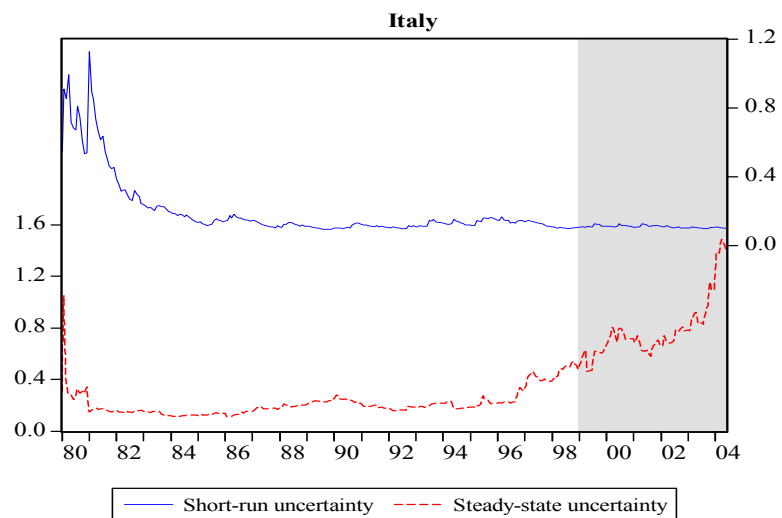
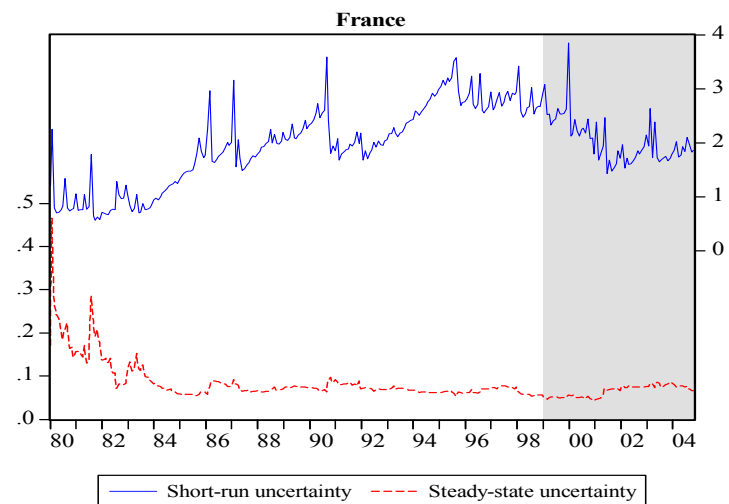
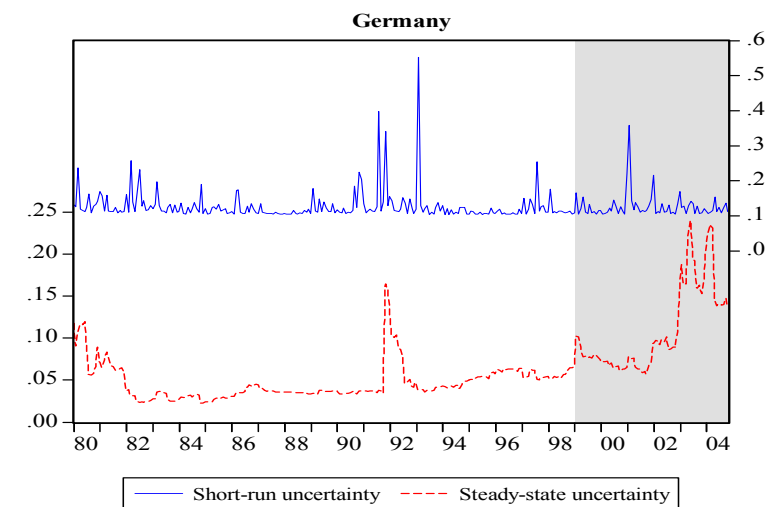
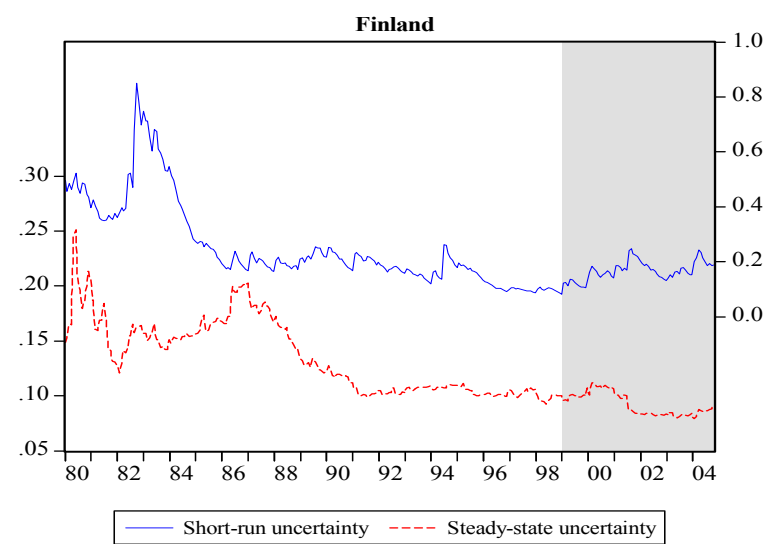
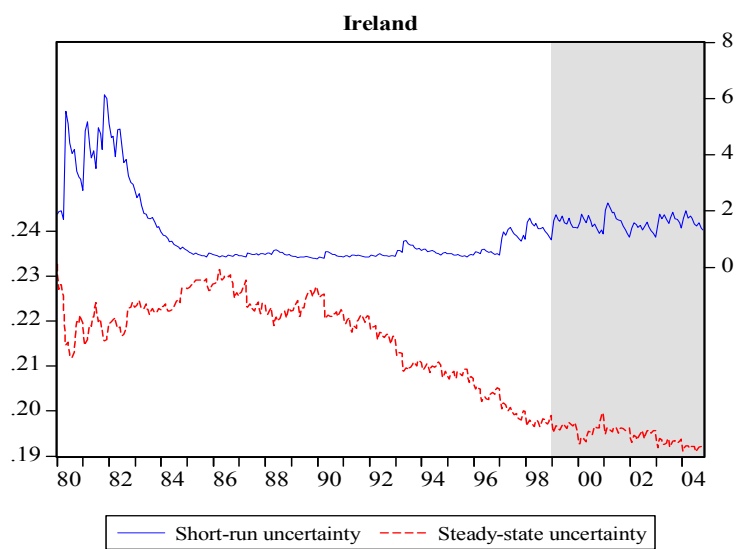
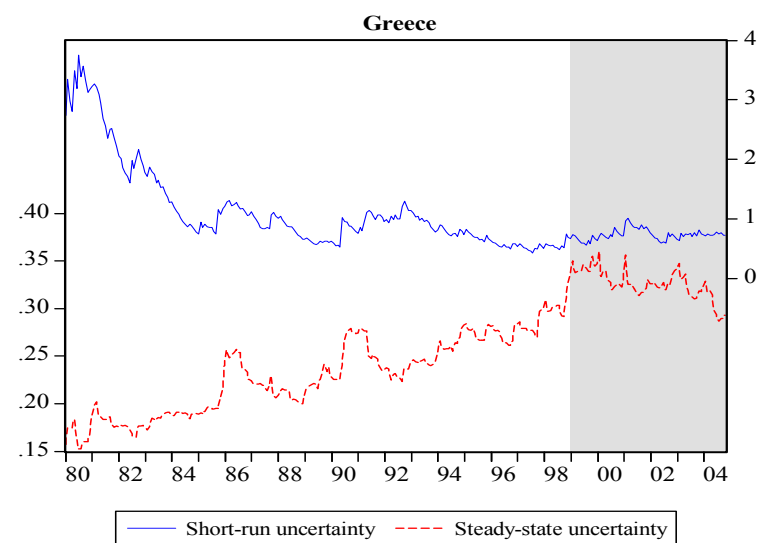
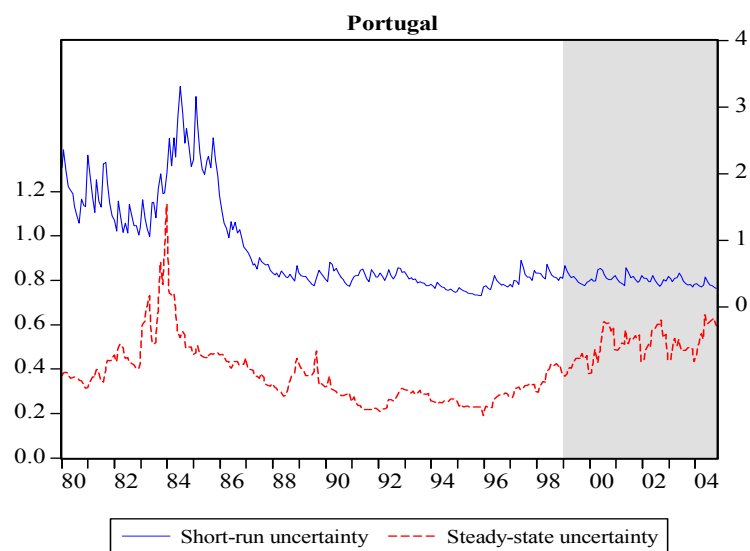


Figure 2: Short-run and steady-state inflation uncertainty, 1980-2004.





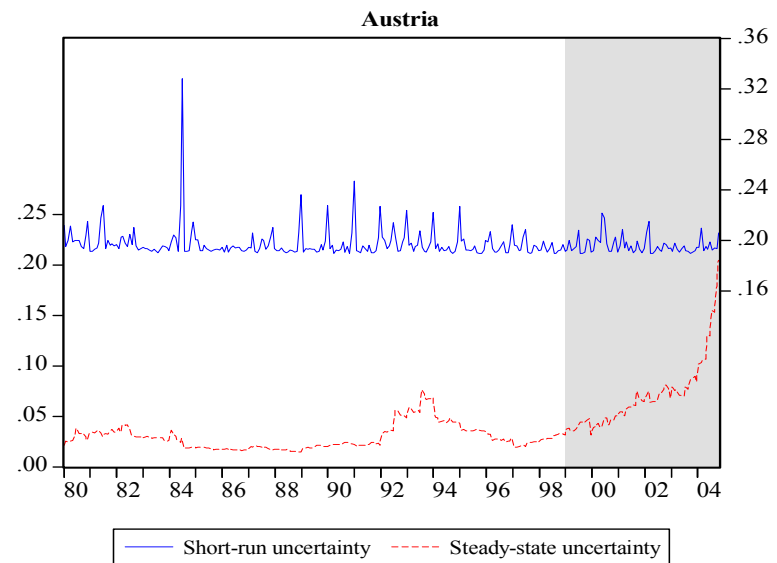
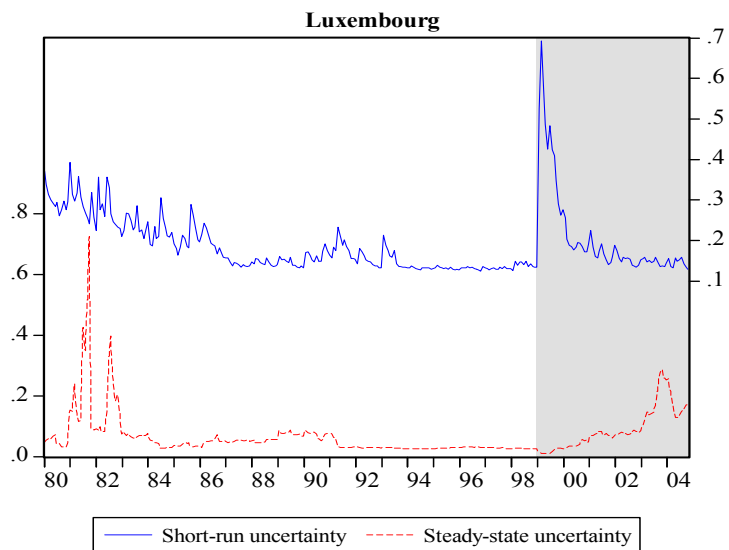
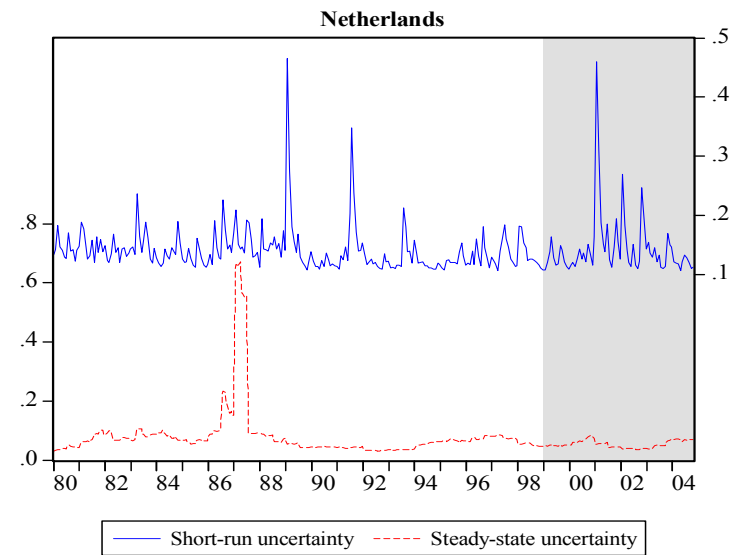
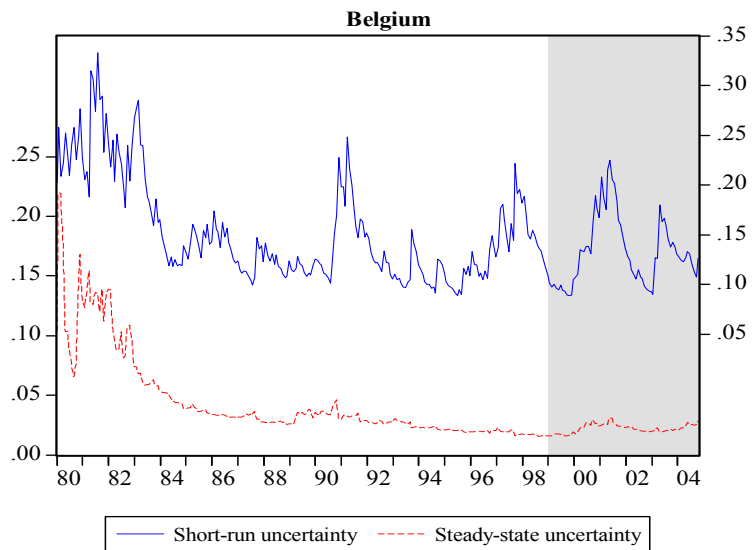


Figure 3: Inflation persistence and trend inflation, 1980-2004.

