Monetary Policy Orientation in Times of Low Inflation

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1. Introduction

The past twenty years have seen a general reduction in inflation rates to very low levels everywhere in the OECD. The general return to (almost) price stability reflects a shift in monetary-policy phlosophies from an attitude of actively exploiting the Phillips curve to manage the macro economy to a more modest one aiming at stable monetary conditions and low inflation. This shift in monetary policy philosophies has had its repercussions in the move to more independent central banks and the adoption of rules-based regimes such as inflation targeting.[1] In Europe, it has its visible reflection in the EU Treaty of 1997 and the charter of the ECB, which, for now, made price stability the principal goal of monetary policy.[2]

The changing pattern of monetary policy has been accompanied by a change in the view most economists take on the inflationary process and the role of monetary policy in it. 20 years ago, it was widely accepted that the main cause of inflation was excessive money growth, and that to keep inflation down the central bank had to control the growth rate of money. Today's New Keynesian consensus model of monetary policy transmission does not even make the role of money in determining the rate of inflation explicit. Instead, it sees the main role of the central bank in setting an interest rate that affects the output gap, which in turn determines the rate of inflation through the Phillips curve. Much of that shift in the consensus view on monetary policy transmission is due to the empirical observation that, both in the US and in Europe, the correlation between money growth and inflation seems to have all but vanished. Based on this observation, many economists have criticized the ECB's original monetary policy framework, which assigned the growth rate of money the first of "two pillars" of its monetary analysis for being out-dated and, hence, inappropriate.[3] Responding to these critics, the ECB recently downgraded the role of money in its policy framework.[4]

This critique, and the consequences taken, however, may well be rushing to unfounded conclusions. The general reduction in inflation rates of the past 30 years has come with a general decline in the volatility of inflation, too. If this is due to less expansionary and less volatile money growth rates, it could well be the result of

[1] For a review of the experience with inflation targeting see Neumann and von Hagen (2002).
[2] After several years of enjoying near price stability, the drafters of the new EU Treaty have eliminated price stability as an explicit policy goal.
[3] See e.g. Alesina et al. (2001), De Grauwe and Nolan (2001), Galí (2001), Svensson (2002).
[4] Specifically, the ECB (ECB, 2003), in a statement of May 2003 reversed the roles of the first and the second pillar and renounced the regular assessment of the monetary reference in the future.

monetary policies aiming at lower and less volatile inflation. Furthermore, as we will show below, the empirical correlation between inflation rates and the output gap has also decreased in the euro area in recent years. This implies that the empirical performance of the consensus model has deteriorated as well.

An important policy implication of these observations is that the traditional signals central banks look at to assess future inflation, namely money growth and output gaps, become less informative, when the level of inflation is low. In this paper, we explore this point and its consequences in more detail. Our main point is that in times of low inflation central banks should focus mainly on the underlying inflation trend rather than on high-frequency changes in inflation. Empirically, this means that they should use information from long-run movements in the determinants of inflation. In principle, they can do that by looking at long-run movements in money, real output and interest rates, or long-run movements in the output gap. However, long-run movements in the output gap are uninformative, since the output gap is zero on average over the business cycle by construction. The implication is that, despite the lower correlation between money growth and inflation at high frequencies, central banks should watch monetary trends especially when inflation is low.

The remainder of this paper is organized as follows. Section 2 reviews the development of monetary and inflation trends in the past 30 years. Section 3 presents a version of the consensus model to interpret these observations. Section 4 reports our empirical estimates showing that the empirical correlation between money growth and inflation has declined as inflation rates have come down, and that the same is true for output gaps and inflation. Furthermore, we develop a model of trend inflation and show that this model continues to predict inflation well even in times of low inflation. Section 5 concludes.

2. Inflation and Monetary Volatility: Empirical Trends

Several recent studies have reconsidered the empirical correlation between money growth and inflation that stands behind Friedman's famous dictum that inflation is always and everywhere a monetary phenomenon. McCandless und Weber (1995) show the high correlation between money growth and inflation in a sample of 110 countries over the period from 1960 to 1990; see figure 1. According to their evidence, high money growth rates are coupled with high inflation rates, while low money growth rates go with low inflation. Their results are robust to variations in the

definition of money and changes in the sample countries. However, the figure reveals that the strength of the correlation is higher for high than for low rates of inflation. King (2001) replicates their study for 116 countries from 1968 to 1998. His basic result is the same. In addition, he shows that the correlation between inflation and money growth becomes visible only if both are averaged over more than ten years.[5] Lucas (1980) finds a strong, positive correlation between US annual inflation and money growth rates, and shows that this increases when short-tun fluctuations are filtered out of the data. Tanner (1993) shows that the correlation between annual US inflation and money growth rates declines in the 1980s compared to the 1970. Christiano und Fitzgerald (2003) find that the correlation between these two variables is positiv and stable for long frequencies in US data spanning the 20th century. After 1960, this correlation has declined for short frequencies.

Friedman and Kuttner (1992) show empirically that monetary aggregates have no marginal information value for US inflation after 1980. Estrella and Mishkin (1997) even ask "Is there a role for money in monetary policy" and conclude that, based on VAR evidence, the answer must be unambiguously "no." Similarly, Stock and Watson (1999) find that the information value of monetary aggregates in inflation forecasts is negligible if not even negative. For the euro area, Gerlach and Svensson demonstrate that growth rates of the ECB's broad monetary aggregate M3 do not Granger-cause inflation. Nicoletti Altimari (2001) follows the Stock and Warson methodology to estimate the marginal information content of money for euro-area inflation. He finds no or little information value for short forecast horizons. Trecroci and Vega (2002) estimate a multivariate VAR with money, output, inflation, short and long-term interest rates and find no Granger causality of money growth for inflation.

DeGrauwe und Polan (2001) are among the most forceful critics of Friedman's dictum and the empirical results mentioned above. Using data for 165 countries and 30 years, they show that the strength of the correlation depends critically on the level of the inflation rate. They report that regressions of inflation on money growth are significant only for inflation rates above 17.4 percent. De Grauwe and Polan conclude that central banks should pay no attention to monetary developments as long as inflation is low or moderate. Similarly, Svensson (2002) argues that money or monetary growth rates are irrelevant for monetary policy in times of low inflation.

[5] Further results supporting the same conclusions are found in Barro (1990), Dwyer and Hafer (1988,

But this conclusion seems premature. Consider the following, simplified representation of money and the price level.

$$\begin{aligned} P_t &= P_t^* + \mu_t, \\ P_t^* &= M_t^* \\ M_t &= M_t^* + \xi_t \\ \Delta M_t^* &= \pi^* + \varepsilon_t. \end{aligned} \tag{1}$$

Here, P is the logarithmic price level and M the logarithmic money supply. The prices level fluctuates randomly around its trend value, P*, e.g., due to temporary shocks to food prices or cost shocks. Similarly, the money supply fluctuates around its trend level M*. Here, the price level trend and the monetary trend are assumed to be proportional to each other. Trend money grows with the permanent (drift) term, π^*, and a random shock, ε.

Assume, for simplicity, that the two temporary level shocks, μ and ε, are uncorrelated. Then the correlation between the average inflation rate and the average money growth rate over T periods is

$$\rho_T = \frac{\mathrm{var}(\varepsilon)}{\sqrt{\mathrm{var}(\varepsilon) + 2T^{-1}\,\mathrm{var}(\xi)}\sqrt{\mathrm{var}(\varepsilon) + 2T^{-1}\,\mathrm{var}(\mu)}}. \tag{2}$$

This says, first, that the estimated correlation coefficient increases with the length of the period, T, over which we compute the averages. The reason is that the temporary level shocks wash out as we consider longer and longer periods. This reproduces King's (2001) observation mentioned above. Second, periods characterized by a series of large money growth shocks, ε, are characterized by a larger correlation between money growth and inflation. In contrast, when money growth shocks are small, the correlation becomes weaker. Thus, if declining and low money growth rates have reduced volatility, the correlation of money growth and inflation becomes weaker. Finally, suppose that the central bank aims at a constant monetary policy in the sense that growth rate shocks completely disappear. In this situation, the correlation between money growth and inflation disappears altogether. However, the trend inflation rate is given by π^*, the trend money growth rate set by the central bank. Obviously, to conclude that money growth has no information about inflation would be completely unwarranted in this situation.

1999), and Poole (1994).

In Table 1, we provide some background data for this reasoning. The first part of this table collects the standard deviations and averages of monthly series of annual inflation rates in 14 OECD countries from 1966 to 2002. Inflation is measured on the basis of consumer price indexes. We consider five sub-periods: The final years of the Bretton Woods System, 1966-1972, the years of oil price shocks and the European „Snake“ (an exchange rate peg of several European countries to the DM), 1973-1978, the years of the European Monetary System, 1979-1991, the early 1990s, 1992-1996, and the late 1990s, 1997-2002. The early 1990s are interesting, because this is the period when several OECD countries started the new regime of inflation targeting. The table shows that inflation rates became much more volatile after the end of the Bretton Woods System. Average inflation rates went up at the same time. Inflation volatility peaked in the 1980s, when inflation rates came down everywhere. The 1990s feature low inflation rates and low volatility.

The second part of the table collects the averages and standard deviations of monthly series of annual money growth rates in the same countries and years. Here, the development of average growth rates is not as clear cut. But with regard to volatilities, we observe a very similar tendency. The volatility of money growth rates generally increased substantially in the 1970s and declined substantially in the 1990s. Interestingly, this is true also for the inflation targeting countries, Sweden, the UK, Canada, and Australia. Thus, at a first glance, the data are consistent with the notion that the observed correlation between money growth and inflation may have declined due to the fall in the volatility of money growth shocks and, hence, inflation. Below, we explore this relationship further. At this point, we simply note that the data do not justify the conclusion that monetary developments have become irrelevant for monetary policy.

A convenient way to judge the indicator property of money for the inflation rate is the P* - approach of Hallman et al. (1991).[6] It inverts the quantity equation to derive a long-run equilibrium price level, $P_t^* = M_t - y_t - v_t$, where v_t is the log of the velocity of money and y_t is log output. The P* approach assumes the existence of a stable long-run money demand function, which we interpret as the existence of a stable, co-integrating relationship between the price level, the money supply, and real output. The main determinant of the velocity of money is the opportunity cost of

[6] Von Hagen and Hayo (1999) were the first to show that this approach yields a good empirical representation of euro area inflation in the 1980s and 1990s.

holding money, which we approximate by the government bond yield.[7] We estimate the long-run money demand function in the euro area based on a co-integrating VAR over the period 1980:1-2002:4. The VAR includes real M3 (currency in circulation, checkable, time and savings deposits and certificates of deposits issued by banks), real GDP and the nominal ten year government bond yield, Rl. Real M3 is defined by nominal M3 deflated with the euro-area consumer price index, HICP. The VAR contains a centered impulse dummy for the third quarter 1990 dummying out a large outlier in the money equation associated with German reunification.

The results are reported in Table 2. The Johansen trace test suggests a single long-run relationship, which we identify by normalizing on the real money coefficient. The restriction that the coefficient on real GDP is one could not be rejected and was therefore imposed. The estimated co-integrating vector states that long-run money demand is homogenous in real GDP and the price level and depends negatively on the government bond yield. Thus, the long-run velocity of money is a positive function of the long-term interest rate.

The long-run money demand relationship yields a solution for P* of

$$P_t^* = M_t - y_t + 0.038\, Rl_t. \tag{3}$$

The P* model is a forward-looking model of inflation in the sense that it considers the long-run price level, P*, as the price level that would prevail if all prices had already adjusted to the current levels of output, the money supply, and the interest rate. The model assumes that the actual price level adjusts gradually to this equilibrium price level, so that the inflation rate will rise if the price gap, i.e. the difference between P* and P, is positive, and will fall if it is negative,

$$P_t - P_{t-1} = \lambda_0 + \lambda_1 (P_t^* - P_t), \tag{4}$$

where $0 < \lambda_1 \leq 1$. Consistency of the model requires that λ_0, the trend inflation rate when the price level equals its long-run value and the long-run interest rate is constant, is equal to the difference between the trend growth rates of money and output.[8]

[7] Euro area money demand models using short term interest rates as the opportunity cost variable often exhibit parameter instability and non-homegeneity with respect to real income.

[8] Hallman, Porter and Small (1992) refer to Mussa (1981) as a theoretical basis for their model, who proposes the price adjustment equation $P_t - P_{t-1} = \alpha(p_t^* - p_t) + \pi_t^*$, where π^* is a forward looking expectation of the trend inflation rate. In empirical implementations of the P*-model, including Hallman et al., this term is usually omitted.

Figure 2 shows the development of the price gap and the inflation rate in the euro area over the period 1980-2002. Three observations stand out. First, in the period of the relatively high and volatile inflation rates of the 1980s, the price gap tracks euro area inflation quite well. When inflation accelerated again in the late 1980s, the price gap over-shoots by a large amount, but this is compatible with the idea that it leads observed inflation and there is gradual adjustment between the two. Second, the relationship between the price gap and inflation seems to become more tenuous in the 1990s, when inflation reached low levels and was much less volatile than before. Third, the inflation rate features a long-run, downward trend over the entire sample period, which is not visible in the price gap. The inability of the price gap to track the long-run trend is implied by its construction from a co-integrated relationship between money, output, and prices.

The new Keynesian model of the monetary transmission mechanism focuses on the Phillips curve relation between money and the output gap. In figure 3, we show the two key variables of this relation for the Euro area from 1980 to 2002. The figure shows the HICP (consumer price) inflation rate and the output gap. Here, output is measured by log real GDP, and the output gap is the log difference between actual output and trend output derived from a conventional HP filter. This figure, too, reveals three main observations: First, the output gap tracks inflation quite well until the mid-1980s and, disregarding some overshooting, even into the early 1990s. Second, the relationship between the output gap and the inflation rate appears to have weakened after 1990, when inflation in the euro area is relatively low and much less volatile. Third, like the price gap, the output gap cannot reproduce the long-run, downward trend of inflation during this period. Again, this is due to the cyclical nature of this indicator. The figure thus suggests a very similar stylized fact for the link between inflation and the output gap: As inflation becomes low and stable, changes in the output gap become less informative for inflationary developments.

3. Inflation, Output, and Money: A Model

The consensus model of monetary policy transmission can be summarized in the following equations:[9]

$$y_t = b_0 - b_1(R_t - E_t \Delta P_{t+1}) + E_t y_{t+1} + v_t, \qquad (5)$$

$$\Delta P_t = (1 - c_1)\Delta P_{t-1} + c_1 E_t \Delta P_{t+1} + c_2 (y_t - y^*) + \phi_t, \quad (6)$$

$0 < c_1 < 1$,

$$R_t = r^* + E_t \Delta P_{t+1} + d_1 (E_t \Delta P_{t+1} - \pi^*) + d_2 (y_t - y^*) + \theta_t, \quad (7)$$

$$M_t - P_t = y_t - a_1 R_t + \varsigma_t. \quad (8)$$

Here, y_t is the log of real output, y* its trend value, and (y_t -y*) the output gap. P_t denotes the log of the price level, R_t an interest rate, r* the equilibrium real interest rate, and M_t the log of the money stock. Finally, π^* is the central bank's target rate of inflation. E_t stands for an expectation based on information available at time t. ν_t, φ_t, θ_t, and ζ_t are random shocks with zero expectation. Equation (5) is a forward-looking IS derived from optimizing consumer behavior. Equation (6) is a new Keynesian Phillips curve, derived from Calvo price setting by firms operating under imperfect competition. Equation (7) is a standard Taylor rule, and equation (8) a standard money demand function. While most representations of the model today skip the latter, it is compatible with the rest of the model to retain it, and it will be important for our subsequent analysis. Assuming that the nominal interest rate is the central bank's policy instrument, the money stock is endogenously determined by equation (8).

The model describes a long-run equilibrium as a situation in which the output gap is zero and the real interest rate equals the Wicksellian rate $r^* = (b_0 + \mu)/b_1$, where μ is the long-run growth rate of trend output. Given that the central bank knows what r* is and sets the nominal interest rate accordingly, the long-run equilibrium has $E_t \Delta P_{t+1} = \pi^*$. That is, the equilibrium inflation rate equals the central bank's target rate. This implies that the money growth rate equals $E_t \Delta M_{t+1} = \mu+\pi$ in the long-run equilibrium. Thus, although most presentations focus on the Phillips curve (6) as the transmission channel of monetary policy, the consensus model embeds a link between inflation and money growth in the long run which is entirely consistent with the traditional quantity equation. Saying that the central bank has kept inflation in the long run at a rate equal to π^*, or that the central bank has kept money growing at a long-run rate of $\mu+\pi^*$ and that this has produced an inflation rate of π^* are equivalent statements in the context of this model – they just look at the long-.run equilibrium from two different angles. Furthermore, comparing a long-run equilibrium with a low inflation rate to a long-run equilibrium with a higher inflation rate is equivalent to comparing a long-run equilibrium with low to one with higher money

[9] See e.g. McCallum (2001), Nelson (2003a,b), or King (2001).

growth. Thus trend money growth rates contain information about trend inflation rates. The same is obviously not true for long-run output gaps, which are zero in all long-run equilibria.

Furthermore, the model also embeds a correlation between changes in the money stock and inflation in the short run, which operates through the impact of monetary policy shocks on aggregate demand and the Phillips curve. Consider a negative interest rate shock, $\theta_t < 0$. This leads to an immediate increase in the output gap and an increase in inflation. At the same time, the money stock increases. Thus, inflation and money growth are positively correlated. This correlation is muted, however, by money demand shocks, ζ_t,. The smaller the variance of monetary policy shocks latter relative to the variance of money demand shocks, the smaller the short-run correlation between money growth and inflation.

As a result, the model generates an interpretation of the statistical argument made in the preceding section. After the end of the Bretton Woods System, monetary policy became more expansionary and more volatile in OECD countries, leading to higher variances in money growth and inflation as well higher inflation rates. In contrast, the 1990s saw a return to less volatile monetary policies. While the first change increased the correlation between money growth and inflation, the second one reduced this correlation. Suppose, furthermore, that the variance of IS shocks has been relatively small all along. The same logic then extends to the correlation between the output gap and inflation. A high volatility of monetary policy shocks implies that this correlation is strongly positive. As the variance of monetary policy shocks declines, fluctuations in the inflation rate become dominated by Phillips curve shocks, θ_t, and the correlation declines.

4. Inflation, the Output Gap, and Money in the Euro Area

In this section, we develop an empirical model of inflation in the euro area. We take the New Keynesian Phillips curve as a starting point and show that it does not yield a satisfactory empirical model in times of low inflation. We then model trend inflation in the euro area and show that a Phillips augmented by trend inflation performs better.

Our empirical version of the New Keynesian Phillips curve takes the following form:

$$\pi_t = \sum_{i=1}^{4} \alpha_i \pi_{t-i} + \beta y_{t-1} + \delta \Delta p_t^{oil} \qquad (9)$$

Here, p^{oil} is the world price of crude oil. The empirical specification approximates the expected inflation term of equation (6) by a distributed lag over past inflation rates, and includes a lagged instead of a current output gap. The output gap is derived from real GDP subtracting trend output determined by using an HP filter. Estimating the empirical Phillips curve over the period from 1980 to 2002 in quarterly data yields the model reported in Table 3. Over the entire time period, inflation responds to the output gap with a coefficient for the output gap of 0.36 with a t-statistic of 2.59.

In order to assess whether the relationship between the inflation rate and the output gap has indeed weakened as Figure 3 suggested, we estimate this Phillips Curve recursively over the sample period. Figure 4 plots the coefficient on the output gap together with its 2-standard error confidence bands. The graph indicates that the output gap elasticity drops substantially the second half of the 1980s. Furthermore, the lower bound of the confidence almost touches zero towards the end of the sample period. Thus, the estimate has lost significance compared to the earlier part of the sample period. This confirms the notion that, in the low-inflation 1990s, the output gap has lost information content for inflation in the Euro area.

One interpretation of this result is that the short-run, cyclical information contained in the autoregressive term in equation (8) is insufficient to predict inflation well in times of low inflation. Our next step is, therefore, to add the price gap as more forward-looking inflation forecast to the new Keynesian Phillips curve. This yields an inflation adjustment equation of the form

$$\pi_t = \sum_{i=1}^{n} \alpha_i \pi_{t-i} + \beta y_{t-1} + \lambda (p^* - p)_{t-1} + \delta \Delta p_t^{oil} \qquad (9)$$

Estimating the new inflation adjustment equation over the period 1980-2002 yields the results reported in Table 4. Over the entire time period, the estimated coefficient for the price gap of 0.003 with a t-statistic of 0.16 and an estimated output gap coefficient of 0.24 with a t-statistic of 1.84.

Recursive estimates of the price gap and the output gap coefficient, reported in Figure 4, suggest that the relationship between the inflation rate and both the price gap and the output gap has weakened since the second half of the 1980s. Thus, both variables provide less guidance for central bank policy in the low-inflation period.

Compared to the theoretical model above, the empirical specification of the Phillips curve considered so far makes no use of the trend inflation rate, π^*. As indicated above, this trend inflation rate must be consistent with the long-run money demand function. By first differencing the quantity equation and inserting trend values, we can derive the long-run trend inflation rate as:

$$\pi^* = \Delta M^* - \Delta Y^* - \Delta v^*. \quad (10)$$

The trend inflation rate is therefore given by the trend growth rate of money less trend output growth and less trend velocity. A velocity trend could result from wealth effects or an income elasticity above one in the long-run money demand function. In this vein, the ECB argues that the velocity of money in the euro area exhibits a negative trend of around (-1.0) percent annually. Note, however, that over the 23 years considered in our sample, we observe a gradual decline in long-term interest rates, which is due to the gradual disinflation in the euro area. Given our estimates of the long-run money demand function, this also gives rise to a secular decline in the velocity of money. Over the sample period, the long-term nominal interest rate fell by an average of seven basis points per quarter. From the estimated long-run money demand equation this implies a lasting decline in the velocity of money of about 1% per year. Thus, the estimated money demand function yields exactly the same trend inflation rate as the one calculated based on the assumption of a deterministic trend in the velocity.[10]

Figure 6 plots the velocity of money and the long-term nominal interest rate over the sample period. The graph suggests that a deterministic trend would track the long-run development of the velocity similar to the long-run interest rate. However, there are several episodes in the 1990s where the long-run interest rate moves up and the velocity with it. Thus, we find the specification using the interest rate more satisfactory than the specification using a deterministic trend. This yields our estimate of trend inflation:

$$\pi^* = \Delta M^* - \Delta Y^* + 0.0387 * \Delta i^*, \quad (12)$$

where, Trend money growth and trend GDP growth were calculated using standard HP filters. Δi^* is the trend in the long-term nominal interest rate over the sample

[10] The ECB argues that the velocity of money in the euro area exhibits a falling trend estimated to be around one percent annually. The ECB attributes this trend to a real income elasticity of the long-run demand for money larger than one. If we follow the ECB and assume that velocity declines by about 1% per year, trend inflation is:

$$\pi^* = \Delta M^* - \Delta Y^* - 1.0,$$

period. Long term interest rates declined on average by seven basis points per quarter, which implies a trend decline of velocity of about 1% annually.

In Figure 7, we show the development of the inflation rate and the trend inflation rate $\pi *$ estimated in this way. The trend inflation rate implied by the quantity equation describes the long-run development of the actual inflation rate well. Importantly, our estimated trend inflation rate is leading turning points of the actual inflation rate in the mid-1980s, and early 1990s, and also in the low-inflation period of the mid-1990s. Adding the trend inflation rate to the inflation adjustment equation yields the following equation:

$$\pi_t = \sum_{i=1}^{n} \alpha_i \pi_{t-i} + \beta y_{t-1} + \lambda (p^* - p)_{t-1} + \gamma \pi * \tag{13}$$

In Table 5 we report estimates of this equation over the entire time period. The table shows the elasticities of the output gap, the price gap and the trend inflation rate together with their long-run multipliers calculated as the estimated elasticity divided by one less the sum of the coefficients of the autoregressive inflation terms. The results show that the output gap elasticity is significant at the 10% level, while the price gap is again not significantly different from zero.

The trend inflation rate is significant at the 1% level. Thus, the monetary trend inflation rate appears to be the most important determinant of the inflation rate. The long-run multipliers of the output gap and of the price gap are both not significantly different from zero, while the long-run multiplier of the monetary trend inflation rate is significant at the 1% level and the hypothesis that the inflation rate adjusts in the long-run fully to the trend inflation rate, i.e. that the long-run multiplier of the trend inflation rate is not significantly different from one cannot be rejected.

Figure 6 presents the recursive estimates of the coefficients on the output gap, the price gap, and the inflation trend for this model. The coefficients for the output gap and the price gap are positive in the 1980s, but come close to zero in the 1990s and lose significance. The coefficient on the inflation trend falls, but it remains positive and significant overall. The decline in the trend coefficient is consistent with the notion that trend shocks were more important in the early than in the later part of the sample. Thus, the two more cyclically oriented indicators loose information value for inflation, while the inflation trend remains important in the low-inflation period. As a test of the robustness of this finding, we estimate the model of equation again using

data only for the low-inflation period, i.e., starting in 1990. As shown in Table 6, the output gap is not significant for explaining euro-area inflation in this period. In contrast, the inflation trend is important and highly significant.

5. Conclusions

Numerous authors have claimed that, under conditions of low inflation, monetary and money growth have become irrelevant for inflation. This claim is based on the observation that the correlation between money growth and inflation has become weak if not vanished in recent years.

In this paper, we argue that the policy conclusion drawn from this observation is unwarranted. A general feature of the move to low inflation is that the volatility of inflation has declined, too. Our interpretation is that this reflects the move to a less activist and erratic conduct of monetary policy. As monetary policy shocks become less important, other shocks affecting inflation temporarily move to the forefront and dampen the correlation between money and inflation. We show that a similar argument holds for the output gap.

Thus, with low and less volatile inflation, the traditional indicators central banks look at to assess the inflation outlook become less informative. This leaves the central bank with less orientation. However, we show that trend inflation still provides good guidance for monetary policy under low inflation. For the euro area, trend inflation can be estimated from monetary and output trends. Thus, despite the declining correlation of money growth rates and inflation at high frequencies, monetary aggregates remain important as an orientation for monetary policy.

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Table 1

Part 1: Inflation: Average and Volatility

	Average Inflation					Standard Deviation of Inflation				
	66-72	73-78	79-91	92-96	97-02	66-72	73-78	79-91	92-96	97-02
USA	4.1	7.7	5.9	2.9	2.3	1.2	2.2	3.5	0.3	0.8
CAN	3.8	9.0	6.5	1.5	2.0	0.9	1.7	3.0	0.8	0.9
JPN	5.5	11.4	2.7	0.8	0.0	1.5	6.2	2.0	0.8	1.1
AUS	3.9	7.0	3.7	2.9	1.6	1.6	2.1	1.8	0.9	0.8
AUT*	3.9	12.2	10.9	2.2	0.8	1.6	3.2	2.5	1.4	2.0
CH	4.4	4.9	3.7	2.2	0.8	1.8	3.8	1.9	1.4	0.6
D	3.3	5.1	2.9	3.1	1.5	1.6	1.7	2.0	1.6	0.8
DK*	6.5	10.7	6.5	1.9	2.4	2.4	3.0	3.5	0.4	0.4
E	6.0	17.7	10.1	4.7	2.7	2.3	4.6	4.3	0.8	0.8
I	3.3	15.7	10.9	4.6	2.2	2.0	4.5	5.7	0.8	0.4
IRE*	6.2	14.8	8.7	2.2	3.4	2.6	4.9	6.5	0.7	1.8
NL	5.6	7.9	3.4	2.5	2.8	2.0	2.2	10.1	0.6	1.0
NZ*	6.0	12.9	10.9	2.2	1.7	2.5	3.1	5.4	1.4	2.0
SE	5.1	9.7	8.2	2.5	1.1	2.1	2.1	2.9	1.5	1.1
UK	5.7	15.0	7.9	2.7	2.4	2.3	5.7	4.4	0.8	0.9

Note: *based on quarterly data. Source: International Financial Statistics

Part 2: Money Growth: Average and Volatility

	Average Money Growth Rate					Standard Deviation of Money Growth				
	66-72	73-78	79-91	92-96	97-02	66-72	73-78	79-91	92-96	97-02
USA	8.2	9.8	7.4	2.2	7.0	3.4	2.8	2.4	1.6	1.5
CAN	5.3	8.3	10.0	8.3	10.0	8.1	3.8	9.1	3.5	3.9
JPN	18.6	13.8	5.4	7.4	11.7	5.0	6.7	4.3	4.6	7.6
AUS	7.4	12.0	11.5	13.7	11.9	2.9	7.8	7.9	5.9	4.1
AUT	8.9	9.1	5.2	8.8	5.3	4.4	3.4	5.6	2.8	0.8
CH	11.6	3.4	2.6	5.7	6.0	5.1	7.9	8.1	5.4	5.4
D	8.7	9.6	7.4	8.1	7.4	3.9	4.7	5.9	2.8	2.0
DK	9.5	10.7	12.1	4.4	6.1	4.9	6.9	7.3	6.8	3.2
E	14.1	20.4	14.3	4.1	12.3	6.5	3.4	4.4	4.1	2.0
I	19.2	17.8	12.2	4.3	10.0	5.0	7.3	4.6	3.8	2.4
IRE	10.3	19.4	16.3	18.1	0.5	9.2	22.5	27.6	25.9	20.5
NL	11.6	10.3	5.9	7.7	9.9	4.4	7.7	3.3	4.2	1.6
NZ	5.2	12.7	13.1	3.7	8.6	6.9	11.0	12.6	4.4	6.7
SE	12.3	10.7	10.1	3.4	4.4***	3.1	3.2	6.6	4.4	3.0***
UK	10.3	21.4	14.3* **	6.3**	7.8**	6.7	7.2	4.1* **	3.2**	3.4**

Notes: *1982-1991; ** annualized 6-months growth rates from Bank of England; ***1997-2000. Source: International Financial Statistics

Table 2: Estimating a Long-run Money Demand Function for the Euro Area

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.206156	33.07013	29.68	35.65
At most 1	0.134700	12.75370	15.41	20.04
At most 2	0.000249	0.021905	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at the 5% level
Trace test indicates no cointegration at the 1% level

Estimated cointegrating vector:

$$M / P = Y - \underset{(-9.24)}{0.038}\, irl$$

Test of homogeneity restriction: Chi-square 1 = 2.19 (0.14)

Error Correction:	D(LNRM3)	D(LNGDPR)	D(IRL)
CointEq1	-0.033403	-0.041891	-0.897962
	(0.01332)	(0.01231)	(0.78605)
	[-2.50849]	[-3.40401]	[-1.14238]
D(LNRM3(-1))	0.155890	-0.063314	-5.359175
	(0.10103)	(0.09337)	(5.96373)
	[1.54305]	[-0.67812]	[-0.89863]
D(LNRM3(-2))	0.055251	-0.016947	3.990832
	(0.09891)	(0.09142)	(5.83904)
	[0.55857]	[-0.18539]	[0.68347]
D(LNGDPR(-1))	-0.018760	-0.059016	11.16043
	(0.12519)	(0.11570)	(7.39029)
	[-0.14985]	[-0.51007]	[1.51015]
D(LNGDPR(-2))	0.190490	-0.101837	-0.641314
	(0.12261)	(0.11332)	(7.23802)
	[1.55357]	[-0.89869]	[-0.08860]
D(IRL(-1))	-0.001410	0.003980	0.632798
	(0.00182)	(0.00168)	(0.10728)
	[-0.77591]	[2.36977]	[5.89841]
D(IRL(-2))	0.000396	-0.000785	-0.180336
	(0.00193)	(0.00178)	(0.11372)
	[0.20572]	[-0.44074]	[-1.58577]
C	0.005555	0.007162	-0.101495
	(0.00146)	(0.00135)	(0.08595)
	[3.81507]	[5.32224]	[-1.18082]
D903	0.024250	0.006176	0.352946
	(0.00622)	(0.00575)	(0.36715)
	[3.89889]	[1.07448]	[0.96130]
R-squared	0.361610	0.182590	0.379831

Table 3: A New Keynesian Phillips Curve for the Euro Area

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DHICP(-1)	0.354826	0.096669	3.670518	0.0004
DHICP(-2)	-0.053469	0.099889	-0.535282	0.5939
DHICP(-3)	0.173041	0.103339	1.674492	0.0977
DHICP(-4)	0.435977	0.100113	4.354859	0.0000
DOIL	0.006531	0.002198	2.972039	0.0038
GAP(-1)	0.356075	0.137298	2.593442	0.0112
C	0.161383	0.205422	0.785619	0.4343
Adjusted R-squared	0.861676	DW	1.880418	

Table 4: A Empirical New Keynesian Phillips Curve Including the Price Gap

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DHICP(-1)	0.354874	0.097044	3.656855	0.0004
DHICP(-2)	-0.049181	0.100540	-0.489168	0.6260
DHICP(-3)	0.175791	0.103845	1.692821	0.0942
DHICP(-4)	0.441757	0.100980	4.374680	0.0000
DOIL	0.006497	0.002207	2.943992	0.0042
GAP(-1)	0.368721	0.139499	2.643178	0.0098
PGAP(-1)	-0.013933	0.023705	-0.587774	0.5583
C	0.106213	0.226575	0.468776	0.6404
Adjusted R-squared	0.871325		DW	1.892062

Table 5: A New Keynesian Phillips Curve Including Trend Inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DHICP(-1)	0.243801	0.098591	2.472844	0.0154
DHICP(-2)	-0.123969	0.098364	-1.260311	0.2111
DHICP(-3)	0.109658	0.100816	1.087698	0.2799
DHICP(-4)	0.384609	0.097595	3.940866	0.0002
DOIL	0.006305	0.002097	3.006309	0.0035
GAP(-1)	0.235438	0.138995	1.693855	0.0940
PGAP(-1)	0.013050	0.024066	0.542264	0.5891
DHICPT	0.429297	0.135137	3.176752	0.0021
C	-0.334095	0.255994	-1.305087	0.1955
Adjusted R-squared	0.885274		DW	1.859912

Long- run Multipliers:

Variable	Long-run Multiplier	Standard Error
GAP(-1)	0.60	0.43
PGAP(-1)	0.01	0.04
DHICPT	1.11	0.15

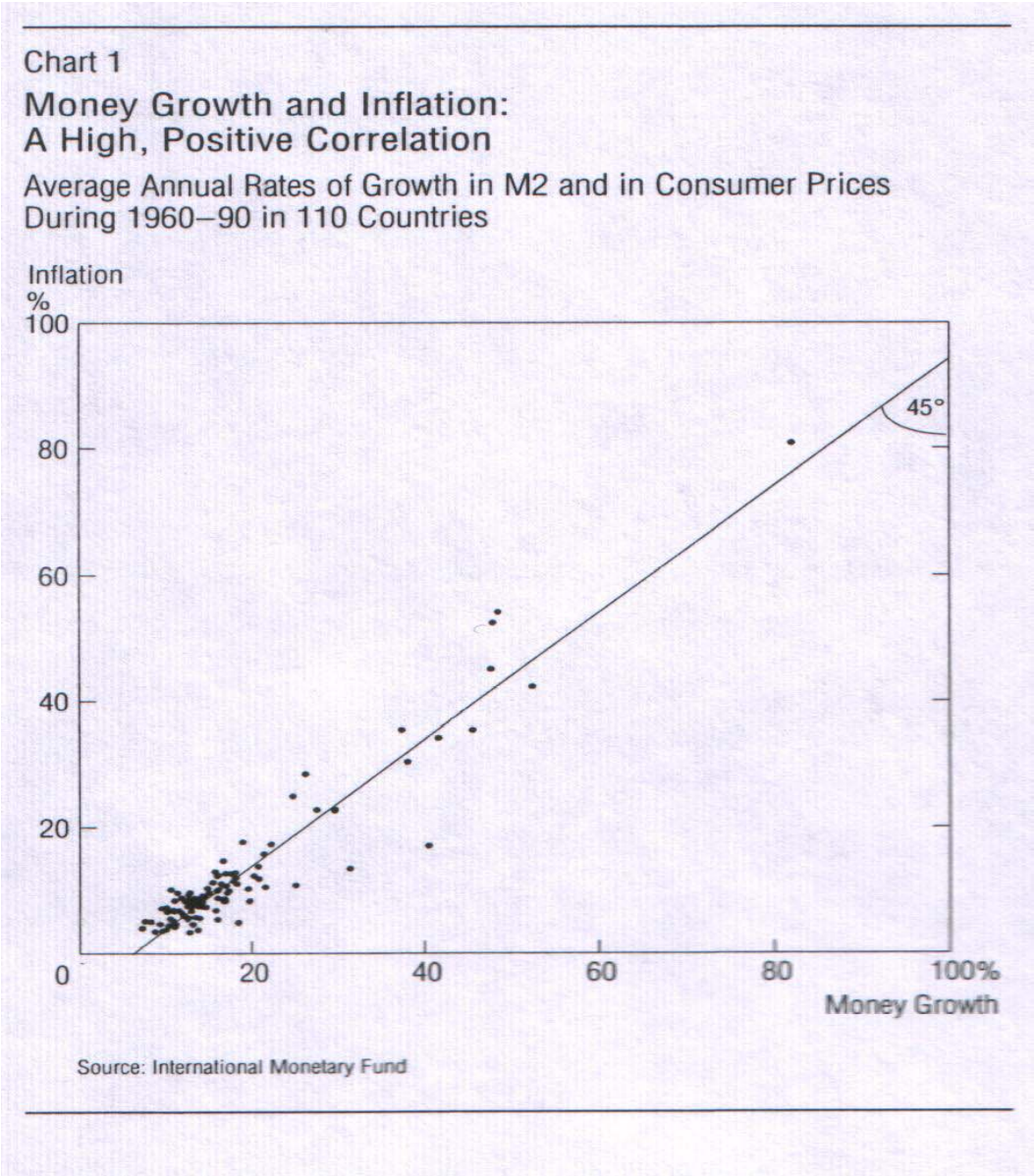
Table 6: A New Keynesian Phillips Curve Including Trend Inflation, 1990-2002

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DHICP(-1)	-0.190740	0.142574	-1.337832	0.1880
DHICP(-2)	-0.328433	0.144873	-2.267043	0.0285
DHICP(-3)	-0.035015	0.136486	-0.256545	0.7988
DHICP(-4)	0.165337	0.138752	1.191604	0.2400
DOIL	0.003406	0.002281	1.493398	0.1426
GAP(-1)	0.127286	0.184329	0.690536	0.4936
PGAP(-1)	0.096774	0.044196	2.189665	0.0340
DHICPT	0.763268	0.237746	3.210435	0.0025
C	1.448568	0.633744	2.285731	0.0273
Adjusted R-squared	0.605176		DW	2.052629

Long- run Multipliers:

Variable	Long-run Multiplier	Standard Error
GAP(-1)	0.09	0.13
PGAP(-1)	0.07	0.02
DHICPT	0.55	0.12

Figure 1:



Source: McCandless and Weber (1995)

Figure 2: Inflation and the Price Gap in the Euro Area

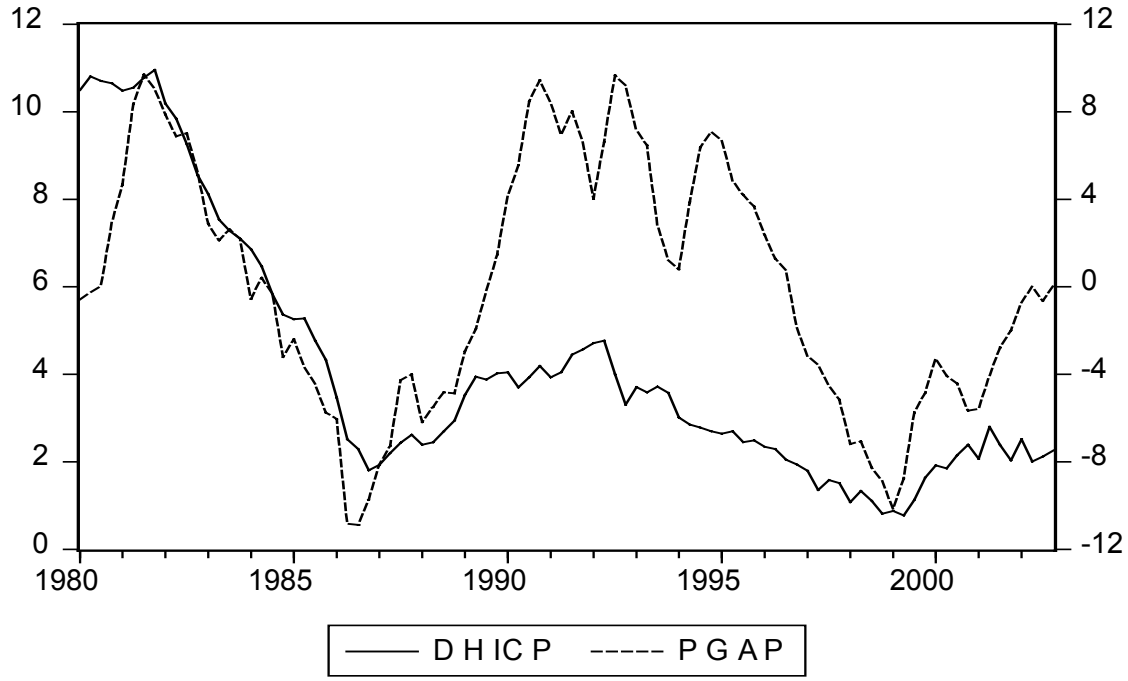


Figure 3: Inflation and the Output Gap in the Euro Area

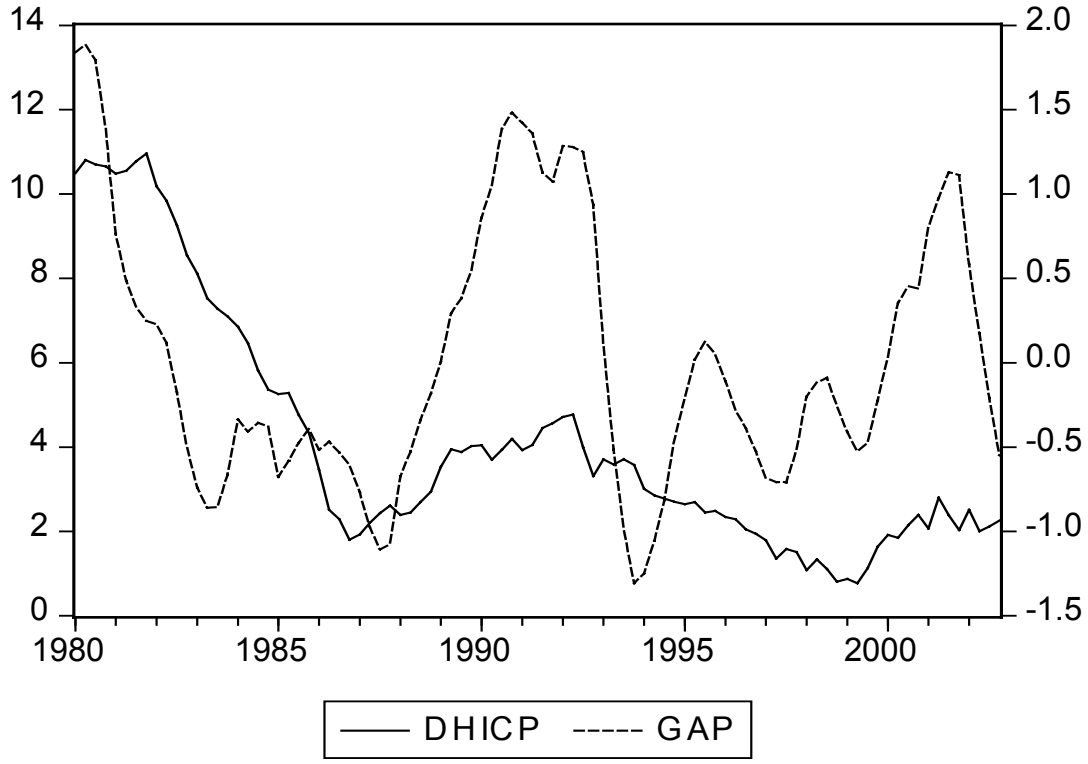


Figure 4: Recursive Estimates of the Output Gap Coefficient

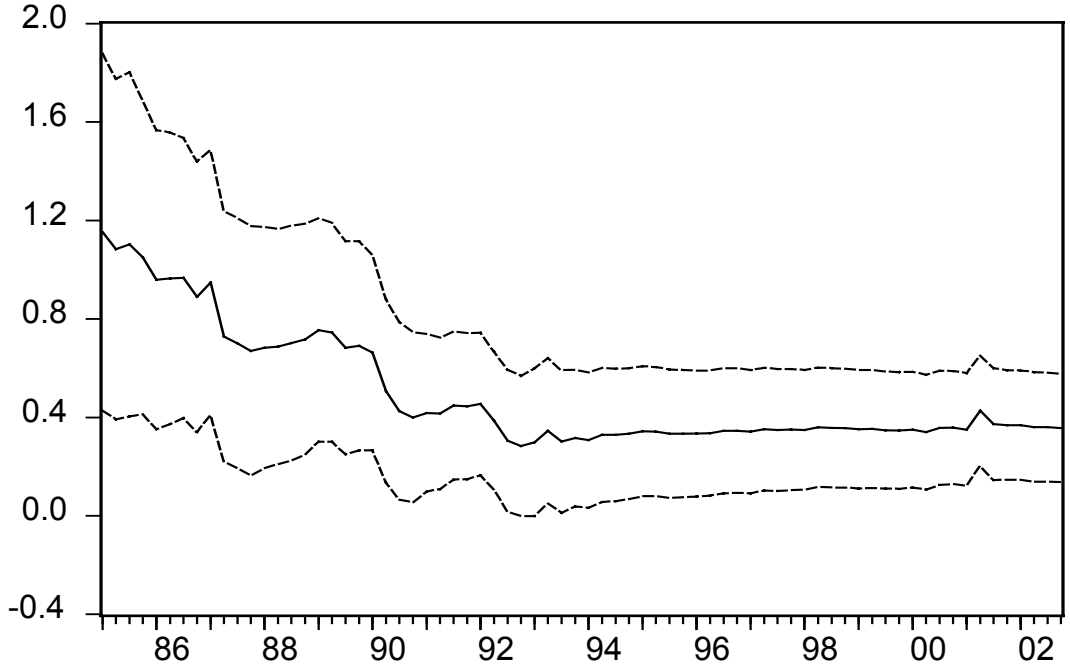


Figure 5: Recursive Coefficients for the price gap model

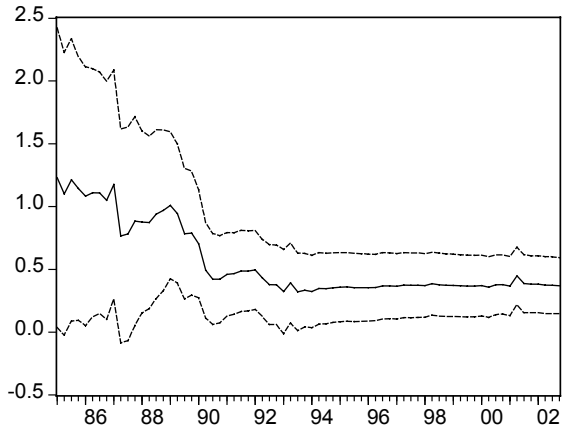
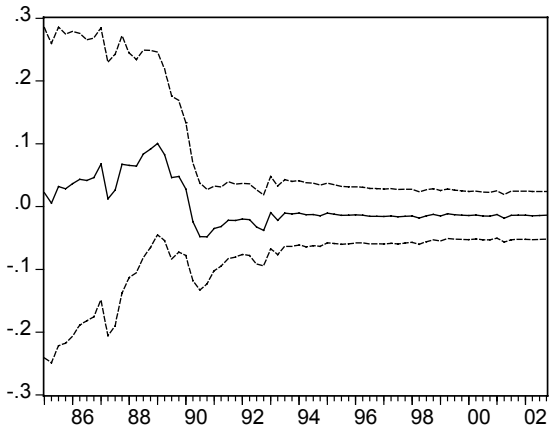
Recursive output gap coefficient	Recursive price gap coefficient
	

Figure 6: Recursive Coefficients for the inflation trend model

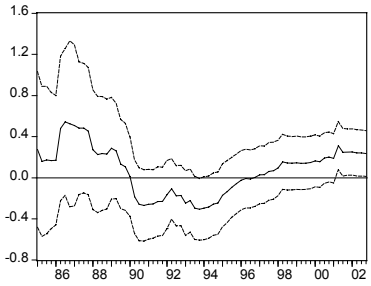
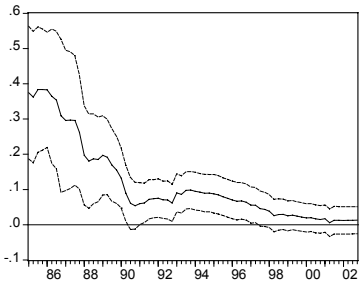
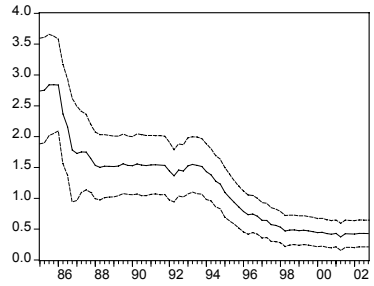
Recursive output gap coefficient	Recursive price gap coefficient	Recursive inflation trend coefficient
		

Figure 7: Velocity and the Long Run Interest Rate in the Euro Area

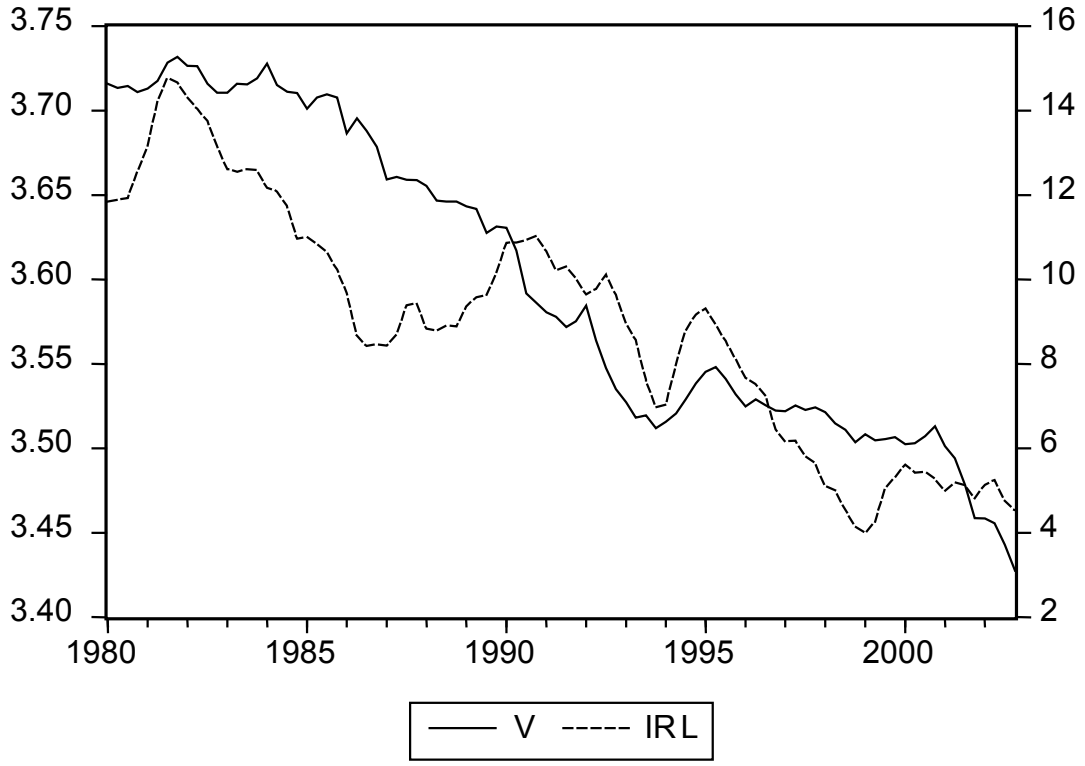
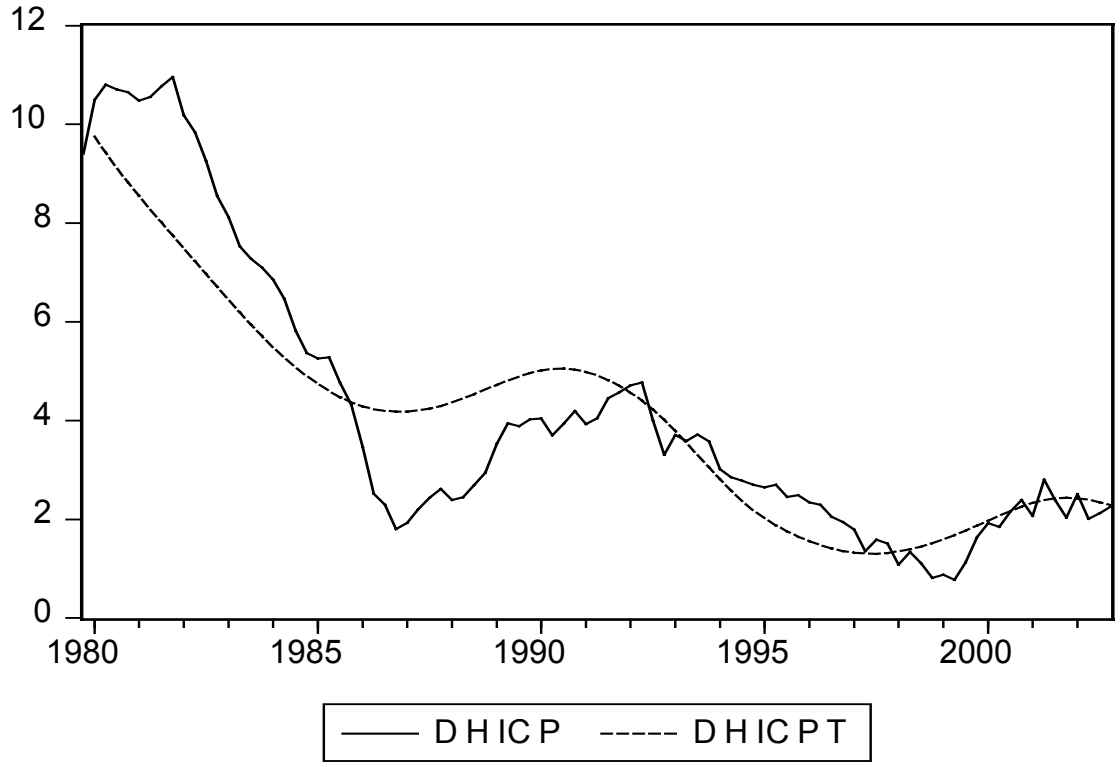



Figure 8: Inflation and Trend Inflation in the Euro Area