# Inflation, inflation uncertainty, and Markov regime switching heteroskedasticity: Evidence from European countries

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**Abstract**

We use a Markov regime-switching heteroskedasticity model in order to examine the association between inflation and inflation uncertainty in four European countries over the last forty years. This approach allows for regime shifts in both the mean and variance of inflation in order to assess the association between inflation and its uncertainty in short and long horizons. We find that this association differs (i) between transitory and permanent shocks to inflation and (ii) across countries. In particular, the association is positive or zero for transitory shocks and negative or zero for permanent shocks. Hence, Friedman's belief that inflation is positively associated with inflation uncertainty is only partially supported in this study, i.e., by short-run inflation uncertainty.

**Keywords:** Inflation, Inflation uncertainty, Markov process, regime-switching heteroskedasticity
**JEL Classification:** C22, C51, C52, E0

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# 1 Introduction

The issue of the welfare costs of inflation has drawn the attention of macroeconomists for many years both at the theoretical and empirical level. In fact, the recent emphasis on price stability, expressed for practical purposes as low and stable inflation, among the world's major Central Banks, including the Federal Reserve System and the European Central Bank (ECB), is predicated on the assumed adverse impact of inflation on economic efficiency. Lucas (2000) estimates the welfare gain of reducing inflation from 14% to 3% at about 0.8% of US real GDP irrespective of the explicit form assumed by the money demand function[1]. It is widely accepted that the focus of monetary policy on price stability is the main cause of the low inflation rates achieved by several industrialized countries (Greenspan, 2004).

Considerable ambiguity surrounds the impact of the average rate of inflation on the rate of economic growth at the theoretical level. Furthermore, the impact of inflation on output growth may take place indirectly, via the inflation uncertainty channel. Friedman (1977) in his Nobel lecture argues that a rise in the average rate of inflation leads to more uncertainty about the future rate of inflation, it distorts the effectiveness of the price mechanism in allocating resources efficiently, and thus it creates economic inefficiency and a lower level of output. Moreover, inflation uncertainty by affecting interest rates also impacts on the intertemporal allocation of resources. Hence, a comprehensive empirical study that tests for the real effects of inflation should control for the impact of inflation uncertainty on output. The positive correlation between inflation and inflation uncertainty reported in empirical studies can also arise from a positive causal effect of inflation uncertainty on inflation. Cukierman and Meltzer (1986) provide a theoretical model that explains such a causal effect. In the presence of more inflation uncertainty, less conservative central bankers have an incentive to surprise the public and generate unanticipated inflation, hoping for output gains.

The empirical assessment of the relationship between inflation uncertainty and inflation may be based on various approaches. Early studies focus on the variability (as opposed to uncertainty) of inflation and test for the correlation between inflation and inflation variability. The consensus reached by these studies is that inflation variability is positively correlated with inflation. Following Engle's (1982) pathbreaking paper on Autoregressive Conditional Heteroskedasticity (ARCH) models, researchers measured uncertainty by the conditional variance of unanticipated shocks to inflation.

[1] Most estimates of the cost of inflation are less that 1% of output suggesting that the costs of inflation are very low. An exception is Bullard and Russell (2004) who find that the annual cost of a 10% inflation rate is 11.2% of output.

This allowed for a time-varying measure of inflation uncertainty. Engle (1983) finds that a rise in inflation in the current quarter does not lead to an increase in uncertainty in the next quarter. Subsequent studies summarised by Holland (1993) and Davis and Kanago (2000) find mixed evidence regarding the association between inflation and inflation uncertainty using a variety of methodologies. More recently, Grier and Perry (1998) using the Generalised ARCH (GARCH) approach test for the bidirectional causality between inflation and inflation uncertainty in the G7. The authors find that, first, inflation affects positively inflation uncertainty in all countries and, second, mixed evidence across countries regarding the effect of inflation uncertainty on inflation. However, Fountas and Karanasos (2007) find mixed evidence regarding the causal relationship between inflation and inflation uncertainty.

The above mentioned approaches regarding the association between inflation and inflation uncertainty usually examine this association at either short run or long-run horizons. For instance, the pre-GARCH studies test for the effects of inflation on its variability over several years whereas many GARCH studies test for the short-run (or next-quarter) effect. Ball and Cecchetti (1990) argue that the association between inflation and its uncertainty may differ between short-run and long-run horizons. Some simple correlation analysis between the mean and variance of US inflation in the 1954-89 period reported by the authors indicates that these correlations become larger as the horizon considered increases. These results are confirmed by a more formal approach that distinguishes between permanent and temporary shocks to inflation. Motivated by the Ball and Cecchetti (1990) approach, Kim (1993) proposes a model of Markov-switching heteroskedasticity which is deemed superior to the GARCH approach for three reasons. First, this approach allows for the possibility of regime shifts. Second, the Markov regime-switching approach permits the consideration of temporary and permanent shocks to inflation, thus allowing the examination of the effects of inflation on short run and long-run uncertainty about inflation. Third, in contrast to the GARCH approach, it allows for a nonconstant unconditional variance.

In this paper, the relationship between inflation uncertainty and inflation is analysed empirically with the use of a model that allows for Markov regime-switching heteroskedasticity for four European countries. Our chosen econometric model is similar to the one employed by Kim (1993) and is applied to quarterly inflation data from the last forty years. Our results are likely to shed some light on the empirical relationship between inflation and inflation uncertainty. In particular, they will indicate whether inflation uncertainty is associated with inflation as predicted by Friedman (1977). This is a necessary requirement for the welfare costs of inflation that work via the inflation uncertainty channel. Moreover, the results will show whether there is evidence that higher inflation is associated with more uncertainty about long-run inflation or short-run inflation or both. Finally, our methodological approach will indicate whether short-run and long-run inflation uncertainty affects positively or negatively the rate of inflation as predicted by Cukierman and Meltzer (1986) and Holland (1995), respectively.

The paper is outlined as follows. Section 2 discusses the theoretical basis for the relationship between inflation and inflation uncertainty. Section 3 summarises the empirical literature to date on the association between inflation and uncertainty about the rate of inflation. Section 4 presents our econometric model and section 5 reports and discusses our results. Finally, Section 6 summarises our main conclusions and draws some policy implications.

# 2 Theoretical background

## 2.1 The impact of inflation on inflation uncertainty

Economists have appealed to the uncertainty about the future rate of inflation in order to account for the welfare loss that monetary economics has associated with inflation. Predictable inflation should not lead to welfare loss since indexation will allow agents to minimize the costs of inflation. However, uncertainty about future inflation distorts the efficient allocation of resources that is based on the price mechanism. Friedman (1977) presents an informal argument regarding the real effects of inflation. Friedman's argument represents one of the few existing arguments on the rationalisation of the welfare effects of inflation. His point comes in two parts. In the first leg of the Friedman hypothesis, an increase in inflation may induce an erratic policy response by the monetary authority and therefore lead to more uncertainty about the future rate of inflation. As Friedman (1977, p. 466) wrote: "A burst of inflation produces strong pressure to counter it. Policy goes from one direction to another, encouraging wide variation in the actual and anticipated rate of inflation... Everyone recognises that there is great uncertainty about what actual inflation will turn out to be over any specific future interval." The second part of Friedman's hypothesis predicts that increased inflation uncertainty would increase the observed rates of unanticipated inflation and hence will be associated with the costs of unanticipated inflation. Such costs arise from the effect of inflation uncertainty on both the intertemporal and intratemporal allocation of resources. Combining the link of inflation to inflation uncertainty and the link of inflation uncertainty to output, we obtain the testable hypothesis that higher inflation leads to lower output, i.e., a positively-sloped Phillips curve[2].

Friedman's intuitive result has also been subsequently derived formally by Ball (1992) in an asymmetric information game where the public faces uncertainty about the type of the policymaker (monetary authority). The two types of policymaker differ in terms of their willingness to bear the economic costs of reducing inflation. In periods of low inflation, the tough type will apply contractionary monetary policy. Ball assumes that the two types of policymakers alternate in office in a stochastic manner. Therefore, a higher current inflation rate creates more uncertainty about the level of future inflation since it is not known whether the tough type will gain power and fight inflation.

### 2.2 The impact of inflation uncertainty on inflation

The opposite direction of causality to that examined by Friedman in the inflation/inflation uncertainty relationship has also been addressed by the theoretical literature. This literature examines the impact of a change in inflation uncertainty on the average rate of inflation. Cukierman and Meltzer (1986) employ a Barro-Gordon model, where agents face uncertainty about the rate of monetary growth and therefore, inflation. In the presence of this uncertainty, the policymaker applies an expansionary monetary policy in order to surprise the agents and enjoy output gains. This argument implies a positive causal effect from inflation uncertainty to inflation and has been dubbed by Grier and Perry (1998) the Cukierman-Meltzer hypothesis. Holland (1995) has supplied a different argument based on the stabilisation motive of the monetary authority, the so-called "stabilising Fed hypothesis". He claims that, as inflation uncertainty rises due to increasing inflation, the monetary authority responds by contracting money supply growth, in order to eliminate inflation uncertainty and the associated negative welfare effects. Hence, Holland's argument supports the opposite sign in the causal relationship, i.e., a negative causal effect of inflation uncertainty on inflation. The theoretical ambiguity surrounding this causal relationship necessitates an empirical investigation of the sign of the effect.

[2] The effect of inflation uncertainty on output has been addressed formally by Dotsey and Sarte (2000). In a cash-in-advance model that allows for precautionary savings and risk aversion, they show that more inflation uncertainty can have a positive output growth effect. According to the authors' argument, an increase in the variability of monetary growth, and therefore inflation, makes the return to money balances more uncertain and leads to a fall in the demand for real money balances and consumption. Hence, agents increase precautionary savings, and the pool of funds available to finance investment increases. This result is analogous to the literature's finding that fiscal policy uncertainty is conducive to growth by encouraging precautionary savings.

## 3 The empirical evidence

Early empirical studies on the relationship between inflation and its uncertainty used the variance (or standard deviation) as a measure of uncertainty and hence measured inflation variability as opposed to uncertainty. The use of the autoregressive conditional heteroskedasticity (ARCH) and generalised ARCH (GARCH) approaches introduced by Engle (1982) and Bollerslev (1986), respectively, allows us to proxy uncertainty using the conditional variance of unpredictable shocks to the inflation rate. Engle (1983) and Bollerslev (1986), making use of the ARCH techniques, do not perform a statistical test of the Friedman-Ball hypothesis but only compare the estimated conditional variance series with the US average inflation rate over various time periods. Engle (1983) in an application of the ARCH approach finds that US inflation is not related to inflation uncertainty, a result being inconsistent with the Friedman-Ball hypothesis[3]. Grier and Perry (1998) use the estimated conditional variance from a GARCH model and employ Granger-causality tests to test for the direction of causality between average inflation and inflation uncertainty. Baillie et al. (1996) perform these tests simultaneously in a single model by including lagged inflation in the conditional variance equation and the conditional standard deviation in the inflation equation. In particular, using G7 data, Grier and Perry (1998) find that inflation has a significant and positive effect on inflation uncertainty in all countries[4]. On the other hand, Baillie et al. (1996) find no significant relationship between inflation and inflation uncertainty. More recently, Karanasos et al. (2004) using a GARCH-in-Mean (GARCH-M) model enriched with lagged inflation in the conditional variance equation find that US inflation affects positively inflation uncertainty, a result supporting the Friedman-Ball hypothesis. A similar model applied by Fountas (2001) using historical UK data shows support for the Friedman-Ball hypothesis.

[3]The evidence on the impact of inflation uncertainty on growth is more limited and is summarised in Holland (1993). GARCH studies of this issue that represent a more accurate test of the hypothesis that inflation uncertainty has negative welfare effects are mostly based on US data (e.g., Coulson and Robins, 1985; Jansen, 1989; Grier and Perry, 2000, Grier et al., 2004). Exceptions are the studies of Fountas and Karanasos (2006), Fountas et al. (2006) and Fountas et al. (2004a). The first two studies use data on the G7 and the last one uses data on six European countries. The evidence is rather mixed. Grier and Perry (2000) and Grier et al. (2004) find evidence for a negative effect. In contrast, Coulson and Robins (1985) and Jansen (1989) find evidence for a positive and zero effect, respectively. Fountas et al (2004a) and Fountas and Karanasos (2006) find mixed evidence using a two-step approach that combines the estimation of a GARCH model with the implementation of Granger-causality tests.

[4]Using a Component GARCH-M model of inflation that includes lagged inflation in the conditional variance, Grier and Perry (1998) estimate simultaneously the relationship between inflation and inflation uncertainty. They find that inflation has a positive effect on inflation uncertainty (the Friedman-Ball hypothesis), but uncertainty has no significant impact on inflation.

The causal impact of inflation uncertainty on inflation is tested empirically using the GARCH approach in Baillie et al. (1996), Grier and Perry (1998, 2000), Grier et al. (2004) and Fountas et al. (2004). Grier and Perry (2000) and Grier et al. (2004) use only US data, whereas the rest of the studies use international data. In general, the evidence is mixed. Baillie et al. (1996) find evidence supporting the link between the two variables for the UK and some high-inflation countries, whereas Grier and Perry (1998) in their G7 study find evidence in favour of the Cukierman-Meltzer hypothesis for some countries and in favour of the Holland hypothesis for other countries. Fountas et al. (2004) also obtain mixed evidence. Finally, Grier and Perry (2000) and Grier et al. (2004) find evidence for a zero and negative effect of inflation uncertainty on inflation in the US, respectively.

GARCH models suffer from a potential disadvantage: they cannot account for regime shifts that may affect both the mean and the variance of inflation. Bhar and Hamori (2004) applying the Kim (1993) model for the G7 for the 1961-1999 period find that inflation is positively related with long-run uncertainty in some countries and positively or negatively related with short-run uncertainty (depending on the country considered).

## 4 Econometric Methodology

We adopt the Kim (1993) approach where two different volatility regimes, conditional and unconditional, are determined by two different Markov-switching processes. The following decomposes inflation into its two components:

$$\pi_t = T_t + \mu_2 S_{1,t} + \mu_3 S_{2,t} + \mu_4 S_{1,t} S_{2,t} + (h_0 + h_1 S_{2,t}) e_t \tag{1}$$

$$T_t = T_{t-1} + (Q_0 + Q_1 S_{1,t}) v_t \tag{2}$$

In the two equations above both $v_t$ and $e_t$ are N(0,1). The empirical model in equations (1) and (2) was first discussed by Ball and Cecchetti (1990). It decomposes inflation into two components, a stochastic component and a stationary component with shocks to these two components represented by $v_t$ and $e_t$, respectively. For example, trend inflation is determined by trend money growth and examples of shocks may include a rise in trend inflation to take account of supply side shocks. The effect of shocks to the stochastic trend feed through to inflation via equation (2) above. Transitory shocks ($e_t$) are also represented and take account of any shock that leads to a deviation of inflation from its trend. These may be demand (e.g. monetary policy) shocks or supply shocks. In equations (1) and (2),

$S_{1,t}$ and $S_{2,t}$ are unobserved state variables that determine the regime for the trend and temporary component, respectively. It is assumed that $S_{1,t}$ and $S_{2,t}$ evolve independently of each other. A two-state Markov switching process is adopted with values of 0 taking account of the low variance state and 1 the high variance state. The two-state Markov process takes on the following transition probabilities:

$$Pr[S_{1,t} = 0 \mid S_{1,t-1} = 0] = p_{00}, Pr[S_{1,t} = 1 \mid S_{1,t-1} = 1] = p_{11},$$

$$Pr[S_{2,t} = 0 \mid S_{2,t-1} = 0] = q_{00}, Pr[S_{2,t} = 1 \mid S_{2,t-1} = 1] = q_{11} \tag{3}$$

where regime 1 is a low $Q_t$ and low $h_t$, $(S_{1,t} = 0, S_{2,t} = 0)$, regime 2 is a low $Q_t$ and high $h_t$, $(S_{1,t} = 0, S_{2,t} = 1)$, regime 3 is a high $Q_t$ and low $h_t$, $(S_{1,t} = 1, S_{2,t} = 0)$ and finally regime 4 is a high $Q_t$ and high $h_t$, $(S_{1,t} = 1, S_{2,t} = 1)$. For example, in equation 3, $p_{00}$ is the probability that the trend component will remain in regime 1. The effect of the uncertainty on inflation is represented by $\mu_2$, $\mu_3$ and $\mu_4$. $\mu_2$ indicates the effect of uncertainty associated with the high inflation state for the permanent (long-run) component, while $\mu_3$ indicates the effect of uncertainty associated with the high inflation state for the temporary (short-run) component. It may be the case that the effect on inflation may be non-linear, as a result we also include the interaction between the two, $\mu_4$. This term captures the effect of a change in both short run and long-run uncertainty on inflation. Finally, $Q_1$ $(Q_0)$ represents the increase in the variance of the trend component during the high (low) variance state and $h_1$ $(h_0)$ represents the increase in the variance of the temporary component during the high (low) variance state.

# 5 Data and results

## 5.1 Data

We use quarterly data on the GDP deflator as a proxy for the price level (the only exception being Italy where in the absence of a long time series CPI is used instead). The data refer to four European countries, namely, Germany, Italy, Holland and the UK. The sample starts in 1966 (except for Holland and Italy where it starts in 1977 and 1960, respectively) and ends in the first quarter of 2005. All data are taken from the International Financial Statistics published by the IMF. We measure inflation by the quarterly difference of the logarithm of the GDP deflator [$\pi_t = \log(\frac{\mathrm{PI}_t}{\mathrm{PI}_{t-1}})$]. We first test for the stationarity properties of our data using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results of these tests (not reported) indicate that we can treat the inflation rate in each country as a nonstationary process[5].

## 5.2 Results

Table 1 reports estimates of the Markov regime-switching model of inflation. In particular, we include estimates of the transition probabilities, the Qs, the hs and the $\mu_s$. With very few exceptions, all estimated probabilities are close to one and statistically significant, a finding consistent with regime switching. In two of the four countries (Italy and UK), $\mu_2$ is negative and significant at 5% implying that an increase in long-run uncertainty leads to lower inflation. This supports the theoretical argument of Holland (1995). In contrast, in two of the four countries (Holland and UK), $\mu_3$ is positive and significant at 5% implying that an increase in short-run uncertainty raises average inflation, thus supporting the Cukierman-Meltzer hypothesis. In half of the countries examined, both short run and long-run uncertainty regarding inflation have no impact on inflation. Finally, the parameter $\mu_4$ is positive and significant in three of the four cases considered implying that an increase in both long run and short-run uncertainty raises average inflation.

Figures 1-8 plot the inflation rate and the probability of being in the high-variance state for the permanent and transitory (temporary) shocks in the four countries. Inflation (the probability of the high-variance state) is measured along the left-hand (right-hand) side vertical axis. A close look at the figures represeinting inflation an dthe probability of a high-variance state for permanent shocks leads to the following observations:

[5]Results are available from the authors upon request.

(1) The probability of a high-variance state varies widely across countries. However, in some countries (Uk and Italy) it is observed that these probabilities are quite high (close to one) during thetimes of the oil price shocks, 1973-74 and 1979. In addition, for Italy the probability is close to zero in 1979, the year the country joined the European Monetary System.

(2) There is evidence for structural change in several countries. For example, in the UK the probability of high-income state is close to one in the second half of the 1970s. Similarly, this probability is very high for Italy in 1973-79 and in 1962 and in Holland for several years in the early 1990s. In contrast, for Germany the probability is never lower than 0.5, most likely indicating the absence of regime changes. This evidence supports the choice of the methodology of Markov regime-switching heteroskedasticity.

(3) In Italy and the UK there seems to exist a negative association between inflation and the probability of a high-variance state for permament shcoks. In other words, inflation and long run inflation uncertainty are negatively related. This is in agreement with the negaive sign of $\mu_2$. This finding constradicts the Friedman-Ball hypothesis.

A close look at the figures that plot the rate of inflation and the probability of a high-variance state for the transitory shocks reveals the following:

(1) The probability of a high variance state for transitory shocks varies significantly across countries. This probability is quite large (close to 1) for the UK in 1974, for Germany in the early 1970s and early 1990s (the post-reunification years). In contrast, the probability is close to zero for Italy in 1979, the year it joined the EMS.

(2) There is evidence for structural change in several countries. For example, in Germany the probability is close to 1 for several quarters in the early 1970s, for Italy the probability is close to zero in 1979, and for Holland the probability is close to zero in 1998 and quite small in the following quarters.

(3) A positive association between inflation and the probability of the high-variance state for transitory shocks is evident for Holland and the UK. This is consistent with the positive sign of $\mu_3$. Equivalently, inflation and uncertainty about short-run inflation are positively related. This evidence is consistent with the Friedman-Ball hypothesis. As inflation rises above normal, the public is facing more uncertainty regarding the response of the monetary authority which may be accommodating or disinflating.

## 6 Conclusions

We use a Markov regime-switching heteroskedasticity model in order to examine the association between inflation and inflation uncertainty in four European countries over the last forty years. This approach allows for regime shifts in both the mean and variance of inflation in order to assess the association between inflation and its uncertainty in short and long horizons. We find that this association differs (i) between transitory and permanent shocks to inflation and (ii) across countries. In particular, the association is positive or zero for transitory shocks and negative or zero for permanent shocks. Hence, Friedman's belief that inflation is positively associated with inflation uncertainty is only partially supported in this study, i.e., by short-run inflation uncertainty. The evidence for regime shifts highlights the advantage of the present approach relative to the GARCH methodology where such regime changes are unaccounted for.

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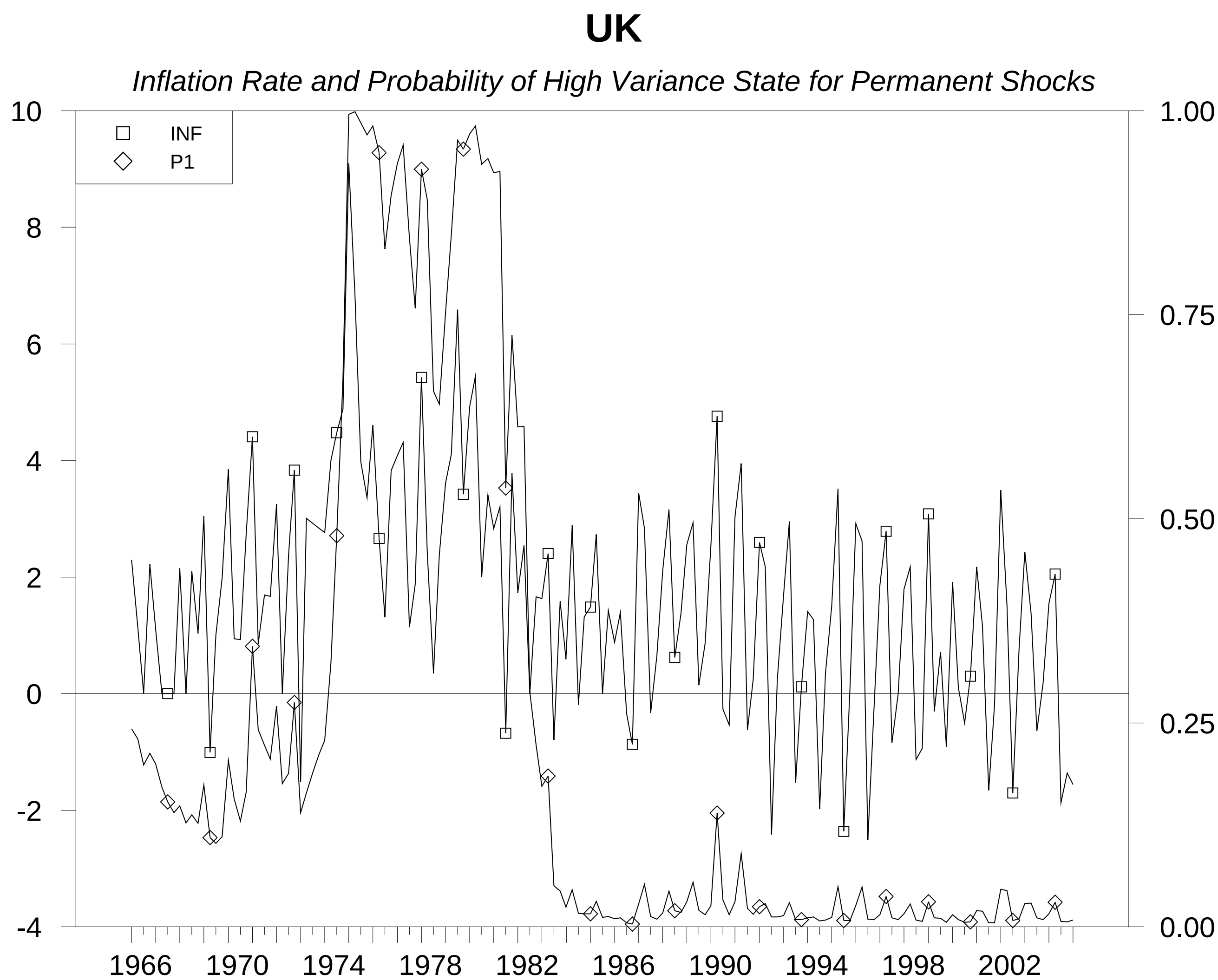
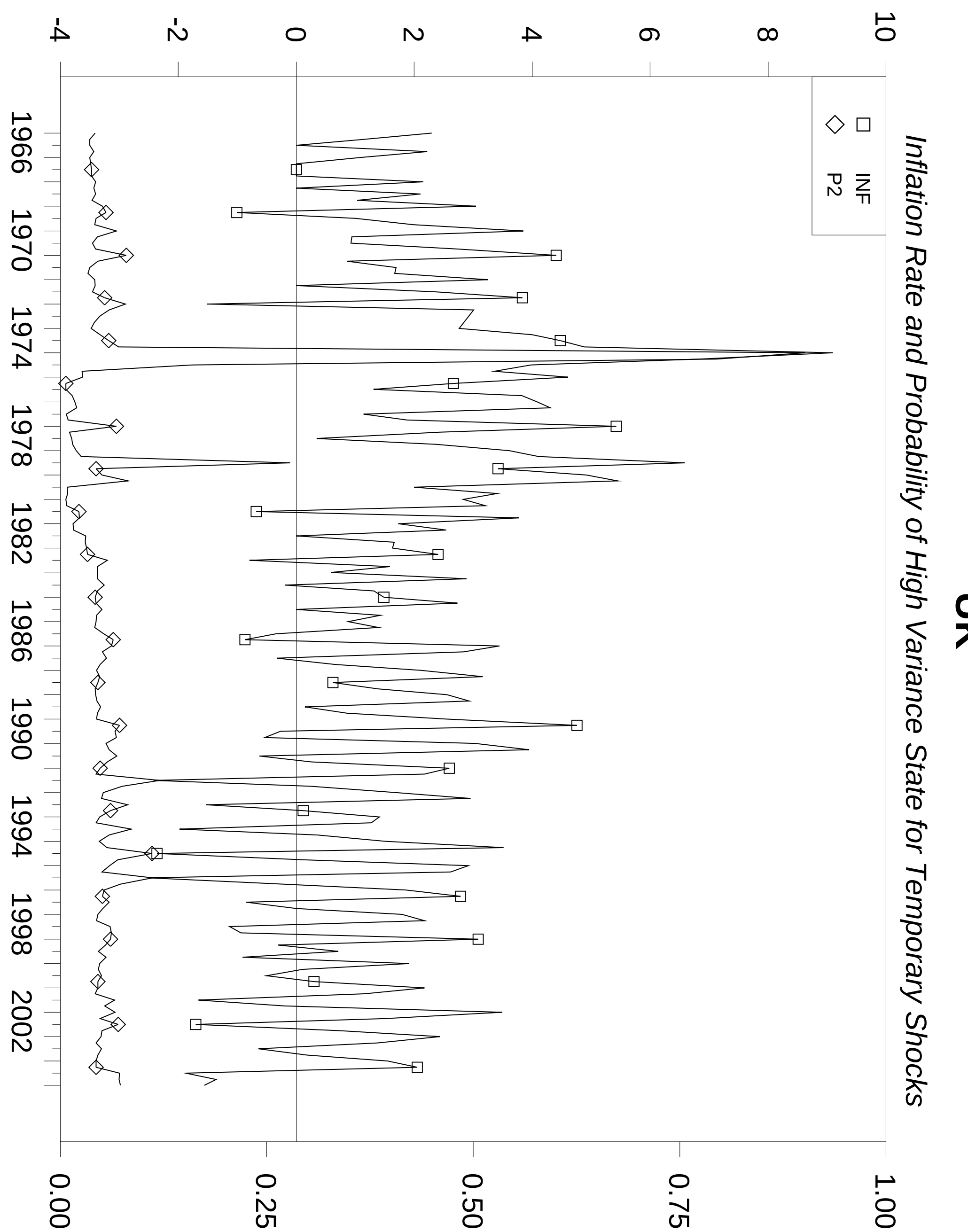
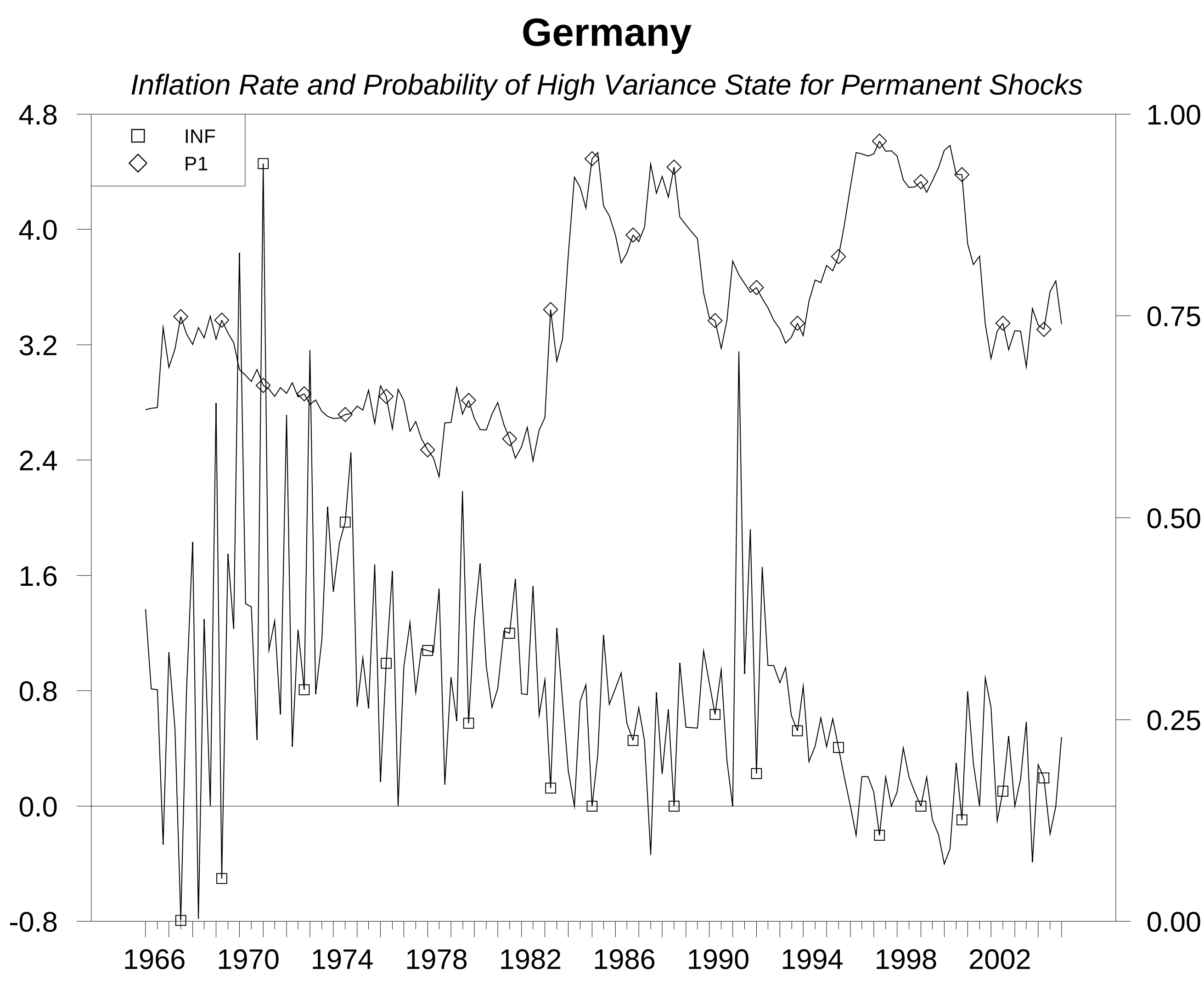
Table 1: Markov Switching Model of Inflation .

| | **Germany** | **Holland** | **Italy** | **UK** |
|---|---|---|---|---|
| | (1966.I-2005.I) | (1977.I-2005.I) | (1966.I-2005.I) | (1966.I-2005.I) |
| $Q_0$ | 0.001 | 0.0001 | 0.1245* | 0.0599 |
| | (0.0777) | (0.0225) | (0.0374) | (0.0532) |
| $Q_1$ | 0.0600 | 0.0001 | 1.2329* | 0.0001 |
| | (0.0825) | (0.0014) | (0.2247) | (0.0001) |
| $h_0$ | 0.3729* | 0.4442* | 0.0001 | 1.5367 |
| | (0.0363) | (0.0545) | (0.0015) | (0.0975) |
| $h_1$ | 0.7491* | 1.2693* | 0.4546* | 0.3415 |
| | (0.1322) | (0.4159) | (0.0369) | (0.5634) |
| $\mu_2$ | 0.4171 | 0.2217 | -2.3195* | -0.1350* |
| | (0.5647) | (0.4566) | (0.5397) | (0.0002) |
| $\mu_3$ | -0.2157 | 0.5896* | 0.1266 | 1.9422* |
| | (0.3646) | (0.1802) | (0.2540) | (0.5722) |
| $\mu_4$ | 0.0812 | 3.6081* | 1.2855* | 3.4291* |
| | (0.8829) | (1.2543) | (0.4257) | (0.0003) |
| $p_{00}$ | 0.9805* | 0.8635* | 0.8821* | 0.9726* |
| | (0.0711) | (0.1343) | (0.0633) | (0.0306) |
| $p_{11}$ | 0.9550* | 0.9758* | 0.9745* | 0.9910* |
| | (0.1038) | (0.0217) | (0.0162) | (0.0082) |
| $q_{00}$ | 0.9365* | 0.3270 | 0.9930* | 0.4303 |
| | (0.0445) | (0.2207) | (0.0068) | (0.3852) |
| $q_{11}$ | 0.9769* | 0.9132* | 0.9445* | 0.9665* |
| | (0.0173) | (0.0533) | (0.0599)) | (0.0431) |

Full details on each of the parameters are discussed in the methodology section in the text. Standard errors are in parenthesis. Significance at the 5% level is indicated by a *.

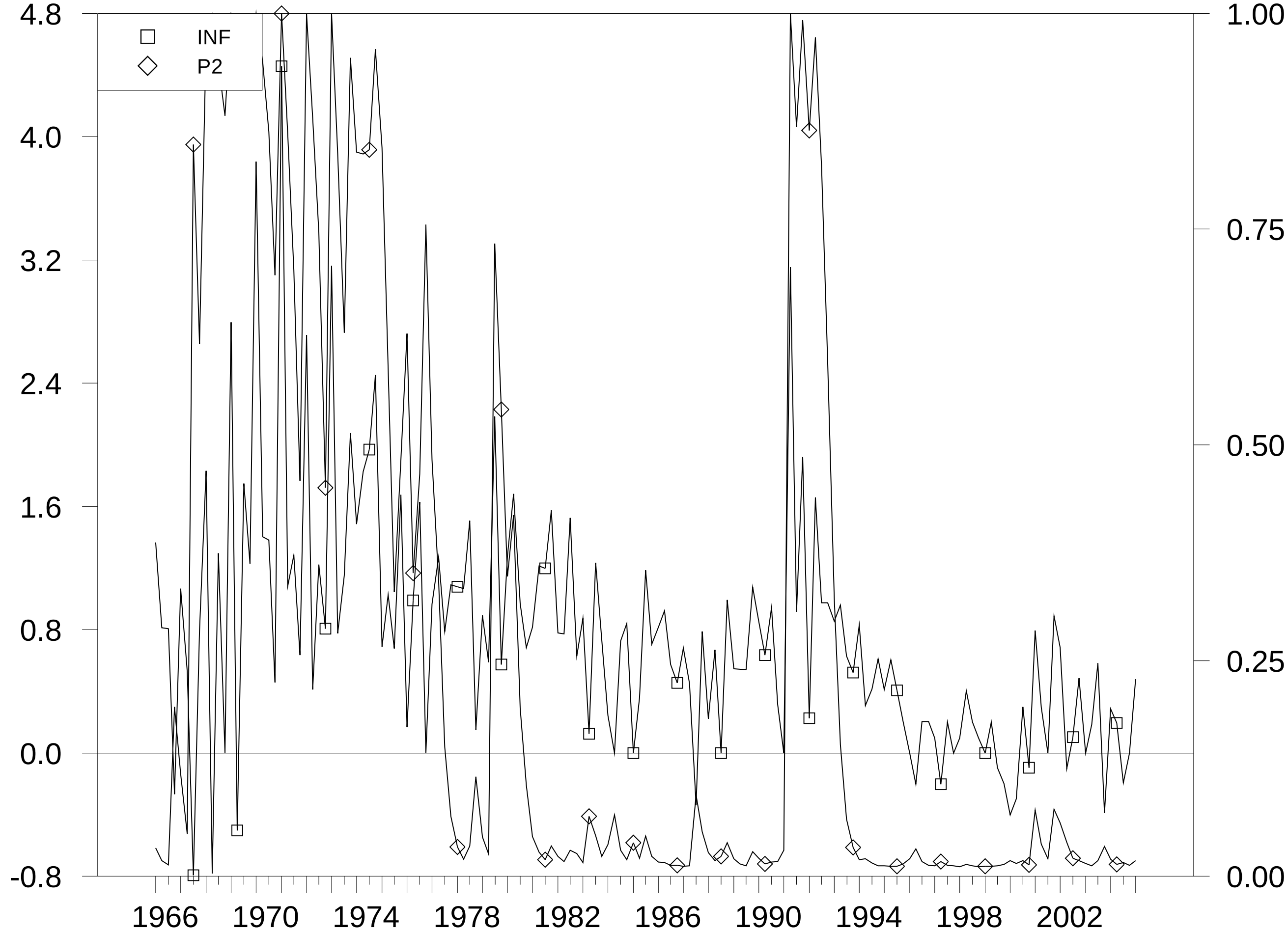

UK
Inflation Rate and Probability of High Variance State for Permanent Shocks
INF
P1
10
8
6
4
2
0
-2
-4
1.00
0.75
0.50
0.25
0.00
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002

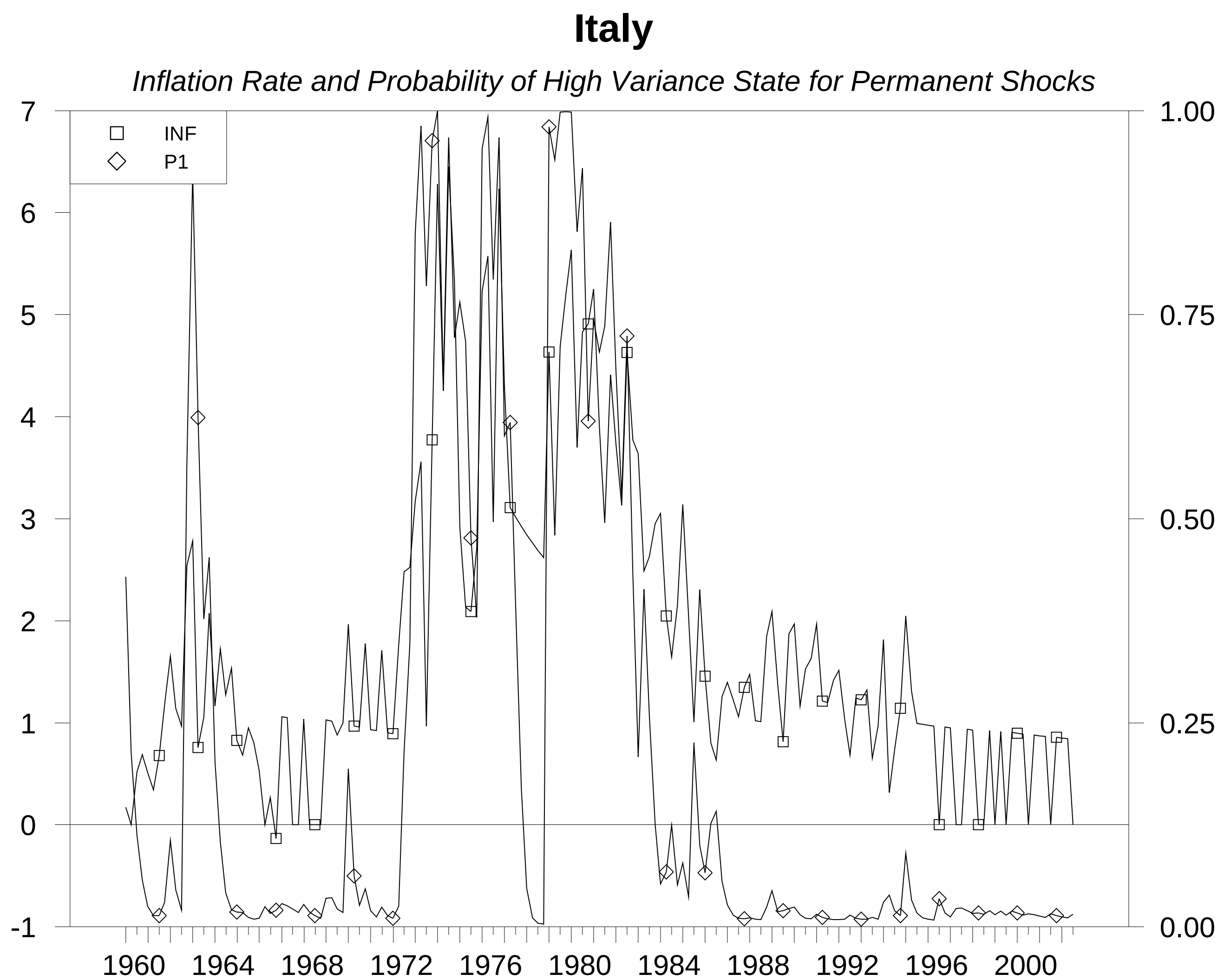

UK
Inflation Rate and Probability of High Variance State for Temporary Shocks
INF
P2
10
8
6
4
2
0
-2
-4
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
0.00
0.25
0.50
0.75
1.00


Germany
Inflation Rate and Probability of High Variance State for Permanent Shocks
INF
P1
4.8
4.0
3.2
2.4
1.6
0.8
0.0
-0.8
1.00
0.75
0.50
0.25
0.00
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002

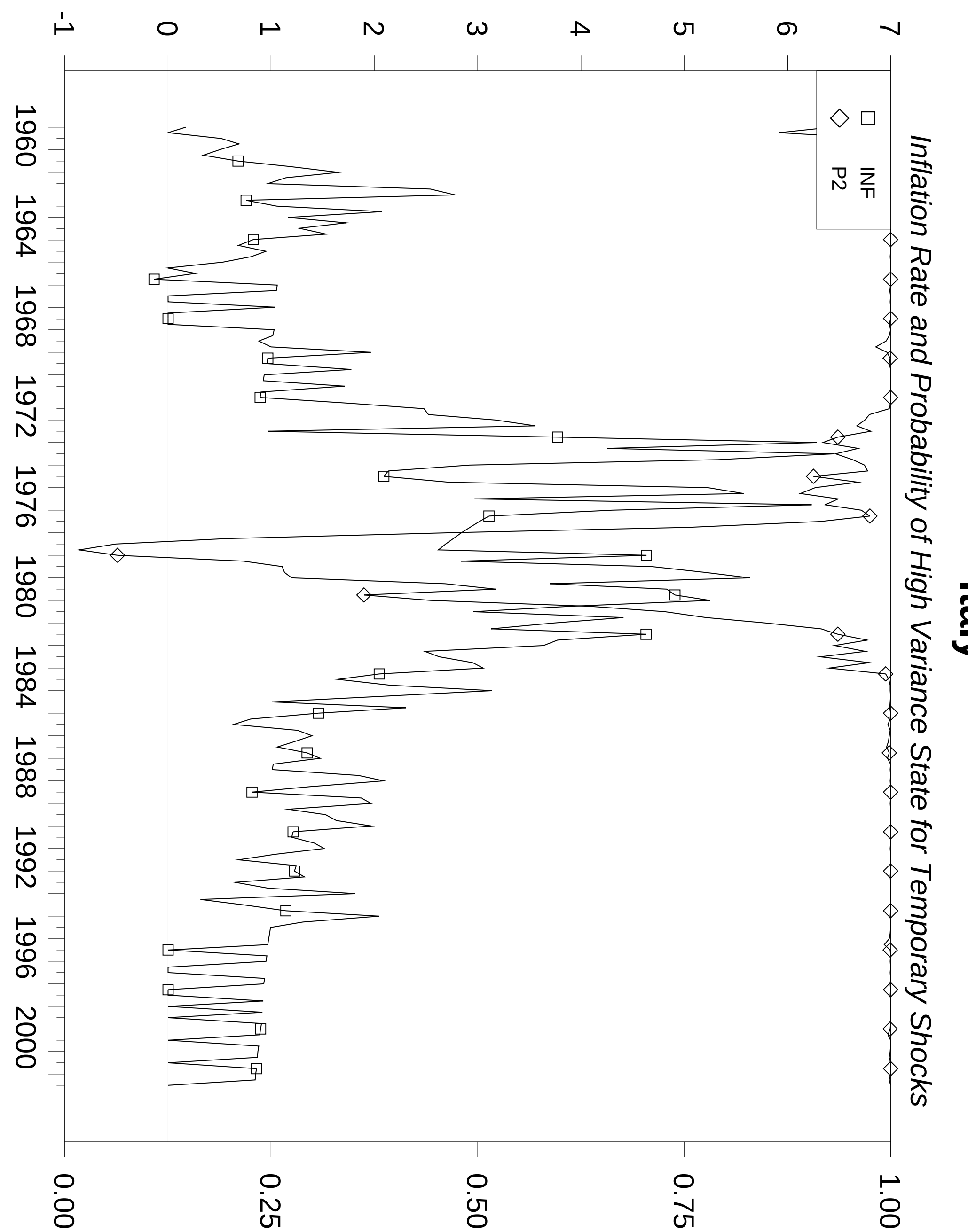
## Germany

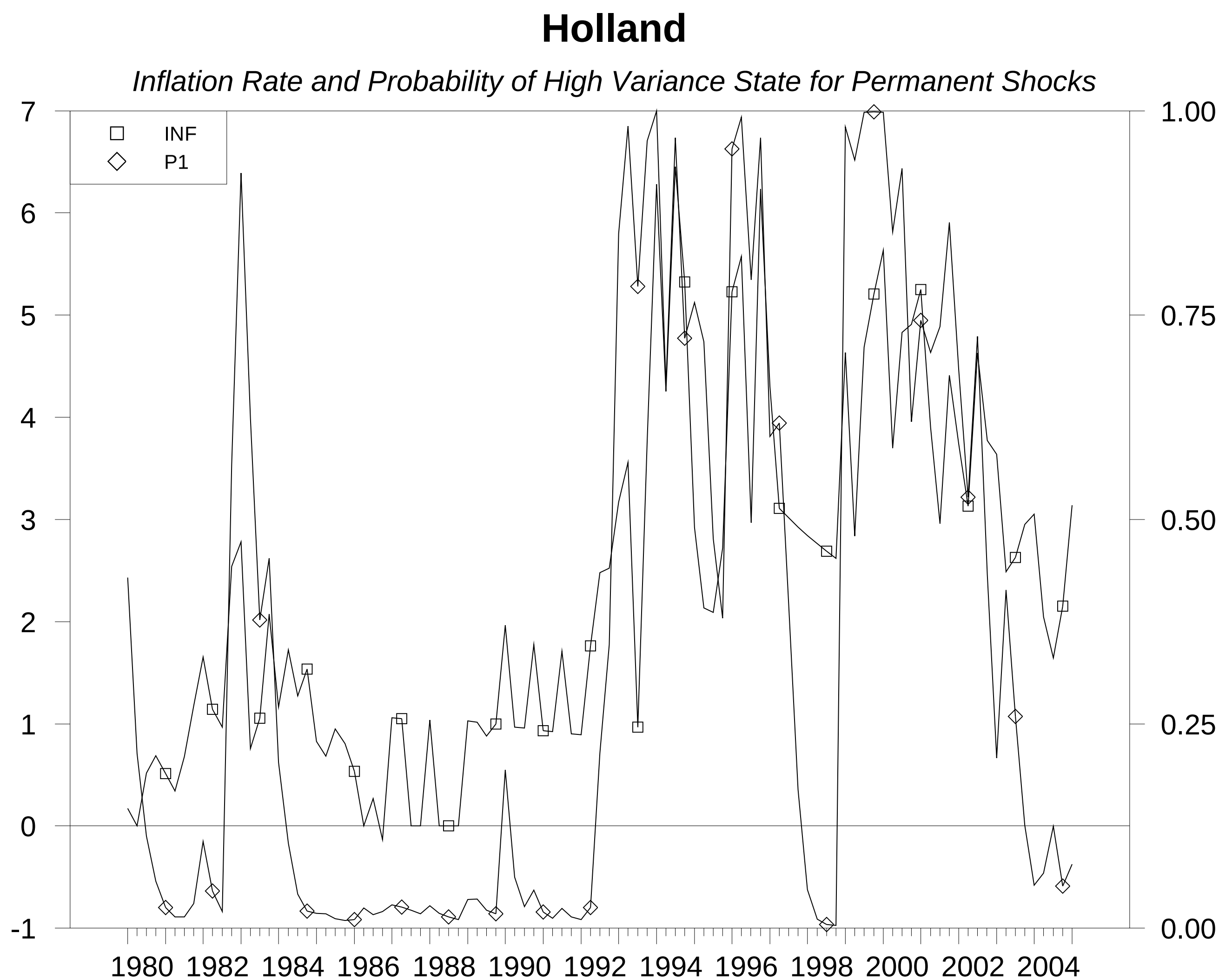
*Inflation Rate and Probability of High Variance State for Temporary Shocks*



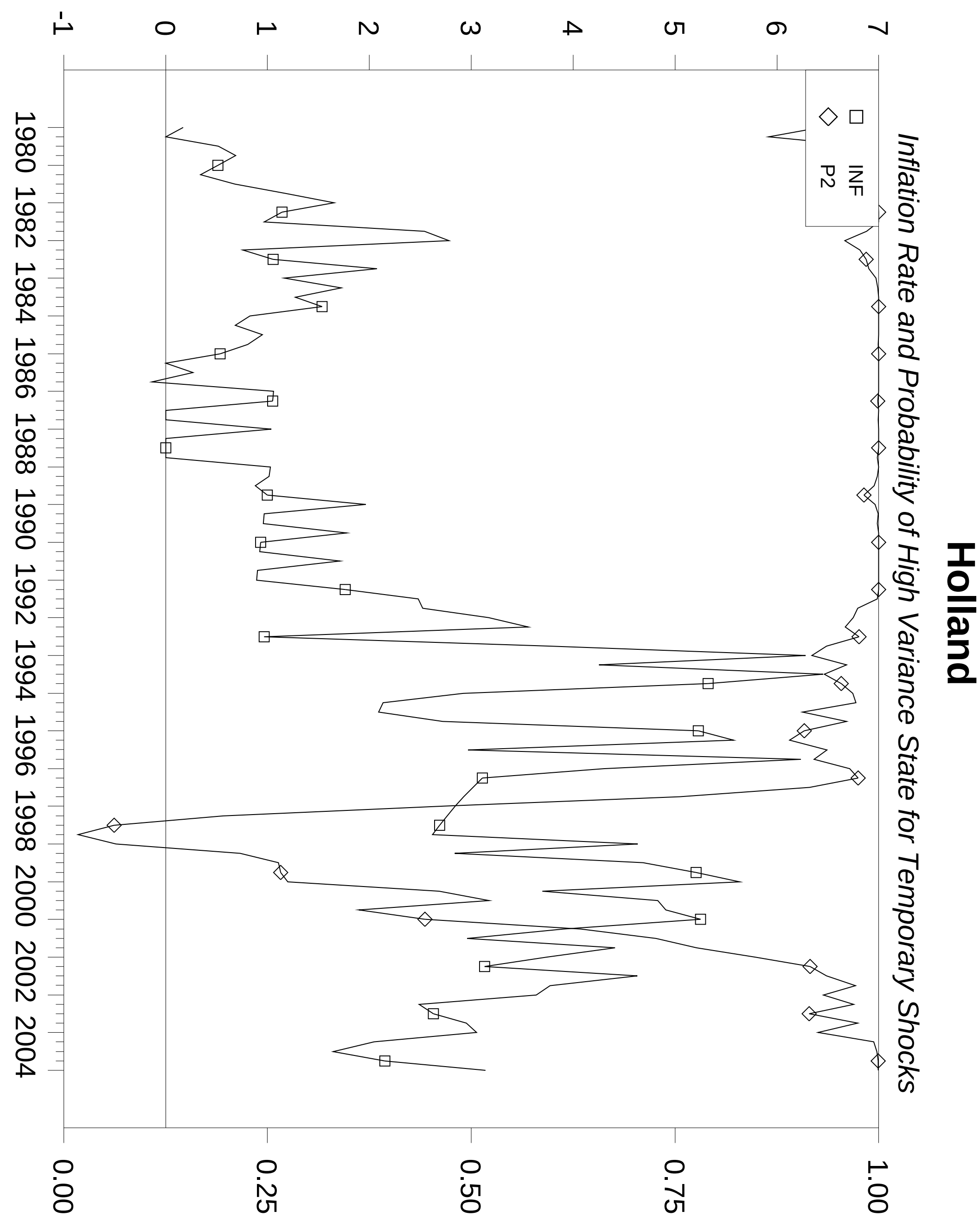


Italy
Inflation Rate and Probability of High Variance State for Permanent Shocks
INF
P1
7
6
5
4
3
2
1
0
-1
1.00
0.75
0.50
0.25
0.00
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000


Italy
Inflation Rate and Probability of High Variance State for Temporary Shocks
INF
P2
-1
0
1
2
3
4
5
6
7
0.00
0.25
0.50
0.75
1.00
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000



Holland
Inflation Rate and Probability of High Variance State for Permanent Shocks
INF
P1
7
6
5
4
3
2
1
0
-1
1.00
0.75
0.50
0.25
0.00
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004



Holland
Inflation Rate and Probability of High Variance State for Temporary Shocks
INF
P2
-1 0 1 2 3 4 5 6 7
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004
0.00 0.25 0.50 0.75 1.00