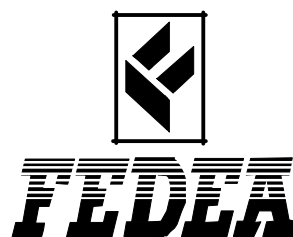


ESTUDIOS SOBRE LA ECONOMIA ESPAÑOLA

Inflation regimes and stabilization policies, Spain 1962-1997

Juan Ayuso
Graciela L. Kaminsky
David López-Salido

EEE 10



Fundación de Estudios de Economía Aplicada

<http://www.fedea.es/hojas/publicado.html>

INFLATION REGIMES AND STABILIZATION POLICIES, SPAIN 1962-1997

Juan Ayuso

Banco de España
Madrid 28014
SPAIN

Graciela L. Kaminsky

Department of Economics
George Washington University
Washington, D.C. 20052
USA

David López-Salido(*)

Banco de España
Madrid 28014
SPAIN

November 1998

Abstract

After reaching high levels in the 1970s and 80s, inflation in Spain has been brought under control. To fight inflation, Spain implemented austere monetary programs, joined the EMS in 1989, enacted central bank autonomy in 1994, and introduced inflation targets in January 1995. This paper takes the first steps in capturing the magnitude of the effects of the different policies on inflation. It estimates a switching-regime model of inflation that allows for the endogenous identification of the dates of the switching from one regime to another, allowing us to link the evolution of inflation regimes to the timing of implementation of the anti-inflationary strategies.

(*) This paper was started in June 1997 while Graciela Kaminsky was visiting the Banco de España. It has benefited from comments received from Juan J. Dolado, Javier Vallés, José Viñals and participants in seminars at the Banco de España and Bank of Finland. The views expressed are those of the authors and should not be interpreted as reflecting those of the Banco de España.

NON-TECHNICAL SUMMARY

In the early 1980s, after the explosion in inflation in the 1970s following the two oil shocks, all European economies engaged -to different extents- in extremely tight monetary policies to fight the escalating inflation. Many of those countries also joined the EMS in the hope that this arrangement, by accepting Germany monetary policy, would provide additional discipline, and thus, would help in further reducing inflation. The efforts to reduce inflation were further intensified in the late 1980s with a push for increased institutional independence for central banks. Finally, in the 1990s many countries introduced the so called inflation target regime, with explicit quantitative inflation targets at the center of stabilization programs.

Spain, as the other European economies, also suffered high rates of inflation in the 1970s and in the early 1980s, but inflation did decline and by 1997 inflation had collapsed to approximately 2 percent. To fight inflation, Spain implemented austere monetary programs, joined the EMS in 1989, enacted central bank autonomy in 1994, and introduced inflation targets in January 1995. Certainly, these and other policies are in part responsible for the drop in inflation. However, it is unclear the extent of the contribution of each policy. This paper takes the first steps in capturing the magnitude of the effects of the different policies on inflation. It estimates a model of inflation that allows for different regimes, with the mean rate of inflation, inflation persistence, and volatility possibly differing across regimes.

We estimate a Hamilton filter model, which allows for the endogenous identification of the dates of the switching from one regime to another. Our results point towards a model with three different regimes for inflation. The first regime is characterized by high and volatile inflation. The second regime is better described by high inflation and low volatility. Finally, the third regime is one of both low inflation and volatility. Average low and high inflation are estimated around 3 and 11 percent, respectively, whereas low and high standard deviations are estimated at 0.65 and 2.05. According to our estimates, agents perceived a change from high to low inflation volatility around 1978 and a change from high to low inflation around 1989. Both years are important in the evolution of the Spanish policy-mix: in 1978 the *Pactos de la Moncloa* marked an important change in the economic environment and in 1989 Spain joined the EMS.

We also illustrate that the existence of different inflation regimes has major implications for inflation forecasting. With imperfect information, agents do not observe the current regime nor are they able to fully anticipate a switch to another one. Thus, there are protracted periods in which inflation expectations are over or under the ex-post observed inflation and, therefore, *ex-post* expectation errors are correlated over time. These expectation errors, however, are not a sign of agents irrationality but can be explained in terms of an imperfect information problem.

1. INTRODUCTION

In the early 1980s, after the explosion in inflation in the 1970s following the two oil shocks, all European economies engaged -to different extents- in extremely tight monetary policies to fight the escalating inflation. Many of those countries also joined the EMS in the hope that this arrangement, by accepting Germany monetary policy, would provide additional discipline, and thus, would help in further reducing inflation. The efforts to reduce inflation were further intensified in the late 1980s with a push for increased institutional independence for central banks. Finally, in the 1990s many countries introduced the so called inflation target regime, with explicit quantitative inflation targets at the center of stabilization programs. Again, this new regime was introduced to help in reducing inflation. While the economics profession views about the role of the EMS, central bank independence, and inflation targeting in effectively reducing inflation differs, inflation did fall in Europe with inflation rates now oscillating around 2 percent.

Spain, as the other European economies, also suffered high rates of inflation in the 1970s and in the early 1980s, but, as shown in Figure 1, inflation did decline and by 1997 inflation had collapsed to approximately 2 percent. To fight inflation, Spain implemented austere monetary programs, joined the EMS in 1989, enacted central bank autonomy in 1994, and introduced inflation targets in January 1995. Certainly, these and other policies are in part responsible for the drop in inflation. However, it is unclear the extent of the contribution of each policy. The evolution of inflation and the implemented stabilization policies render Spain a suitable case study. This paper takes the first steps in capturing the magnitude of the effects of the different policies on inflation. It estimates a model of inflation that allows for different regimes, with the mean rate of inflation, inflation persistence, and volatility possibly differing across regimes.

The method implemented is the Hamilton (1989) filter, which allows for the endogenous identification of the dates of the switching from one regime to another. This possibility of dating the start of the different inflation regimes will allow us to link the evolution of inflation regimes to the timing of implementation of the anti-inflationary strategies. For example, it will allow us to examine whether membership in the EMS affected the persistence of inflation or whether the *Banco de España* gained reputation as a tough anti-inflationary monetary authority as a result of this decision. The rest of the paper is

organized as follows. Section 2 provides a chronology of the events leading to the reduction of inflation from 25 percent in 1977 to 2 percent in 1997. Section 3 presents the methodology and the models to be estimated. Section 4.1 reports the estimation of a two-state switching-regime model for inflation. Section 4.2 generalizes the model of inflation to a three-state switching-regime model. Section 5 concludes.

2. A CHRONOLOGY OF ANTI-INFLATION STRATEGIES

The return of Spain to democracy in 1975 was accompanied by expansionary fiscal policies. The structural fiscal deficit increased to 2 percent of GDP in 1976 and continuously increased thereafter reaching 7 percent of GDP by 1985. In the first few years monetary policy basically accommodated to the changes in the fiscal stance, with money supply (M1) growing around 20 percent between 1975 and 1977. By the end of 1977, inflation had reached almost 25 percent. In December 1977, with inflation rapidly accelerating, the Suárez government, announced the *Pactos de la Moncloa* plan. The social pact between the government, political parties, and the labor unions included among its key features a mechanism to break the inflation inertia: wages were going to be set according to expected inflation and not to compensate for past inflation. The *Pacto* was complemented with contractionary monetary policy. In contrast with the previous accommodating monetary policy, the *Banco de España* started to take an active role in monetary policy by publicly announcing monetary growth target rates, with the target bands for M3 declining from 14.5-19.5 percent in 1978 to 10.5-14.5 percent in 1984. The plan was very successful with inflation declining to less than 10 percent by 1984.

The instability of money demand brought about by the liberalization of the banking industry starting in 1978 and the flurries of financial innovations that followed the deregulation, led the *Banco de España* to de-emphasize the targeting of monetary aggregates. Notably, around this time monetary policy started to take into account the trade-weighted exchange rate, particularly after 1986 when Spain joined the European Economic Community. With the de-facto pegging of the peseta since 1986 and the more formal pegging after Spain joined the ERM in the first half of 1989, the monetary authority lost some control over monetary policy. During the 1986-1991 period, there were large, cumulative inflows of capital attracted by the higher yields of Spanish bonds and by investor's growing belief that Spain was on an irreversible convergence path

toward the Economic and Monetary Union. As it is examined in greater detail in Ayuso and Escrivá (1998), the large capital inflows could not be completely sterilized, with money supply growing at a pace extremely high to guarantee price stability. In fact, during the 1986-1991 period the growth rate of the targeted broad monetary aggregate always surpassed the target band and inflation increased rapidly, climbing from about 5 percent in 1987 to about 7.5 percent in 1989. Inflation was further fuelled by an expansionary fiscal policy. Between 1988 and 1993, the public deficit increased from 3.3 percent of GDP to 7.5 percent, with public expenditure reaching 50 percent of GDP and government debt also increasing to approximately 60 percent of GDP. Although inflation started to converge to the rate of inflation in Germany, the convergence was slow and the peseta appreciated massively. The ERM crisis in 1992, with the devaluations of the peseta in September and November, interrupted briefly this process, with inflation increasing to about 5 percent in 1994.

In 1994 the government implemented a new set of anti-inflationary policies. First, the Program of Convergence for the Spanish economy was revised and more emphasis was given to reducing public deficit according to the guidelines included in the Maastricht Treaty. Second, the labor market was given more flexibility, and third the *Banco de España* gained independence in 1994 (*Ley de Autonomía del Banco de España de 1994*). Also, in 1995 the *Banco de España* started to implement a regime of inflation targets. By the end of 1997 inflation had declined to approximately 2 percent.

3. METHODOLOGY

With a changing fiscal and monetary stance, the stochastic process followed by inflation will also eventually change. To examine what type of policies were more effective in bringing inflation down, we estimate a switching-regime model for inflation. The model consists of the following equations:

$$\pi_t = \delta_0(R_t) + \sum_{j=1}^q \delta_j(R_t) \pi_{t-j} + \varepsilon_t(R_t), \quad \varepsilon_t(R_t) \sim N(0, \sigma^2(R_t)) \quad [2]$$

where π_t is the annual rate of inflation, R_t is the variable representing the inflation regime, and n is the number of possible regimes. In expression (1), inflation is modeled as an autoregressive process of order q with regime-dependent constant, autoregressive

parameters, and volatility. Since some of the anti-inflation programs included de-indexation schemes, inflation persistence is expected to decrease after the stabilization program is implemented, that is, the sum of the $\delta_j(R_t)$ parameters will become smaller after an anti-inflation program is implemented. Equation (2) shows the Markov chain transition probability matrix, where p_{ij} is the probability of switching from Regime i to Regime j in one period.

We allow for up to a maximum of three regimes. We first explore a two-regime switching model. Next, we examine whether the inflation rate can be best described by a three-regime switching model and finally we explore different formulations for the three-regime model.

To estimate the model in equations [1]-[2], we use a modified Hamilton's (1989) nonlinear filter. Since there is no presumption that in fact there were changes in regime, the estimation procedure does not impose the existence of two or more differentiated states. Moreover, the estimation is based on the assumption that the regime is not observed directly but must be inferred based on the observation of current and past values of inflation. For the two-regime model, with regimes 0 and 1, the optimal forecast of this process can be thought of as the following sequence of steps.

For any period t , we have a certain prior about the probability of being in state 1 or 0 based on past information:

$$Prior(R_t = 1) = (1 - p_{10}) Post(R_{t-1} = 1) + p_{01} [1 - Post(R_{t-1} = 1)] \quad [3]$$

where

$$Prior(R_t = 1) = Prob(R_t = 1 | I_{t-1}), I_t = \{\pi_t, \dots, \pi_1\}, \text{ and } Post(R_t = 1) = Prob(R_t = 1 | I_t). \quad [4]$$

We then calculate the density function of π_t

$$f(\pi_t | I_{t-1}) = f(\pi_t | R_t = 1) Prior(R_t = 1) + f(\pi_t | R_t = 0) [1 - Prior(R_t = 1)] \quad [5]$$

Finally, we update our predictions using the Bayes formula:

$$Post(R_t = 1) = \frac{f(\pi_t | R_t = 1) Prior(R_t = 1)}{f(\pi_t | I_{t-1})} \quad [6]$$

We update repeatedly over the entire sample using [3]-[5].

¡Error! Marcador no definido.

The estimation procedure is as follows. We start at $t=1$ with the unconditional probability, which we set equal to the limiting probability of being in Regime 1 of the Markov process in equation [2]. Using [3]-[5] we construct the sample log likelihood

$$\sum_{t=1}^T \log f(\pi_t | I_{t-1}) \quad [6]$$

which can be maximized numerically with respect to the unknown parameters $\delta_o(R_t)$, $\delta_j(R_t)$ and $\sigma^2(R_t)$.

The test of the multi-regime models against single-regime models (or a multi-regime model with fewer regimes) is not straightforward because some of their parameters become nuisance parameters, i.e. they are not identified under the null hypothesis. The likelihood surface under the null will be flat, instead of locally quadratic in the neighborhood of the null, as required by standard distribution theory. As a result the global maximum may be quite far from the null. Hansen (1992) proposes a method for calculating an approximation to the distribution of a valid test statistics using the empirical distribution of an upper bound of the LR statistic.

In our case, to test a two-regime versus a single regime model we consider two different assumptions about the inflation process under the null: a random walk and a more general autoregressive model¹. For the nuisance parameters, we follow Hansen (1992) and use three different grids for the relevant parameters. The use of different grids is aimed, first, at covering a reasonable range, and second, at analysing the robustness of the result of the test.

To overcome the econometric and computational problems involved in testing a three-regime model against an alternative two-regime model, we follow a two step approach that will be described in the next section.

4. DATA AND RESULTS

¹ See the Appendix for more details.

As it is usual in the related literature, we use the Consumer Price Index (CPI). Our sample spans the period 1961:1 -1997:3. Due to the well documented seasonality in the Spanish CPI (Matea and Regil, 1996) we focus on annual inflation. However, we sample the data at quarterly frequencies. As it is well-known, this implies an overlapping in the data that induces a moving average component in the residual of the univariate model. This requires a correction for autocorelation in the estimated variance-covariance matrix (see Newey and West, 1987). In addition, we approach the MA component by expanding the autoregressive one.²

4.1 The Two-Regime Model

Table 1 shows the maximum-likelihood estimates of several two-regime switching models chosen according to the standard strategy of going from the general to the particular. Three main characteristics can be inferred from the results in Table 1. First, the autoregressive structure of the two-state model is quite simple: only the first order autoregressive parameter is found to be significant and there are no differences in persistence between both regimes. In spite of the above-mentioned problem of overlapping, we cannot reject the null of zero higher order autoregressive parameters in any of the regimes.

Second, our model is in levels, although it is well documented that the standard tests -based in single-regime models- usually reject the stationarity of the annual Spanish inflation series (see Matea and Regil, 1996). Non-stationarity, however, could be the result of a switching process between two stationary but different regimes. Unfortunately, it is not obvious how to test for unit roots in non-linear models like ours.³ Alternatively, we replicated 1000 times of our preferred stationary two-regime model and checked whether the ADF test is able to reject the null of the existence of a unit root in the

² Notice that using monthly data would have intensified the data overlapping problem.

³ Although their critical values are not tabulated for non-linear models, the ADF statistic decreases from -1.38 to -3.09 when the switching between two different stationary regimes is allowed for. In this case, without constant or trend, the 5% critical value tabulated for linear models is -2.59.

simulated inflation series, when the switching is ignored. Only in 197 cases is the standard ADF test is able to properly reject the null of a unit root in the series.⁴ Therefore, our approach -in levels- does not seem to be inappropriate.

Third, according to the estimated means and variances, there seem to be two different regimes, one of them showing a much higher volatility (2.08 versus .71) and also a higher unconditional mean⁵ (15.8 vs. 2.3). This result is in line with those presented, among others, by Evans and Wachtel (1992) and Ricketts and Rose (1995). That is, in a two-state model, high inflation seems to be associated with increased uncertainty about future inflation. Nevertheless, note that the intercepts in both regimes are only marginally different from each other.

Before going further in the interpretation of our results, we have to test formally whether our two-regime model provides a better fit than a single-regime model. Table 2 shows the main results of the Hansen test. As can be seen, we clearly reject in all cases the null hypothesis of single-state representation against our two-state representation for the inflation process in Spain.

According to our estimates of the transition matrix, the probabilities of staying in any regime are quite high. This is a rather standard result in the related literature (see, for example, Ricketts and Rose, 1995). Using the probabilities of our preferred model (Table 1, column (5)) and expressions (3)-(5), we can construct the prior probabilities of being in different inflation regimes and the expected inflation rate according to this model. Figure 2 shows the prior probabilities of being in each of the two regimes. These probabilities point towards a change initiated around 1978 and consolidated around 1984, which could be related to the anti-inflation program implemented in that year, *Los Pactos de la Moncloa*. As is the case with the transition probabilities, prior probabilities are also close to the limit 0-1 case. However, the average inflation in each regime is different enough as to yield forecasting errors comparable to those in Ayuso and López-Salido (1998). As Chart 3

⁴ This result does not change if the Philips-Perron test is used. The number of rejections increases to 199.

⁵ The unconditional mean is [click here to view equation.](#) **¡Error! Sólo el documento principal.**

shows, there are different periods where systematic differences arise between the annual observed and 1-year-ahead expected inflation. During the period of increase in the inflation rate, the two-state model tends to under-predict, but it tends to overpredict once inflation starts to decrease. During the long disinflationary episode experienced by the Spanish economy, inflation expectations reflected the observed inflation movements with some delay. This process seems to end around 1989. After 1989, the observed inflation movements are identified mainly as transitory deviations around the values that characterize the low inflation regime. Thus, under- and over-prediction periods are much shorter and less important from a quantitative standpoint.

The main difference between the inflation process in regimes 1 and 2 is the substantial increase in volatility in regime 1. In contrast, mean rates of inflation in both regimes seem to be not significantly different. Next section examines whether changes in the average rate of inflation and volatility occur sequentially. Thus, we examine whether the inflation process in Spain can be better characterized by a three regime process.

4.2. A Three-Regime Model

Again, the model estimated is represented by equations (1)-(2) with several restrictions. First, the model estimated is an AR(1) with regime-independent first order autoregressive parameter. Second, the transition probability matrix is restricted so that the transition between the 'high' inflation regime to the 'low' inflation regime can only occur through an intermediate regime of 'medium' inflation.⁶

Table 3 shows the main results of our estimates. We have estimated two different models. Model 1 corresponds to the most general specification of the equation (2). Interestingly, mean and volatility are positively correlated, that is the higher the rate of inflation, the higher the volatility. Our estimates suggest the existence of three regimes. They can be characterized as follows: a low and stable inflation regime, a medium and more volatile

⁶ Three-state models with different and higher order autoregressive parameters and unrestricted transition probabilities have also been estimated. First, we cannot reject the null hypothesis of a single first order common parameter at 3 percent level of significance (see Table 3). Second, when they are not restricted, the transition probabilities from state 1 to state 3 and from state 3 to state 1 are estimated at around 5e-06.

inflation regime, and a high and volatile inflation regime. Nevertheless, the intercepts (and therefore, average inflation) in States 2 and 3 are somewhat similar and the same applies to the estimated variance in regimes 1 and 2. We cannot reject these two restrictions, which are therefore incorporated into Model 2.

Model 2, our preferred specification, allows us to identify three regimes slightly different from the three regimes in Model 1. Thus, as Table 4 shows, there seem to be a high and volatile inflation regime, a high but stable inflation regime and a low and stable inflation regime. According to the unconditional means in each regime, average 'low' and 'high' inflation are estimated to be 3.7 and 11.9 percent, respectively, whereas 'low' and 'high' standard deviations are estimated to be 0.65 and 2.05. These estimates are quite similar to those of the two-regime model, particularly those regarding volatility.

The transition probabilities among those regimes are now less close to the limit 0-1 values but for Regime 1. Chart 4 shows the corresponding prior probabilities of being in each regime. As can be seen, volatility declines substantially around 1978. But we do not observe a similar perceived change in the average inflation by that time. Such a change does not occur until the late 1980s. Interestingly, it is at this time that Spain joined the ERM and a fiscal consolidation plan was announced, suggesting that both events could have helped in achieving a lower inflation.

Chart 5 shows 1-year-ahead expected annual inflation and the actually observed one. This chart offers a picture rather similar to that of the two-regime model and therefore, expanding the model does not modify our previous conclusions. Doubts about the current inflation regime and -maybe to a lesser extent- non-zero probabilities of changing to a different regime can explain forecasting errors far from the usual white noise assumption. As examined before, it seems that agents' expectations adjust slowly over time. Note, however, that the relatively protracted periods of under- or over-prediction of inflation are not a sign of irrationality but a sign of imperfect information.

Finally, Table 5 shows the results of an indirect test of a three-regime model against the two-regime model estimated in Section 4.1. Given the heavy computational requirements of the direct Hansen test⁷ and their unknown degree of conservativeness in this case, we

⁷ There are 6 nuisance parameters and therefore, a simple grid of 4 points per parameter would yield a total of 4096 estimates of different three-regime models.

have followed a different approach. According to Table 4 and Chart 4, we have split our sample into two different subsamples. The first one starts in 1962 and ends in 1985. The second one starts in 1978 and ends in 1997. As commented, 1978 and 1985 seem to be the years in which the changes in the inflation volatility and in the inflation mean have occurred. Accordingly, in the first subsample we estimate a two-regime model and test whether the variance is the same in both regimes and whether the intercepts are different. If these constraints are not rejected, we test this restricted model against the null of a single-regime model during the same period. In the second subsample, a similar process is followed (testing, in this case, whether there is a single mean but two different variances). If these two different two-regime models are not rejected, a three-regime model must characterize the inflation series when the whole sample is considered.

The advantages of this indirect test are clear. On the one hand, we can use standard statistics to test whether the means and variances in each regime are different. On the other hand, the number of relevant noisy parameters is reduced and therefore the computational requirements are notably lower. Notice, moreover, that this test, plus a comparison of the resulting (unconditional) means and variances to those of the three-regime model, can also be interpreted in terms of a stability test.

Overall, the results summarized in Table 5 seem to support our three-regime approach. Thus, we cannot reject the existence of a single intercept and two variances in the first subsample, nor the existence of single variance and two intercepts in the second one. Estimates of the (unconditional) means and the variances in each case are also rather similar to those of the three-regime model. Finally, the Hansen tests reject the null of a single-regime model in each subsample, at least at the 10% level.⁸

⁸ It should be remembered, however, that this test provides upper bounds and therefore, 'suffer a loss in effective power (the ability to reject the null when it is false)' (Hansen, 1992, p. S66).

5. CONCLUSIONS

This paper examines whether the stochastic process followed by the rate of inflation in Spain from 1962 to 1997 can be better characterized as following a switching-regime. Our preferred model is the one with three regimes. The first regime is characterized by high and volatile inflation. The second regime is better described by high inflation and low volatility. Finally, the third regime is one of both low inflation and volatility.

Average low and high inflation are estimated around 3 and 11 percent, respectively, whereas low and high standard deviations are estimated at 0.65 and 2.05. According to our estimates, agents perceived a change from high to low inflation volatility around 1978 and a change from high to low inflation around 1989. Both years are important in the evolution of the Spanish policy-mix: in 1978 the *Pactos de la Moncloa* marked an important change in the economic environment and in 1989 Spain joined the EMS.

Finally, we illustrate that the existence of different inflation regimes has major implications for inflation forecasting. With imperfect information, agents do not observe the current regime nor are they able to fully anticipate a switch to another one. Thus, there are protracted periods in which inflation expectations are over or under the ex-post observed inflation and, therefore, *ex-post* expectation errors are correlated over time. These expectation errors, however, are not a sign of agents irrationality but can be explained in terms of an imperfect information problem.

REFERENCES

- Ayuso, J. and J.L. Escrivá (1998): "Trends in the Monetary Policy Strategy in Spain", in Molina, J.L., Viñals, J. and Gutiérrez, F. (eds) *Monetary Policy and Inflation in Spain*, McMillan.
- Ayuso, J. and J.D. López-Salido (1998): "Ex-post real interest rates versus ex-ante real rates: a CCAPM approach", *Spanish Economic Review*, forthcoming.
- Evans, M. and P. Watchel (1992): "Inflation Regimes and the source of inflation uncertainty", Federal Reserve Bank of Cleveland, Conference on Inflation Uncertainty.
- Hamilton, J. (1989): "The new approach to the economic analysis of non stationary time series and the business cycle", *Econometrica*, 57, 357-84.
- Hansen, B.E. (1992): "The likelihood ratio test under nonstandard conditions: testing the Markov switching model of GNP", *Journal of Applied Econometrics*, 7, 61-82.
- Matea, M.Ll. and A.V. Regil (1996): "Indicadores de inflación a corto plazo", *Estadística Española*, v. 38, n. 141, 83-114.
- Ricketts N. and D. Rose (1995): "Inflation, learning and monetary policy regimes in the G-7 economies", Bank of Canada, Working Paper 95-06.

TABLE 1
INFLATION IN SPAIN:
TWO REGIME MODELS MAXIMUM LIKELIHOOD ESTIMATES

Parameters	(1)	(2)	(3)	(4)	(5)
$\delta_0(R_t = 0)$ 22	-.02 (.16)	-.02 (.10)	-.02 (.11)	-.00 (.04)	.08 (.15)
$\delta_1(R_t = 0)$ 23	.87 (.11)	.87 (.10)	.87 (.12)	.98 (.01)	.97 (.01)
$\delta_2(R_t = 0)$ 24	.17 (.12)	.16 (.13)	.11 (.11)	--	--
$\delta_3(R_t = 0)$ 25	.01 (.10)	-.05 (.08)	--	--	--
$\delta_4(R_t = 0)$ 26	-.06 (.08)	--	--	--	--
$\sigma(R_t = 0)$ 27	.70 (.06)	.71 (.06)	.71 (.06)	.71 (.06)	.71 (.06)
$\Delta\delta_0$ 28	1.07 (.49)	.92 (.50)	.84 (.49)	.95 (.47)	.44 (.26)
$\Delta\delta_1$ 29	.08 (.17)	.09 (.16)	.09 (.16)	-.05 (.04)	--
$\Delta\delta_2$ 30	-.09 (.22)	-.08 (.23)	-.14 (.16)	--	--
$\Delta\delta_3$ 31	.16 (.18)	-.07 (.16)	--	--	--
$\Delta\delta_4$ 32	-.23 (.14)	--	--	--	--
$\Delta\sigma$ 33	1.26 (.17)	1.34 (.17)	1.34 (.16)	1.35 (.16)	1.37 (.16)
p_{11} 34	.991 (.009)	.992 (.008)	.992 (.009)	.992 (.009)	.992 (.009)
p_{00} 35	.992 (.007)	.992 (.007)	.992 (.008)	.992 (.008)	.992 (.009)
$\log L$ 36	-219.4	-224.4	-226.6	-229.9	-230.5
N 37	139	140	141	142	142

Notes:

(a) Robust standard errors in parentheses.

(b) $\Delta\delta_j = \delta_j(R_t = 1) - \delta_j(R_t = 0)$ 38

(c) $\Delta\sigma = \sigma(R_t = 1) - \sigma(R_t = 0)$ 39

TABLE 2
STANDARDISED LIKELIHOOD RATIO (LR) HANSEN TEST

Grid	$H_0: \Delta\pi = u_t$ 40	$H_0: P_4(L)\Delta\pi = u_t$ 41
1	6.785 (2.721)	4.741 (2.767)
2	6.712 (3.156)	5.650 (3.421)
3	6.662 (3.685)	5.450 (3.719)

Notes:

(a) LR statistics have been obtained using 1000 Monte Carlo replications in each grid point. 5 percent critical values are in brackets.

(b) Grid 1 (256 grid points):

δ_0 42 from .05 to .11 in steps of .02 (4 grid points);

σ 43 from .60 to .75 in steps of .05 (4 grid points);

p_{00}, p_{11} 44 from .87 to .99 in steps of .04 (4 grid points);

(c) Grid 2 (256 grid points):

δ_0 45 from .01 to .31 in steps of .10 (4 grid points);

σ 46 from .40 to 1.0 in steps of .02 (4 grid points);

p_{00}, p_{11} 47 from .54 to .99 in steps of .15 (4 grid points);

(d) Grid 3 (1296 grid points):

δ_0 48 from .05 to 1.3 in steps of .25 (6 grid points);

σ 49 from .01 to 1.26 in steps of .25 (6 grid points);

p_{00}, p_{11} 50 from .49 to .99 in steps of .10 (6 grid points);

(e) Under the null, inflation is non-stationary, as it is well-known.

(f) When testing the null of an AR(4) the two-regime model has been accordingly extended to include 5 lags on the right hand side.

TABLE 3
MAXIMUM LIKELIHOOD ESTIMATES
OF ALTERNATIVE THREE-REGIME MODELS

	MODEL 1			MODEL 2		
Parameters	$R_t = 1$ 51	$R_t = 2$ 52	$R_t = 3$ 53	$R_t = 1$ 54	$R_t = 2$ 55	$R_t = 3$ 56
$\delta_o(R_t)$ 57	.26 (.22)	.74 (.74)	.92 (.39)	.28 (.16)	.90 (.36)	
$\delta_l(R_t)$ 58	.93 (.03)			.92 (.02)		
$\sigma(R_t)$ 59	.64 (.06)	.89 (.19)	2.07 (.14)	.65 (.15)		2.05 (.16)
p_{1R_t} 60	1.00	.00	--	1.00	.00	--
p_{2R_t} 61	.03	.94	.03	.05	.84	.11
p_{3R_t} 62	--	.02	.98	--	.03	.97

logL (Model 1) = -228.4 logL (Model 2) = -229.35

LR test Model 2 vs. Model 1 = 1.90

Notes:

(a) Standard errors -in brackets- are robust to heteroscedasticity.

(b) T-ratios for δ_j , $j = 2, 3, 4$ 63 are .07, -.92 and -1.5, respectively.

(c) The likelihood ratio statistics for $\delta_1(R_t = 1) = \delta_1(R_t = 2) = \delta_1(R_t = 3)$ 64 is 7.4, with a p-value of .03.

TABLE 4
INFLATION REGIMES IN OUR THREE-REGIME SWITCHING MODEL

Inflation variability		Average inflation	
		Low	High
	Stable	Regime 1	Regime 2
	Volatile	--	Regime 3

TABLE 5
THREE-REGIME MODEL AGAINST THE TWO-REGIME ONE

$R_t = \{1, 2\}$	
1962:I - 1985:IV	1978:I - 1997:IV
$t [\delta_0(1) = \delta_0(2)] = 1.0$ 67	$t [\sigma(1) = \sigma(2)] = 1.1$ 68
$t [\sigma(1) = \sigma(2)] = 5.6$ 69	$t [\delta_0(1) = \delta_0(2)] = 2.4$ 70
$\hat{E}(\pi) = 10.6(1.7)$ 71	$\hat{E}(\pi 1) = 4.4(.8)$ 72
$\hat{\sigma}(1) = .88(.14)$ 73	$\hat{E}(\pi 2) = 12.2(3.0)$ 74
$\hat{\sigma}(2) = 2.07(.15)$ 75	$\hat{\sigma} = .72(.06)$ 76
LR Hansen statistic of the null $\Delta\pi_t = u_t$ 77	
Grid 1: 2.08 (2.51, 2.15)	Grid 3: 1.77 (1.99, 1.56)
Grid 2: 2.31 (2.40, 2.17)	Grid 4: 1.86 (1.89, 1.51)

Notes:

(a) $\hat{E}(\pi | R)$ 78 and $\hat{\sigma}(R)$ 79 are, respectively, the unconditional mean and standard deviation estimated in each regime. Corresponding standard errors are in brackets.

(b) LR statistics have been obtained using 1000 Monte Carlo replications. 5 percent and 10 percent critical values are in brackets.

(c) Grid 1 (810 grid points):

σ 80 from .25 to 2.5 in steps of .25 (10 grid points);

p_{00}, p_{11} 81 from .1 to .9 in steps of .1 (9 grid points);

(d) Grid 2 (1000 grid points):

σ 82 from .25 to 2.5 in steps of .25 (10 grid points);

p_{00}, p_{11} 83 from .5 to .95 in steps of .05 (10 grid points);

(e) Grid 3 (810 grid points):

δ_0 84 from .1 to 1.0 in steps of .1 (10 grid points);

p_{00}, p_{11} 85 from .1 to .9 in steps of .1 (9 grid points);

(f) Grid 4 (1000 grid points):

δ_0 86 from .1 to 1.0 in steps of .1 (10 grid points);

p_{00}, p_{11} 87 from .5 to .95 in steps of .05 (10 grid points);

APPENDIX

TABLE A1
UNIVARIATE (ONE-REGIME) INFLATION MODEL
ALTERNATIVE REPRESENTATION

$$\Delta\pi_t = \sum_{j=1}^4 \rho_j \Delta\pi_{t-j} + u_t; u_t \sim D(0, \sigma_u^2) \quad 88$$

	Random Walk	AR(4)
ρ_1 89 (s.e.)	-	.09 (.07)
ρ_2 90 (s.e.)	-	.11 (.07)
ρ_3 91 (s.e.)	-	.18 (.07)
$\square$ 92 (s.e.)	-	-.56 (.07)
σ 93	1.55	1.22
Q(1) (p-value)	0.00 (.96)	0.02 (.89)
Q(4) (p-value)	47.32 (.00)	1.30 (.86)
Q(20) (p-value)	75.27 (.00)	23.3 (.27)

Note: Q(n) is the Ljung-Box statistic for residual autocorelation up to order n.

CHART 1. INFLATION IN SPAIN
PERCENT PER ANNUM

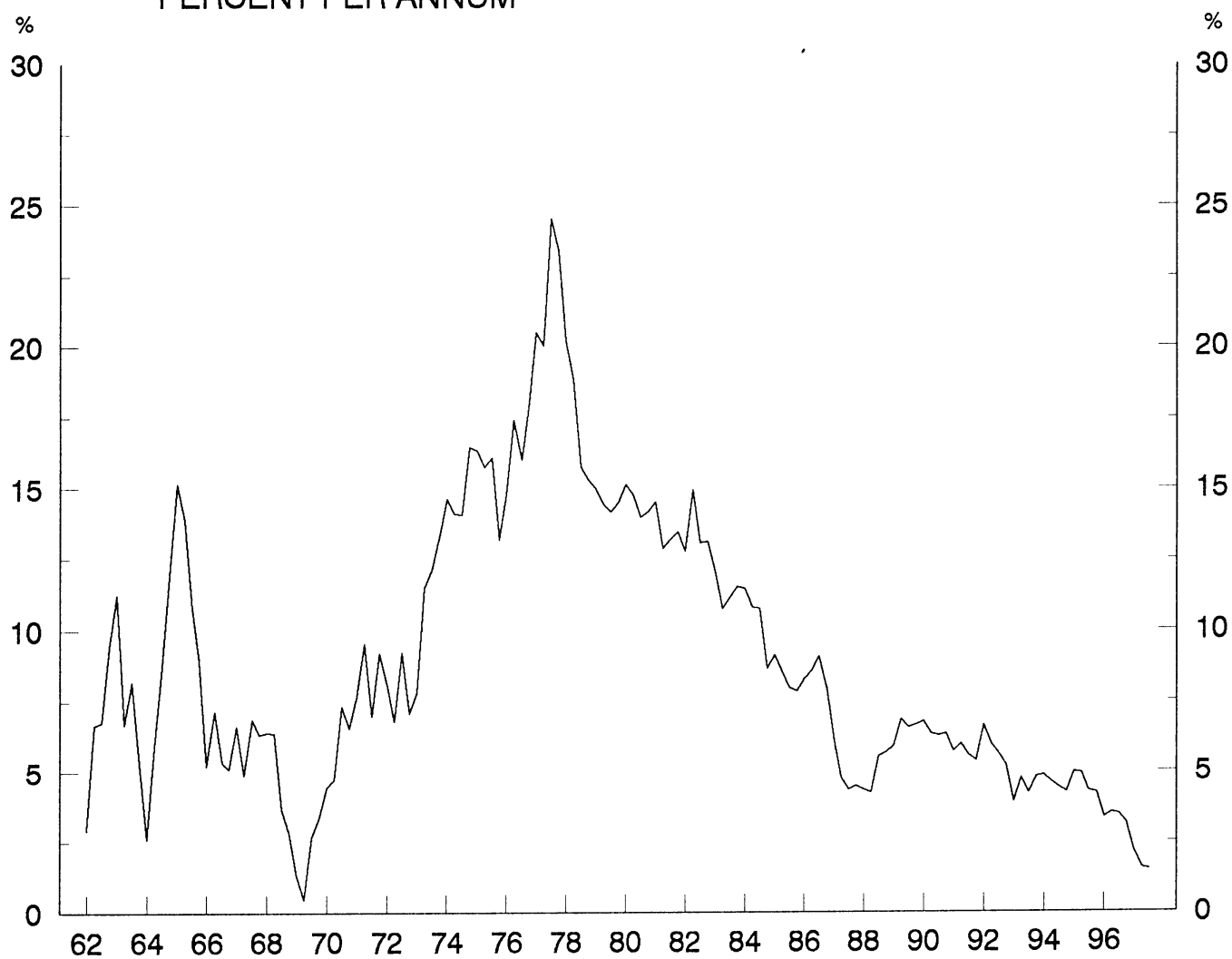


CHART 2. ESTIMATED PRIOR PROBABILITIES
2-REGIME MODEL

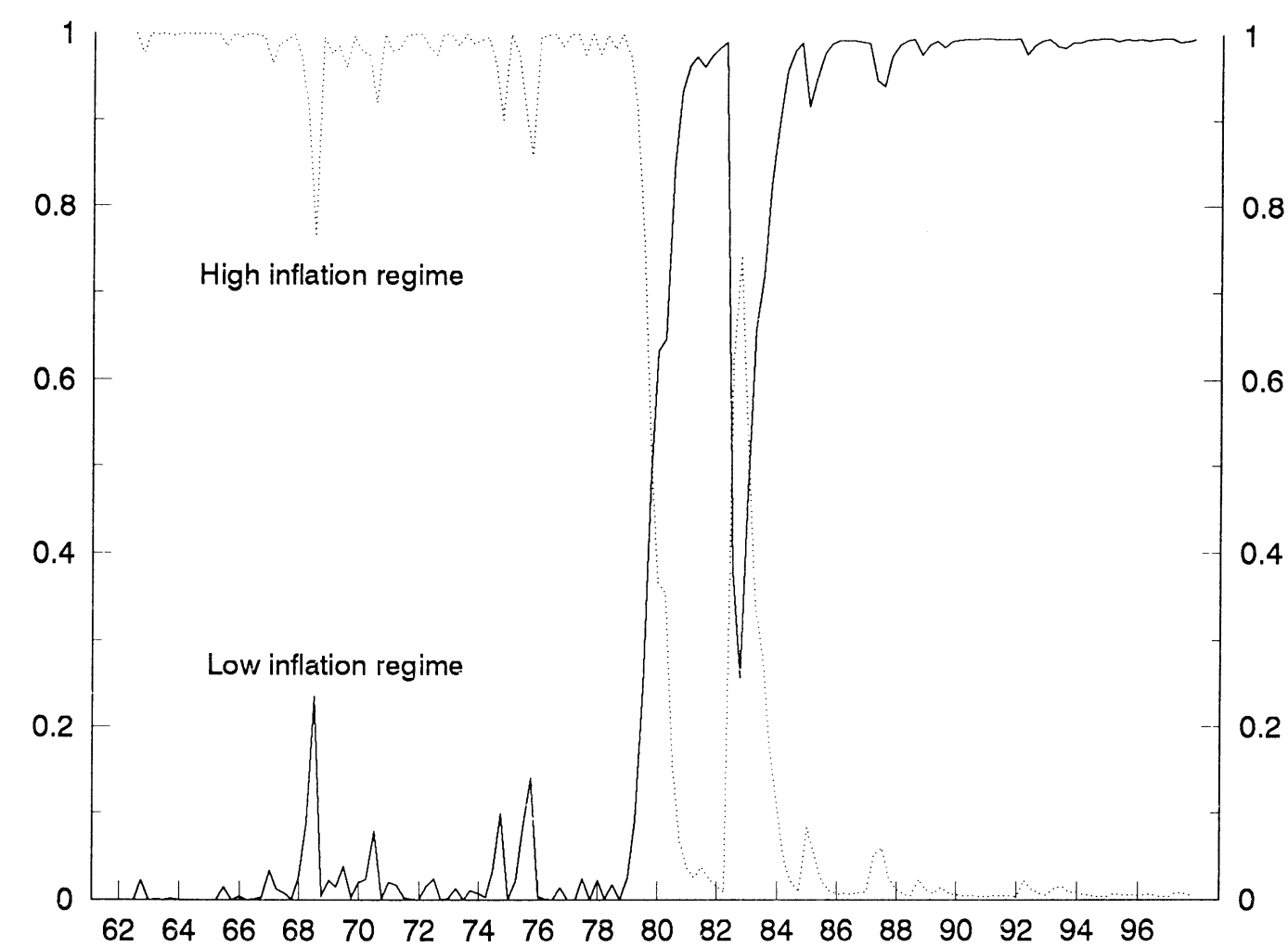
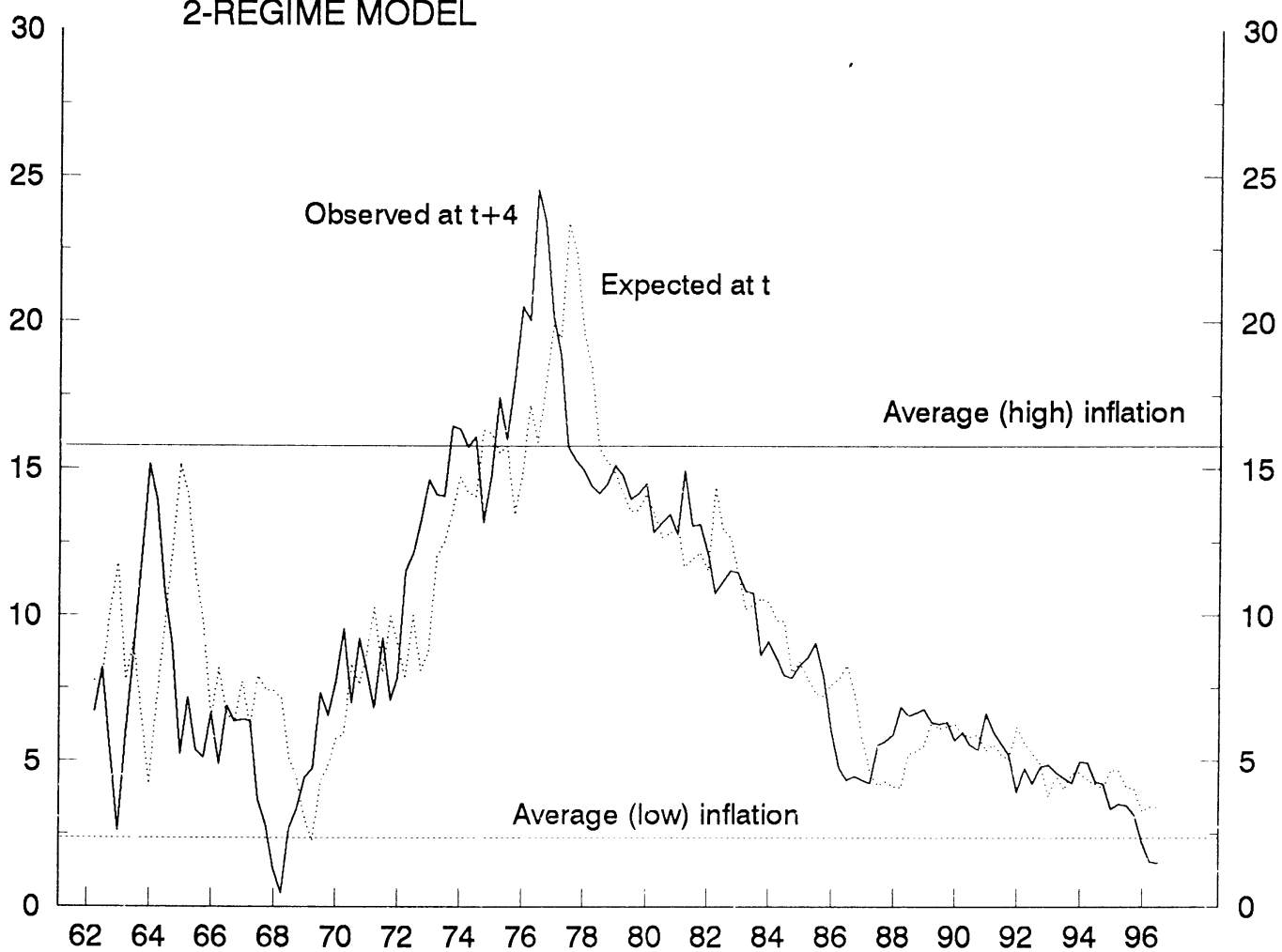


CHART 3. EXPECTED AND OBSERVED ANNUAL INFLATION
2-REGIME MODEL



**CHART 4. ESTIMATED PRIOR PROBABILITIES
RESTRICTED 3-REGIME MODEL**

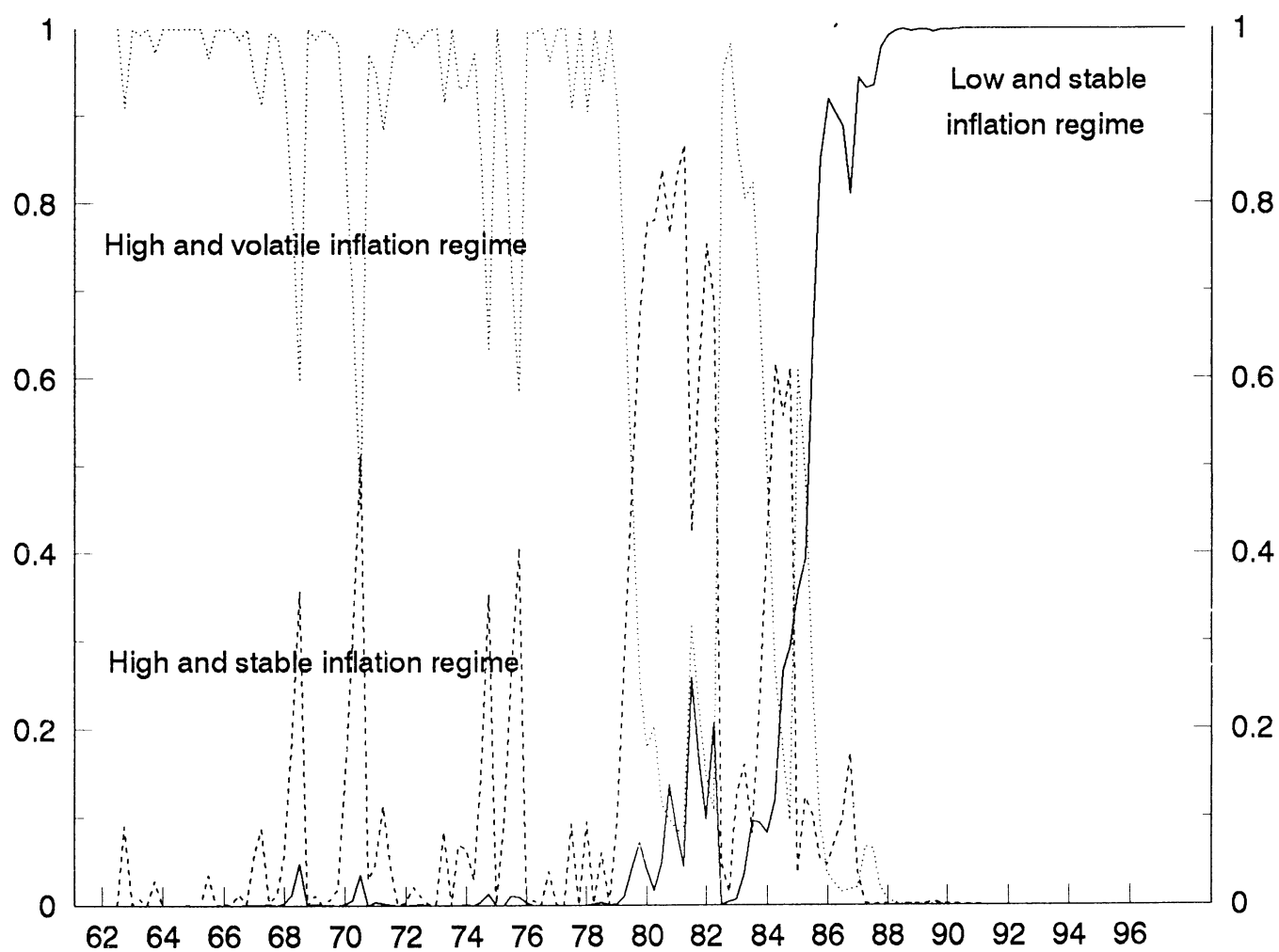
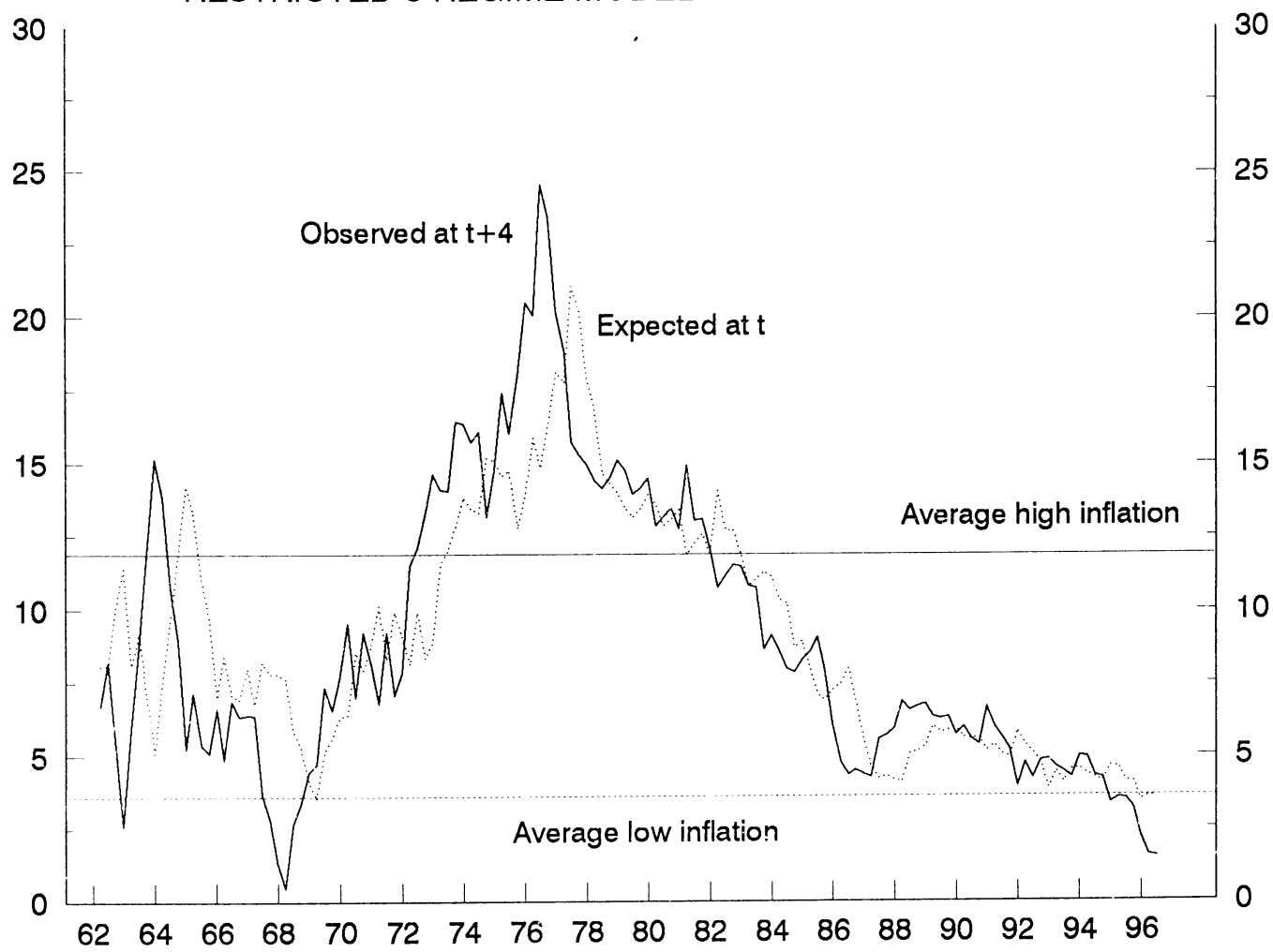


CHART 5. EXPECTED AND OBSERVED ANNUAL INFLATION
RESTRICTED 3-REGIME MODEL



APPENDIX

TABLE A1
UNIVARIATE (ONE-REGIME) INFLATION MODEL
ALTERNATIVE REPRESENTATION

$$\Delta\pi_t = \sum_{j=1}^4 \rho_j \Delta\pi_{t-j} + u_t; \quad u_t \sim D(0, \sigma_u^2)$$

	Random Walk	AR(4)
ρ_1 (s.e.)	-	.09 (.07)
ρ_2 (s.e.)	-	.11 (.07)
ρ_3 (s.e.)	-	.18 (.07)
ρ_4 (s.e.)	-	-.56 (.07)
σ	1.55	1.22
Q(1) (p-value)	0.00 (.96)	0.02 (.89)
Q(4) (p-value)	47.32 (.00)	1.30 (.86)
Q(20) (p-value)	75.27 (.00)	23.3 (.27)

Note: Q(n) is the Ljung-Box statistic for residual autocorrelation up to order n.