

# DOCUMENTOS DE ECONOMIA Y FINANZAS INTERNACIONALES

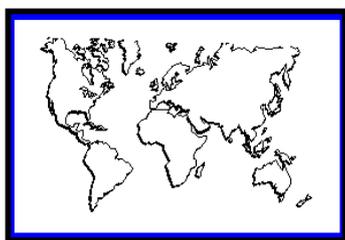
## BUSINESS CYCLE SPECULATIVE PRESSURES IN A TARGET ZONE

**M. Isabel Campos López**

**M. Araceli Rodríguez López**

March 2001

DEFI 01/04



Asociación Española de Economía y Finanzas Internacionales



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

# Business Cycle and Speculative Pressures in a Target Zone

M. Isabel Campos López and M. Araceli Rodríguez López<sup>∗</sup>

University of Valladolid

[Preliminary Version]

March 2001

## Abstract

In the past time, most economies have suffered cyclical fluctuations in their activity which may influence the optimal use of productive factors in long slow-growth phases or price stability in periods of fast growth. This paper focuses on the possible interrelationship between business cycles and exchange rate fluctuations.

We have chosen the European Monetary System framework in the nineties, from June 1989 to December 1998, because the Peseta belonged to the EMS during that time. This sample is specially interesting because it includes the worst crisis of the System in 1992-93 and the following ones affecting emerging countries like Mexico, Brazil or Russia at the end of the decade. We use a Binary Dependent Variable Logit Model to estimate the readjustment probability inside a band for two currencies, the Peseta and the french Franc . We calculate the dependent variable values from a Markov-Switching Regime Model with constant transition probabilities. We prove that it is a suitable method and that it allows both real and monetary variables to be identified in order to explain speculative pressures.

Keywords: Readjustment Probability, Speculative Pressures, Economic Fluctuations.

JEL: F31 - Foreign Exchange.

---

<sup>∗</sup>Dpto. de Fundamentos del Análisis Económico. Facultad de CC.Económicas y Empresariales (Universidad de Valladolid). Avda Valle Esgueva, 6, E-47.011-Valladolid (Spain). Tfno: +34 983 423392. Fax: +34 983 423299. E-mail: maribel@eco.uva.es; araceli@eco.uva.es

# 1 Introduction

In the past time, most economies have suffered cyclical fluctuations in their activity. Those events may have influenced the optimal use of productive factors in long slow-growth phases or price stability over long periods of time.

A better understanding of the interactions between the economic policies and business cycles has been and still is one of the main questions in macroeconomic theory. A good example of this is the favorable experience of some countries in the nineties, with respect to the mixing of objectives for inflation. This has contributed to a relative stability in prices and has helped to reduce the risk of sharp fluctuations in the future.

This paper focuses on the relationship between business cycles and exchange rate fluctuations. Empirical evidence seems to confirm the hypothesis of a relationship between exchange rate fluctuations and international differences in economic activity. That is, an appreciation trend in exchange rates corresponds to fast growth phases and a depreciation, to recessions. The recent experience of The United States or The United Kingdom strengthens our hypothesis because both the strong Dollar and the strong Pound, as compared to the Japanese Yen or the Deutsche Mark, corresponds to fast economic growth phases in the former and a decline in the latter countries.

The Uncovered Interest Parity condition can be a useful tool to show the link between exchange rates and business cycles. Economic growth could provoke, through an increase in the demand for money, an increase in the interest rates differential and, therefore, the appreciation of the domestic currency. The strengthening of the currency will be sufficient for the depreciation expectations of the exchange rate to be equal to the interest rates differential [when the risk premium is very small, or even zero].

However, it is not always possible to find a positive relationship between interest rate differentials and exchange rates. For instance, if the monetary policy tries to maintain an exchange rate objective, a real or foreseen appreciation of the national currency can provoke a decrease in the national interest rate and a smaller interest rate differential, at least in the short run<sup>1</sup>. This question may have influenced the discouraging results of econometric studies which tried to establish a relationship between exchange rates and business cycles or other macroeconomic variables.

This study tries to show some evidence with respect to that issue by using the Uncovered Interest Parity and then the interest rate differentials as a "proxy" variable of the readjustment probability. We have chosen the European Monetary System framework in the nineties, from June 1989 to December 1998, because the Peseta belonged to the EMS during that time. This sample is specially interesting because it includes the worst crisis of the System, in 1992-93, and the following ones affecting emerging countries such as, Mexico, Brazil or Russia at the end of the decade.

Those currency crises, above all those affecting the European countries, have demonstrated that turbulences can occur in economies with supposedly healthy macroeconomic policies. It is possible that the decision to leave parity was not based on the depletion of reserves, so much as on the governments' reluctance to maintain high interest rates that were unsuitable for maintaining domestic stability. A government can follow multiple objectives, so it may have to choose between the maintenance of a fixed exchange rate and the control of unemployment or economic growth.

Our purpose is to investigate the reasons underlying devaluations or speculative pressures in countries which suffered the ERM crisis. Besides, as we shall show later, the results of the crisis were different depending on the country. For instance, Spain readjusted the central parity four times,

---

<sup>1</sup>In February 1987, after the Louvre Intervention Accord, which tried to stabilize the Dollar exchange rate, its relationship with the interest rate differential was the opposite.

while France kept the parity over the entire sample period. Nevertheless, both countries had similar readjustment probability values and it is possible to identify almost the same real and monetary variables as being responsible for the crisis.

This paper is divided as follows. Section 1 presents a simplified version of the Obstfeld model [Obstfeld (1994)] with an optimizing government. This theoretical model will be used as the basis of our empirical results, shown in section four. Previously, in section three, the behaviour of the exchange rate in each selected country will be describe. The estimation in the fourth section applies a Binary Dependent Variable Logit Model. We calculate the dependent variable values from a Markov-Switching Regime Model with constant transition probabilities. Our conclusions, in Section 5, underline the most outstanding results. Finally, in the Appendix to this paper, the simplest Hamilton's model is presented.

## 2 A Model with Nonlinearities in Government Behaviour

In general, the basic feature of a currency crisis is the collapse of the exchange rate system. A special part of the economic literature has been concerned with the reasons and determinants of that kind of event<sup>2</sup>. The earlier works about Balance-of-Payments crises ["...rst generation models"] focused on the inconsistency between macroeconomic policies and the maintenance of a fixed exchange parity. If the monetary authority runs overly expansive domestic policies, these measures could lead the economy into a crisis. If private agents consider that the level of international reserves is large enough, then the situation could be maintained for a long time. But if the reserves decrease, the exchange rate parity becomes unsustainable. These models appeared to explain the crises suffered by some developing

---

<sup>2</sup>For a survey of currency crises literature, see Blackburn and Sola (1993), Jeanne (1997) and Flood and Marion (1998).

countries like Mexico (1973-1982) and Argentina (1978-1981)<sup>3</sup>.

Obstfeld's paper "The Logic of Currency Crises" is considered as a very advanced work in currency crisis studies. It introduces nonlinearity in government behaviour. Let us suppose that the government conduct can be given by the following function:

$$\min L = \frac{\mu}{2} \pm^2 + \frac{(\pm - E\pm + \epsilon)^2}{2} \quad (2.1)$$

where L represents the social loss function;  $\pm$  is the rate of currency depreciation;  $E\pm$  is the expected rate of currency depreciation;  $\epsilon$  is a disturbance with zero mean and variance  $\sigma^2$ ;  $\cdot$  is a measure of distortion with respect to the disturbance,  $\mu$  and  $\sigma$  is the relative weight attached to price changes. All the variables are in the same period except the expectation operator, which is based on the past values of the variables.

This function reflects the attempt to minimize either both real price changes, due to reasons of credibility or reputation [first part of the equation (2:1)], and unexpected price changes [second part of the equation (2:1)]; or only the unexpected price changes in order to stabilize unemployment or the business cycle [second part only].

Let us compare the costs and benefits of different actions by authorities:

- 1.- The exchange rate will be fixed [ $\pm = 0$ ] and private agents have predetermined expectations  $E\pm = 0$ . The expected value of the social loss function when the government follows the rule [fixed exchange rate], will be represented by the following expression:

$$EL^{(1)} = \frac{\sigma^2 + \cdot^2}{2} \quad (2.2)$$

- 2.- The government will act bearing in mind the predetermined private expectations while also considering the possibility of modifying

---

<sup>3</sup>Seminal papers of first-generation models are Salant and Henderson (1978) and Krugman (1979).

exchange rate parity [discretion]. We suppose private agents assume this policy and then  $E_{\pm}^2 = \frac{\cdot}{\mu}$ . The expected value of the loss function will be:

$$EL^{(2)} = \frac{\frac{3}{4}^2}{4} + \cdot^2 \quad (2.3)$$

with  $\mu = 1$ .

Let us suppose that there are two possible states in the economy depending on the existence or not of the shocks ". We compare costs and benefits of policymaking ...rst for the rule and then for discretion [modifying the exchange rate parity].

Without disturbances, ", in the economy  $\frac{3}{4}^2 = 0$  and then,

$$EL^{(1)} = \frac{\cdot^2}{2} < EL^{(2)} = \cdot^2$$

But if there are shocks,  $\frac{3}{4}^2 > 0$ . In this case, the result will depend on the value of  $\frac{3}{4}^2$  value with respect to  $\cdot$ . Supposing  $\frac{3}{4}^2$  is large enough with respect to  $\cdot$ , then discretion or the possibility of leaving the exchange rate regime is better than the rule [maintaining the ...xed exchange rate].

In general, it is considered that government should pursue a mixed strategy, that is, ...x the exchange rate but with the possibility of "escape" when the disturbances become especially disruptive. Obviously, this option of invoking the escape clause is a costly action, because otherwise, discretion would always be the best option. With an escape clause, the government follows the rule whenever  $L^{(1)} < L^{(2)} + C$  where  $C$  is the cost for the government when it chooses the possibility of devaluing the currency [escape clause].

It is necessary to know the value of the disturbance, ", which is able to trigger the crisis and therefore, the devaluation. It can be expressed as follows:

$$L^{(1)}(\cdot) > L^{(2)}(\cdot) + C \quad (2.4)$$

This is a nonlinear relationship because of private agents, who form their expectations about the rate of currency depreciation. They set their expectations by calculating a probability weighted average of the expected rate of depreciation under the rule and under discretion at the beginning of the period, when they do not know the policy of the government.

Figure 1 represents this nonlinear problem.<sup>4</sup> The curved line plots  $L^{(1)}$ ;  $L^{(2)}$ , the horizontal lines represent arbitrary levels of  $C$  and the vertical ones show different shock values of  $\epsilon$ . There are two intersections,  $E_0$  and  $E_1$ . One of them corresponds to a small disturbance  $\epsilon_0$  and the other to a larger value,  $\epsilon_1$ .

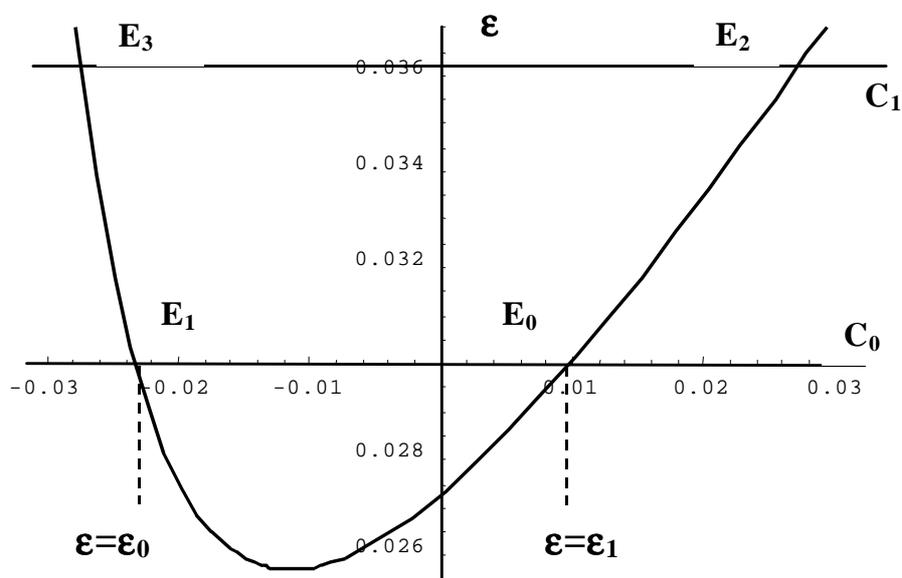


Figure 1: Possibility of Multiple Equilibria

For a given cost  $C$ , if private agents believe that the government will abandon the fixed exchange rate when the disturbance is  $\epsilon_1$ , then

<sup>4</sup>See Obstfeld (1994) to know the specific functional forms. The simulation has been obtained by using the same parameter values as the author assigns in his paper.

government should adopt that value in order to solve its optimization problem. It will be the value at which the escape clause will be adopted, this means it is the shock value that triggers the devaluation. Similarly, if agents adopt  $\pi_0$ , this will be the best strategy for the government. Thus, the possibility of multiple equilibria through nonlinearities in government behaviour depending on predetermined private expectations about the current state of the economy is proved.

When there is the possibility of switching from one equilibrium to another and the cost of abandoning the fixed exchange rate increases, for example, up to  $C_1$ , a crisis becomes more possible if the disturbance value, which triggers the escape clause, decreases <sup>5</sup>. [E<sub>3</sub> in figure 1]

The value of  $C$  may be considered as the government's commitment with the fixed exchange rate. For instance, the members of the European Exchange Rate Mechanism [ERM] had a tight commitment with the fixed exchange rate arrangement before the crisis in 1992. The Maastricht Treaty forced European countries to stay in the EMS for at least two years without realignments. In practice this meant it was impossible to invoke the escape clause. It is, thus possible to justify that countries without important economic imbalances are in a crisis zone.

However, this does not mean that currency crises have no relationship to economic variables, but that the commitment to fixed rate expectations may depend on more than the available international reserves to defend the parity [as First generation models predict]. Those expectations could also depend on the government's will to achieve stability or control of the fundamental variables. As shall be, it is possible that a government could face a very difficult situation should it try to keep interest rates high to defend parity when the economy is in a slow growth phase.

---

<sup>5</sup>Flood and Marion (1997).

### 3 Analysis of Events and Relevant Dates

Figures 2 and 3 plot the evolution of the Peseta/Deutsche mark exchange rate and French franc/Deutsche mark exchange rate in the sample period, from June 1989 to December 1998. We also showed in the figures the central parities and the limits of the bands for both currencies,  $\pm 2.25\%$  for the French franc and  $\pm 6\%$  for the Spanish case, throughout the sample, [corresponding to what we have called the “soft band”]<sup>6</sup> as well as the actual limits of  $\pm 2.25\%$  and  $\pm 6\%$ , respectively, besides  $\pm 15\%$  from August 1992. Empirical evidence justifies the hypothesis of taking into account the “soft bands” because European officials continued to continue the ERM exchange rates within narrower margins and only usually intervening when the rates hovered around their former intervention limits, except in the short run [under strong market pressure].<sup>7</sup>

The most obvious difference that can be seen between both figures is that the evolution of the parity is quite different. In the case of France, the central parity does not change during the sample, whereas the central parity in Spain changes four times with the devaluations [17 September 1992, 23 November 1992, 14 May 1993, and the last one, 6 March 1995]. This difference could lead us to believe that there are different exchange rate behaviours between the currencies. However, as we shall suggest later, both currencies suffered high readjustment probabilities in spite of the fact that the final result was not the same.

In the narrow band period,  $\pm 6\%$  in the Spanish case, an initial phase can be detected from the time of joining the ERM of the European Monetary System until June 1992. During that time, the Peseta was overvalued and it was grazing the lower band and provoking difficulties for other currencies,

---

<sup>6</sup>Bartolini and Prati (1997, 1999) considered the possibility of setting a “soft target zone”.

<sup>7</sup>See European Monetary Institute Annual Report, 1995, p.18

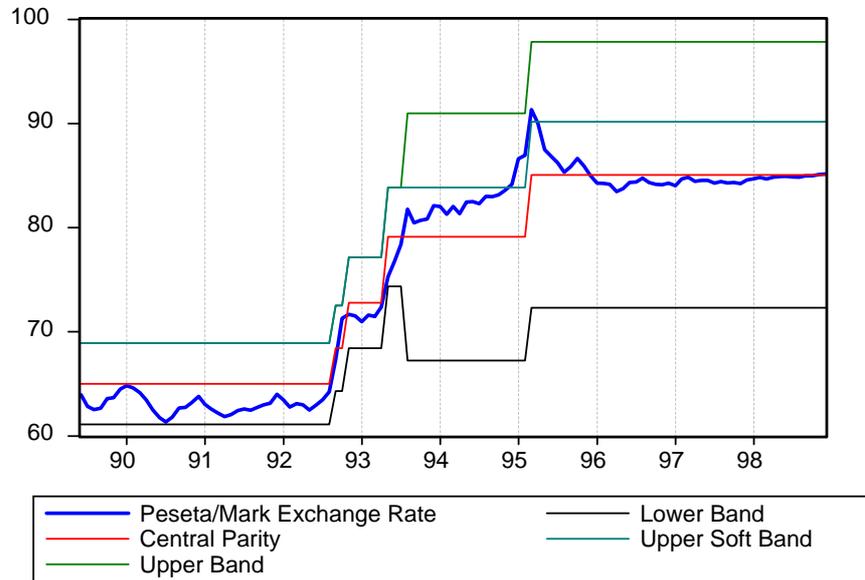


Figure 2: Monthly Peseta/Mark Exchange Rate [June 1989-December 1998]

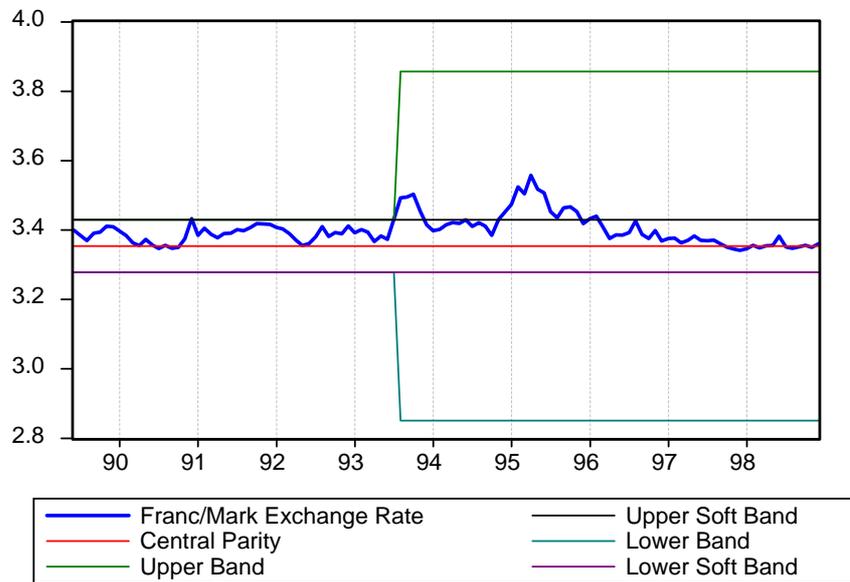


Figure 3: Monthly Franc/Mark Exchange Rate [June 1989-December 1998]

e.g. the French franc<sup>8</sup>. This period brought to light the divergences in business cycles among the European economies, as well as the policymaking dilemmas that stemmed from these divergences. These tensions led to the monetary storm of 1992, when the Peseta was devalued three times.

The French franc also suffered strong speculative pressures which were successfully stopped by the coordinated intervention efforts of Germany and France. At the end of June, a new wave of attacks focused on the French franc and the monetary authorities had to intervene to stop the massive speculation against the currency. Those events led the Economy and Finance Ministers and the Central Banks Chairs to decide the shifts in band widths to  $\pm 15\%$  for all the currencies, except the German mark and the Dutch guilder.

After the shifts in band widths, the Spanish currency showed a relative trend to depreciation that became more intense in 1995. The Mexican peso crisis at the end of December 1994 provoked contagious effects in other countries with close trade links. The US dollar appreciated in value and it caused the mark to strengthen and the rest of the EMS currencies to weaken. The Spanish currency depreciated in value and the risk premium increased due not only to the problems of the dollar, but also because of the political uncertainty in Spain at that moment and the bad evolution that inflation and the budget deficit were showing. At the beginning of March 1995, the pressures on the Peseta increased and this resulted in the monetary authority approving a devaluation. The Peseta suffered from another readjustment of 7% on 6<sup>th</sup> March. That devaluation was qualitatively different to the three previous ones because it happened before the Peseta exchange rate reached the upper band.<sup>9</sup> However, ERM exchange rates never came close to their

---

<sup>8</sup>The French franc passed the upper band in December 1990 and it was grazing this limit during March, April and May in 1991.

<sup>9</sup>This realignment was therefore labelled as a "technical devaluation" because the evolution of the fundamental variables of the economy did not make it necessary, yet it was necessary to stop the exchange rate from reaching the upper band. [See Spanish Central Bank Annual Report, 1995, p. 46]

new limits after August 1993. As mentioned above, European central banks continued to continue exchange rates within narrower margins.

Looking at the figures, it is possible to see that if we consider the narrow bands, both currencies were grazing their upper bands at different moments throughout 1994. Even more, they passed the "soft bands" on occasions [from December 1994 to April 1995 in the Spanish case, and from November 1994 to August 1995 in the French franc case]. The decision to devalue the Peseta in 1995 seems to have been completely justified due to the problems it was having.

The evolution of the Peseta exchange rate in the following months endorsed this action and the markets corrected the excessive depreciation prior to the devaluation. Our period of study concludes with a last phase of relative stability that was influenced by a strong dollar and, above all, by the convergence in fundamental variables of those economies which had expectations of joining the future European Monetary Union<sup>10</sup>.

## 4 Binary Dependent Variable Model

### 4.1 Econometric Specification

As we said before, this paper tries to find whether there is some relation between realignments or exchange rates depreciations and macroeconomic variables. In this section, we shall estimate the readjustment probability of the exchange rate in a target zone regime<sup>11</sup> using a binary dependent variable model with a logistic distribution. We have to specify the moments in which the dependent variable will assume only two values  $\{1, 0\}$ . Let  $j_t$  be our dependent variable and  $j_t = 1$  if there is a lack of credibility and then

---

<sup>10</sup>The evolution of long and short term interest rates was a clear indication of the convergence process.

<sup>11</sup>Our readjustment idea not only refers to realignments or devaluations, but also it considers any exchange rate jump inside the band [depreciation] [Vid. Bekaert y Gray (1998)]

a high probability of readjustment [storm period], and  $j_t = 0$  if it is a calm period with high credibility.

The logistic distribution function we shall use,  $F(\{\}; \circ)$ , is the following:

$$\text{Pr ob}(j_t = 1) = F(\{\}; \circ) = \frac{\exp[\circ \{\}]}{1 + \exp[\circ \{\}]} \quad (4.1)$$

where  $\text{Pr ob}(j_t = 0) = 1 - \text{Pr ob}(j_t = 1)$ , and  $\{\}$  is a vector of observed exogenous variables that we will use in the analysis,  $\circ$  being the parameter vector.

We use a Maximum Likelihood Estimation Method and the numerical optimization is reached through the iterative algorithm known as "Newton-Raphson". The log Likelihood function is given by:

$$\ln L = \sum_{t=1}^N j_t \ln F(\{\}; \circ) + \sum_{t=1}^N (1 - j_t) \ln [1 - F(\{\}; \circ)] \quad (4.2)$$

## 4.2 Selection of Exogenous Variables

To specify the exogenous variables, we have considered the following points of view:

- 1.- Throughout the sample, there were different speculative pressures episodes. Therefore, we consider monetary variables ...rst. If these variables are signi...cant they will ratify the conclusions of the ...rst-generation models. On other hand, we shall also use real variables which, if relevant, can justify the support given to second-generation models, [in our case, discretion or "escape clause"]. If none of them are signi...cant, we would qualify the pressures as "self-ful...lling" attacks.
- 2.- Both currencies [Peseta and French franc] belonged to the ERM of the European Monetary System and we shall therefore stress that fact by introducing some variables related to the existence of the target zone or even a "Soft Target Zone".

As monetary variables, we have used in both cases [France and Spain]: international reserves and the variation in international reserves, the monetary aggregate rate of growth and the differential of the monetary aggregate rates of growth between the country and Germany, the inflation rate, the inflation rate differential between the analyzed country and Germany and the Purchasing Power of Parity.

Of the possible real variables, we have studied the relevance of the domestic industrial production index and the index differential with respect to Germany, the domestic current account balance, the real exchange rate and the unemployment rate.

Finally, as target zone variables, we have included the domestic exchange rates against the Deutsche Mark and the US Dollar, the exchange rate deviations from the central parity, exchange rate deviations from the upper band and exchange rate deviations from the upper soft band.

We have used monthly data for all the variables from June 1989 to December 1998. Most of the series come from the OECD, "Main Economic Indicators".

### 4.3 Dependent Variable Estimation

At the current stage of our work, we have to specify the moments in which the dependent variable assume only two values, 1 or 0. We use the Markov-Switching regime econometric procedure because this method allows us to identify jumps in the variable which either resulted in central parity changes or in exchange rate appreciations or depreciations inside the bands.

The purpose is thus to separate the nominal interest rate differential between Spain and Germany and between France and Germany into two possible states of the economy, calm and storm. This is the variable used as a " proxy" of the expected devaluation in each country. One of the regimes

will be associated to a high mean and a high variance [turbulence state], and the other to small parameters values [calm state].

Let us call  $m_t$  the unobserved random variable which indicates the state of the economy at  $t$ . We suppose it follows a Markov chain with only two possible states,  $m_t = 0$  in the calm state without disturbances, and  $m_t = 1$  in the crisis state.

Table 1 shows the results of the estimation. We have considered the possibility of both the mean and the variance changing with the state. The autorregressive specification used for the nominal interest rate differentials between Spain and Germany is AR (4), whereas in the french case we used the autorregressive specification AR(2). The Markov-Switching model is described in the appendix of this paper. All the estimated parameters are significant as the asymptotic standard errors indicate. Figures 6 and 7 in the appendix show the estimation results and the evolution of the nominal interest rate differentials for both Spain and France.

We should specify the criterion to be used in order to choose the dependent variable values for the Logit Model. That criterion will depend on the confidence percentage the economic agents assign to the readjustment expectations. We build a 95 standard deviation threshold.<sup>12</sup> We shall assign the dependent variable value  $j_t = 1$  [crisis or high realignment probability] whether the threshold is above or below zero. Otherwise, we will consider  $j_t = 0$ .

#### 4.4 Estimation Results

We have estimated the Log Likelihood function expressed in equation (4:2) using the selected exogenous variables.

---

<sup>12</sup>As in Lindberg, Svensson and Söderlind (1993) [13, pp. 1175] we construct a 95 per cent confidence interval of the estimated rate of devaluation; In our case, it comes from the filtered serie using the Hamilton's procedure.

Table 1: Markov-Switching Regime Model. Spain and France

Parameters	Coefficients	
	Spain	France
$\alpha_0$	0:0339 (0:2783)	i 0:3367 (0:1147)
$\alpha_1$	0:6870 (0:3206)	i 0:1228 (0:1224)
$A_1$	0:7089 (0:1098)	1:1389 (0:0421)
$A_2$	0:4469 (0:1368)	i 0:2518 (i 0:0554)
$A_3$	i 0:0045 (0:0877)	
$A_4$	i 0:2524 (0:0790)	
$\beta_0$	0:2390 (0:0098)	0:0906 (0:0024)
$\beta_1$	1:2690 (0:5683)	0:7593 (0:1508)
$c_0$	4:7434 (0:0234)	2:9527 (0:0448)
$c_1$	2:0355 (0:1083)	1:7864 (0:0947)
Log Likelihood	48:5462	105:8699
$P_{00}$	0:9574	0:8971
$P_{11}$	0:8056	0:7614

Note: Asymptotic standard errors are tabulated in parentheses.

The results in table 2 correspond to models which have passed the validation phase in each country case.<sup>13</sup> The omitted variables test enables us to evaluate the set of significant variables to explain the variation in the dependent variable. The only significant variables we obtained were: the industrial production index in both countries,  $y_t$ , the industrial production index differentials,  $(y_t - y_t^a)$  and the Purchasing Power of Parity [PPP], in Spain and France. In the Spanish case, international reserves were also significant. Finally, the exchange rate deviations from the upper band and the upper soft band only have significance in France or Spain, respectively

The LR statistic tests the joint null hypothesis that all slope coefficients except the constant are zero in order to test the overall significance of the model<sup>14</sup>. Our LR statistics value rejects this possibility. We considered it of interest to include a (2 x 2) table of correct and incorrect classification based on a user specified prediction rule. Observations have been classified as having predicted probabilities that are above or below the cutoff value of 0.3.<sup>15</sup> Table 3 provides a measure of the predictive ability of our models. The estimated model correctly predicts more than 90% for the Spanish case and almost 80% for France.

Figures 4 and 5 illustrate the readjustment probability throughout our sample. It is possible to find similar unstable moments in both cases. It is important to point out that the Peseta suffered four devaluations and the French franc did not change the central parity at all. That question concerns the high readjustment probability under speculative pressures in both countries in spite of their having different consequences.

---

<sup>13</sup>We have carried out the ML test for heteroskedasticity [see table 2] and we could not reject the null hypothesis of homoskedasticity.

<sup>14</sup>Greene (1998) [7, pp. 766]

<sup>15</sup>We have used a cutoff value of 0.3 instead of 0.5 because our dependent variables ( $j_t$ ) present many more values of calm ( $j_t = 0$ ) than values of crisis ( $j_t = 1$ ).

Table 2: Logit Model Estimations Results

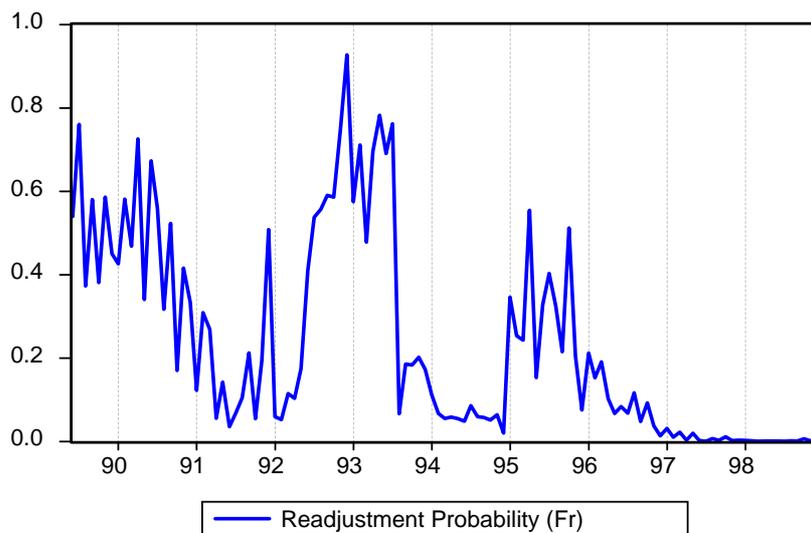
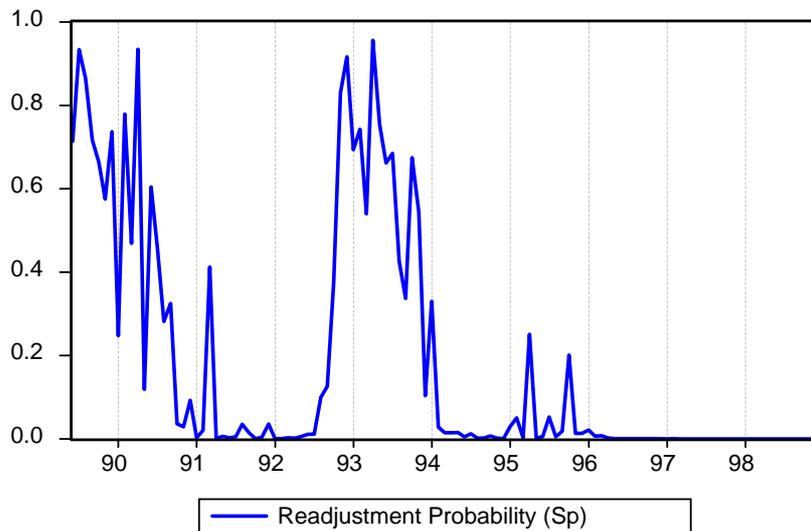
	Spain	France
Constant	198:885 <sup>a</sup> (4:686)	55:483 <sup>a</sup> (3:138)
$y_t$	$\beta_1$ 0:887 <sup>a</sup> ( $\beta_1$ 5:606)	$\beta_1$ 0:325 <sup>a</sup> ( $\beta_1$ 2:828)
$(y_t \text{ i } y_t^a)$	0:573 <sup>a</sup> (4:739)	0:404 <sup>a</sup> (4:011)
Reserves	$\beta_2$ 0:002 <sup>a</sup> ( $\beta_2$ 3:239)	
PPP	21:334 <sup>a</sup> (3:488)	10:413 <sup>a</sup> (2:528)
$(e_{max} \text{ i } e_t)$		$\beta_3$ 15:916 <sup>a</sup> ( $\beta_3$ 3:050)
$e_{max}^{soft} \text{ i } e_t$	$\beta_4$ 35:730 <sup>a</sup> ( $\beta_4$ 2:202)	
LR statistic	61:041 (0:000)	37:341 (0:000)
ML statistic	1:564 (0:211)	0:866 (0:352)
AIC	0.499	0.839

Note: The value in parentheses in the estimated parameters is the z statistic; this statistic has a standard normal distribution. The superscript <sup>a</sup> shows that the corresponding parameter value is significant at 1 per cent. The value in parentheses in both the LR statistic and the ML test for heteroskedasticity is the p-value. The AIC is the Akaike info Criterion.

Table 3: Prediction Evaluation using a Logit Binary Model

	Spain			France		
	$j_t = 0$	$j_t = 1$	Total	$j_t = 0$	$j_t = 1$	Total
$p(j_t = 1) \cdot 0:3$	85	1	86	68	6	74
$p(j_t = 1) > 0:3$	9	19	28	18	20	38
Total	94	20	114	86	26	112
% Correct	90.43	95.00	91.23	79.07	76.92	78.57

Note: Correct classifications are obtained when the predicted probability is greater than 0:3 and the observed  $j_t = 1$ , or when the predicted probability is less than or equal to 0:3 and the observed  $j_t = 0$ .



Even more, we could suggest that the Peseta enjoyed many more periods of calm than did the French franc. The readjustment probability of the franc is higher than the Peseta at two moments: ...rst, during the monetary storm 1992-93, when the French franc detects certain instability before the Peseta, which is probably due to the result in the Danish referendum to ratify

the Maastricht Treaty [June 1992] and the possibility of the same negative result in France [foreseen for September]; secondly, during 95-96, a time in which the Peseta was devalued again and the French franc was outside its hypothetical soft band [Figure 3]. This is a confirmation of Bartolini & Prati's theory [1997, 1999] concerning intervention in the short run to avoid speculative attacks.

It is important to stress the results obtained concerning the significant variables. We have shown that some of the variables belonging to the three types [monetary, real and target zone] are relevant when we try to explain speculative pressure processes suffered by the analyzed currencies. This question is analyzed in greater detail as the conclusions of the paper.

## 5 Conclusions

The aim of this paper was to look for evidence of the relationship between business cycles and exchange rate fluctuations. The nineties offered some examples of currency crises, both in industrial and developing countries. In spite of only having chosen the EMS framework, we have focused on two currencies which are examples of different results in the presence of speculative pressures. Thus, taking the Peseta, we consider attacks which have resulted in devaluations while taking into account the French franc, we try to show pressures which do not imply realignments. For that reason, it was necessary to consider two sorts of studies, those belonging to "Target Zone" literature and those belonging to "Currency Crises".

If intuition suggests that there is a link between exchange rates and business cycles, a second generation model supplies the theory to justify it. Our results seem to illustrate that question by proving that in both cases, the industrial production indexes and the differentials with respect to Germany are significant variables [as well as, the PPP, international reserves and exchange rate deviations from the upper band and the upper soft band,

all of them being, traditional results in this kind of analysis]. Thus we can indicate a set of traditional economic fundamentals and others, linked with business cycles, as variables to be taken into account in order to explain exchange rate turbulences.

Empirical evidence has shown the expectations about the rate of depreciation depend on more than just international reserves, as the first currency models predicted. In this sense, if private agents believe that the government may be worried about the evolution of unemployment or the growth rate of the economy, then there could be expectations of depreciation because there is a cost to maintaining parity through high interest rates which damage the growth rate<sup>16</sup>.

Definitively, we can suggest a non-structural binary dependent variable model as an appropriate method to adequately explain the exchange rate turbulence and the relationship with business cycle.

## References

- [1] Avesani, R.G. and G.M. Gallo (1996) The Hamilton's Treatment of Shifts in Regimes, Background Paper for a Series of Lectures given at MAD, University of Paris.
- [2] Bartolini, L. and A. Prati (1997): "Soft Versus Hard Targets for Exchange Rate Intervention", *Economic Policy*, 24: 15-52.
- [3] Bartolini, L. and A. Prati (1999): "Soft Exchange Rate Bands and Speculative Attacks: Theory, and Evidence from the ERM since August 1993", *Journal of International Economics*, 49, October: 1-29.
- [4] Bekaert, G. and S.F. Gray (1998), "Target Zones and Exchange Rates: an Empirical Investigation", *Journal of International Economics*, 45, 1, June: 1-35.
- [5] Blackburn, K. and M. Sola. (1993), "Speculative Currency Attacks and Balance of Payments Crises", *Journal of Economic Surveys*, 7, 119-144.

---

<sup>16</sup>Before the EMS storm in 1992, France had lower interest rates than Germany as an attempt to lead the economy to faster growth rates. That period supposed a strong monetary instability between both currencies.

- [6] Flood, R.P., and N. Marion, (1997), " Policy Implications of Second-Generation Crisis Models", IMF Working Paper 97-16.
- [7] Greene, W.H. (1998), " Análisis Econométrico", 3ªedc., Madrid: Prentice Hall Iberia.S.R.L.
- [8] Hamilton, J. D. (1989) A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle, *Econometrica*, 57: 357-384.
- [9] Hamilton, J. D. (1990) Analysis of Time Series Subject to Changes in Regime, *Journal of Econometrics*, 45: 39-70.
- [10] Hamilton, J. D. (1994) *Time Series Analysis*, Princeton University Press, Princeton, New Jersey.
- [11] Jeanne, O. (1997), " Are Currency Crises self-fulfilling? A test", *Journal of International Economics*, 43 263-286.
- [12] Krugman, P. (1979), " A Model of Balance of Payments Crises", *Journal of Money, Credit and Banking*, 11, 311-325.
- [13] Lindberg, H., L.E.O. Svensson y P. Söderlind (1993), "Devaluation Expectations: The Swedish Krona 1985-92", *The Economic Journal*, 103, 420, September: 1170-1179.
- [14] Obstfeld, M. (1994), " The Logic of Currency Crises", *Banque de France Cahiers économiques et monétaires*, 43, 189-213. [NBER Working Paper 4640].
- [15] Salant, S.and D. Henderson, (1978), " Market Anticipations of Government Gold Policies and the Price of Gold" *Journal of Political Economy*, August.

## 6 Appendix: Markov-Switching Regime Model (Constant Transition Probabilities)

We have used the known Hamilton's Model to choose the values of the dependent variable of the logit model. Hamilton's model (1989, 1990) allows a variable to follow different time series processes depending on the sample considered. We try to separate two possible states or regimes of the economy. One of them is associated to high variance, the crisis state, and the other will be the calm state. Our state variable is a non-observed  $m_t$  random variable which follows a discrete time two state Markov chain, therefore the change or jump in the state is also a random variable. If  $m_t = 0$ , then the process is in calm regime without shocks or disturbances. In contrast, if  $m_t = 1$  the process is in crisis regime or storm state.

It is possible to model the dynamic of the nominal interest rate differential between Spain and Germany and between France and Germany, using an autorregressive specification AR (4) or AR(2) respectively. We let mean and variance vary with the state. It is given by:

$$y_{t-1} m_t = \alpha_t y_{t-1} + \beta_{m_t} \epsilon_t \quad t = 1::T \quad (A.1)$$

where  $y_t$  represents the interest rate differentials,  $\epsilon_t$  are independent and identically distributed random variables with zero mean and unit variance  $\tilde{A} N(0; 1)$ . We can parametrize linearly mean and standard deviation shift functions as follows:

$$\begin{aligned} \alpha_{m_t} &= \alpha_0 + \alpha_1 m_t \\ \beta_{m_t} &= \beta_0(1 - m_t) + \beta_1 m_t \end{aligned}$$

As the economy can only be in one of two possible states, it is supposed that the probability of being in one of them depends solely on the state it was in on the previous date,  $(t - 1)$ , thus:

$$P(m_t = i | m_{t-1} = j; m_{t-2} = k; \dots) = P(m_t = i | m_{t-1} = j) = p_{ij} \quad (A.2)$$

This equation describes a Markov chain with two states and  $p_{ij} = 0; 1$

transition probabilities. The transition probability matrix will be:<sup>17</sup>

$$P = \begin{pmatrix} p_{00} & p_{10} \\ p_{01} & p_{11} \end{pmatrix}$$

where,  $(1 - p_{00}) = p_{01}$ , and  $(1 - p_{11}) = p_{10}$ .

### 6.0.1 Econometric Specification and Optimal Inference

Let  $y_t$  be a  $(T - 1)$  vector of monthly interest rate differential between Spain and Germany or France and Germany. If the process at  $t$  is governed by the state  $m_t = j$ , the conditional density function of  $y_t$  is given by:

$$f(y_t | j, m_t; \Omega_{t-1}; \theta) \quad (A.3)$$

where  $\Omega_t = (\Omega_t; \Omega_{t-1}; \dots; \Omega_1)$  is the information vector through date  $t$ , and  $\theta = (\mu_0; \mu_1; \hat{A}; \sigma_0^2; \sigma_1^2)$  is a vector of parameters characterizing the conditional density function<sup>18</sup>. With two regimes the densities represented by equation (A.3) are:

$$\begin{aligned} f(y_t | j, m_t = 0; y_{t-1}; \theta) &= \frac{1}{\sigma_0} \exp \left\{ -\frac{[(y_{t-1} - \mu_0) - \hat{A}(y_{t-1} - \mu_0)]^2}{2\sigma_0^2} \right\} \\ f(y_t | j, m_t = 1; y_{t-1}; \theta) &= \frac{1}{\sigma_1} \exp \left\{ -\frac{[(y_{t-1} - \mu_1) - \hat{A}(y_{t-1} - \mu_1)]^2}{2\sigma_1^2} \right\} \end{aligned} \quad (A.4)$$

We could define a new vector  $\Psi$  with all the parameters. We shall estimate  $\Psi = (\mu_0; \mu_1; \hat{A}; \sigma_0^2; \sigma_1^2; p_{00}; p_{11})$ , conditioned to the information through  $t$ .

Even assuming  $\Psi$  is known, we still do not know the regime the process is at on every date in our sample and if it belongs to calm or crisis. We form

<sup>17</sup>We assume the Markov chain is irreducible so  $0 < p_{00}, p_{11} < 1$ . If one of the transition probabilities is 1, then the  $P$  matrix is triangular. Then, once the process enters that state, there is no possibility of ever returning to the other state. [10, Hamilton, 1994, ch. 22, p. 680] and [1, Avesani and Gallo, 1996, p. 12]

<sup>18</sup> $\hat{A}$  is a vector of autoregressive parameters. We have  $\hat{A}_1, \hat{A}_2, \hat{A}_3, \hat{A}_4$  for Spain and  $\hat{A}_1, \hat{A}_2$  for France

a probabilistic inference about the unobserved regime depending on all the observations available:

$$P(f_{t_i} = i | \Omega_{t_i}; \Psi) \quad i = 0; 1 \quad (\text{A.5})$$

We could collect in a  $(2 \times 1)$  vector, denoted  $\hat{\pi}_t$ , these conditional probabilities that the analysis assigns to the possibility that the  $t^{\text{th}}$  observation is generated by regime  $i$ . The optimal inference for each date  $t$  can be found by iterating the equation:

$$\hat{\pi}_{t=t} = \frac{\hat{\pi}_{t_{i-1}} \ddot{A}'_t}{1' \hat{\pi}_{t_{i-1}} \ddot{A}'_t} \quad (\text{A.6})$$

where  $1$  represents a  $(2 \times 1)$  vector of 1s, and  $\ddot{A}$  denotes element-by-element multiplication.

The log likelihood function  $L(\Psi)$  for the observed data evaluated at the value of  $\Psi$  that is used to perform the iterations can be calculated as a by-product of this algorithm from:

$$L(\Psi) = \sum_{t=1}^T \log f(y_t | \Omega_{t-1}; \Psi) \quad (\text{A.7})$$

and where:

$$f(y_t | \Omega_{t-1}; \Psi) = 1' \hat{\pi}_{t_{i-1}} \ddot{A}'_t \quad (\text{A.8})$$

## 6.0.2 Maximum Likelihood Estimates of Parameters

If we iterate equation (A:6), and it is completed for all the dates in the sample, then it is possible to find the log likelihood value through (A:7). The values of the parameters in  $\Psi$ , which maximizes the log likelihood function, is obtained by numerical optimization using, in our case, the Newton-Raphson algorithm.<sup>19</sup>

The following figures 6 and 7 show the estimation results and the evolution of the nominal interest rate differentials for both Spain and France.

<sup>19</sup>[10, Hamilton, 1994, ch. 5, p. 133-142]

