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Is there a Honeymoon Effect?**

ESTUDOS DO GEMF

N.º 03

2013

PUBLICAÇÃO CO-FINANCIADA PELA

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA

Impresso na Secção de Textos da FEUC
COIMBRA 2013

Testing for Nonlinear Adjustment in the Portuguese Target Zone: Is there a Honeymoon Effect?

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Abstract

The aim of this paper is to examine to what extent the adoption by Portugal of an exchange rate target zone regime in the context of its participation in the ERM of the EMS can be characterised by the existence of a nonlinear S-shaped relationship between the exchange rate and its fundamental. If there is such a relationship, a target zone would have a stabilising effect on the exchange rate, the so-called 'honeymoon effect', as predicted by the basic target zone model developed by Krugman (1991). We tested three models: OLS, Auto-correlation by Maximum Likelihood and GARCH (p, q). However, the evidence of a negative trend in the interest rate differential prevented the empirical confirmation of a nonlinear relationship. The use of LSTAR and ESTAR models also failed to reconcile the theory with the data. This does not mean that a stabilising effect on the exchange rate had not happened. Portugal's current participation in the EMU is demonstrative of this reality. Maintaining a downward trend in interest rate differential turns out to reflect the increased credibility in the conduct of monetary policy, allowing the objective of exchange rate stability to be pursued, framed by the main objective of price stability. Without this policy it would not be possible to participate in the Euro Zone. The adoption of a target zone has functioned as an important foreign exchange regime of transition to a single currency 'strategy'. This study also supports the idea that a target zone regime should be considered a feasible solution for 'tomorrow' to countries that 'today' can be forced to abandon the Euro Zone, since this kind of option combines monetary policy autonomy with macroeconomic stability.

JEL Classification: F31, F41, G15.

Key Words: ERM, honeymoon effect, STAR model, nonlinearities and target zones.

1. Introduction

The basic target zone model proposed by Krugman (1991) predicts a nonlinear S-shaped relationship between the exchange rate and its fundamental determinants, with ‘smooth adjustment’ at the edges of the floating band, such that the exchange rate would be totally insensitive to changes in the fundamental. If there is such a relationship, a target zone would have a stabilising effect on the exchange rate, the so-called ‘honeymoon effect’¹.

In a foreign exchange band regime, the part of the adjustment supported by the exchange rate is not in fact constant, but rather decreases as the exchange rate moves away from the central parity, so we should obtain a nonlinear S-shaped relationship, indicative of the lower sensitivity of the variable to changes in the fundamental. The ‘honeymoon effect’ should thus imply that a credible target zone was inherently stabilising, thereby creating macroeconomic stability conditions that would permit a smooth transition to a more extreme exchange rate regime, as is the case, for example, of the current Euro Zone.

Based on the Krugman (1991) model, the aim of this study is to analyse whether the adoption by Portugal of an exchange rate target zone regime in the context of the participation of the Portuguese escudo in the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS), allowed the verification of the existence of a nonlinear S-shaped relationship between the exchange rate and its fundamental determinants. Indeed, it is essential for the Portuguese economy to achieve the conditions of stability, credibility and macroeconomic discipline, since without these it would be very difficult to adopt the European single currency.

To this end, we tested three models — OLS, Auto-correlation by Maximum Likelihood, and GARCH (p, q) — for the period from 2 January, 1989, to 31 December, 1998, corresponding largely to the period during which the Portuguese economy has adopted an exchange rate target zone, even though in the early stage (January, 1989 to April, 1992) this was done unofficially.

¹ Details of this literature can be found in Svensson (1992), Bertola (1994), Kempa and Nelles (1999) and Duarte, Andrade and Duarte (2011).

However, the empirical verification of this implication of the Krugman (1991) model immediately raises the question of how the fundamental can be interpreted, since it is an aggregate of very different determinants of the exchange rate not directly observable. The fundamental can, however, be estimated from observable variables, such as the interest rate differential, the price level, the output or the money supply, as suggested, among others, by Flood, Rose and Mathieson (1991) and Ma and Kanas (2000). In our study, we take the interest rate differential as a proxy to represent the aggregate fundamental. In addition, we also use LSTAR and ESTAR models to justify the nature of the relationship between the two variables.

This analysis is important because it sheds light on macroeconomic stability in a peripheral country of the European Union that has adopted an exchange rate target zone as a transition regime, albeit that it was practically abandoned in recent years as an independent regime for emerging market economies. For the enlargement countries it continues as the ERM II. With this study we also support the idea that a target zone regime should be considered a feasible solution for ‘tomorrow’ for countries that ‘today’ can be forced to abandon the Euro Zone. This kind of option combines monetary policy autonomy with macroeconomic stability. Besides, arrangements between the dollar-euro-renminbi may become a very important topic allowing for the resurgence of international exchange arrangements of the eighties concerning the dollar-deutsche mark-yen. Our contribution is focused not only on *normative issues* concerning the optimal choice of the exchange rate regime, as has been common in most of the studies on target zones, but also on *positive issues*, associated with the explanation of the stabilising effect of target zones on exchange rates.

The paper is structured as follows. Section 2 presents the basic target zone model developed by Krugman (1991) and some of the most important results arising from it. Section 3 describes the data. Section 4 analyses the participation of the Portuguese escudo in the ERM of the EMS in the context of the gradual disinflation process pursued by Portugal. Section 5 presents the empirical results of testing the existence of a nonlinear S-shaped relationship between the exchange rate and its fundamental. Finally, section 6 draws some conclusions.

2. The Basic Target Zone Model and the ‘Honeymoon Effect’

According to the basic target zone model proposed by Krugman (1991), the behaviour of the exchange rate within the band depends on an aggregate fundamental and its expected rate of change, as can be described by the following equation:

$$s(t) = f(t) + \alpha E_t[ds(t)] / dt, \quad \forall t \text{ and } \alpha > 0, \quad (1)$$

where $s(t)$ is the log of the nominal exchange rate at time t , $f(t)$ is the fundamental at time t , α is the absolute value of the semi-elasticity of the exchange rate with respect to its expected rate of change, and E_t is the conditional expectations operator on the available information at time t , according to the rational expectations hypothesis².

The fundamental is the sum of two components,

$$f(t) = m(t) + v(t), \quad (2)$$

the domestic money supply, $m(t)$, and a term representing a composite money demand shock, usually referred to in the literature on target zones as ‘velocity’, $v(t)$. The model assumes that ‘velocity’ is an exogenous stochastic process, whereas the money supply is a stochastic process controlled by the monetary authorities. The question is then, how the presence of a credible floating band may affect the behaviour of the exchange rate.

In the absence of any intervention, a situation common in a free floating regime, it is assumed that the money supply $m(t)$ is kept constant. As a consequence, the fundamental is simply equal to ‘velocity’, $f(t) = v(t)$. It is thus assumed that ‘velocity’ follows a Brownian motion with drift μ and instantaneous standard deviation σ .

$$dv(t) = \mu dt + \sigma dz(t), \quad \mu \text{ and } \sigma \text{ positive parameters and } v(0) > 0, \quad (3)$$

where $z(t)$ is a Wiener process with $E_t[dz(t)] = 0$ and $E_t[(dz(t))^2] = dt$, that is, $f(t)$ is the equivalent of a continuous random walk³.

² In this presentation we follow very closely Svensson (1992) and Duarte, Andrade and Duarte (2011).

³ See Campbell, Lo and Mackinlay (1997), Maddala and Kim (1999) and Demange and Rocher (2005).

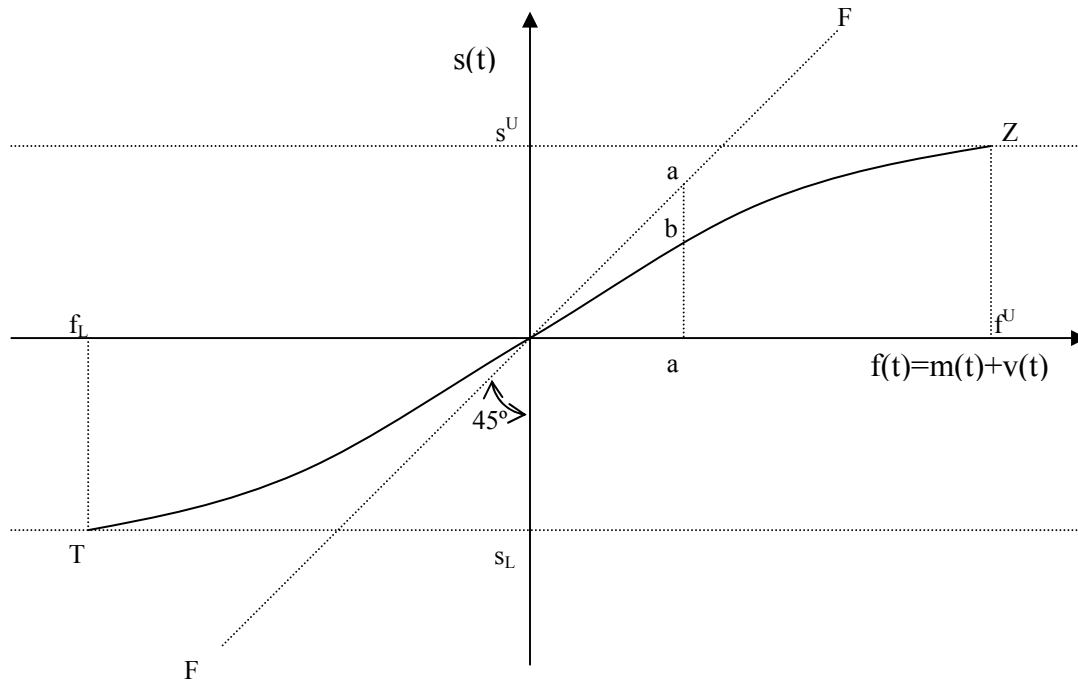
This assumption implies that the exchange rate under a free floating regime is also a Brownian motion. Therefore, changes in the fundamental will translate into equal changes in the exchange rate, $ds(t)=df(t)$.

In a target zone, it is assumed that the intervention rule is based on a specific floating band for the fundamental, $f_L \leq f(t) \leq f^U$, and that, if necessary, the fundamental will be regulated to remain within the band. This implies that the fundamental follows a regulated Brownian motion with constant drift and instantaneous standard deviation⁴:

$$df(t) = \mu dt + \sigma dz(t) + dL(t) - dU(t), \quad (4)$$

where $L(t)$ and $U(t)$ are the lower and upper regulators, defined as continuous and increasing functions of t , so that $dL(t)$ represents increases in the money supply, positive only if $f(t)=f_L$, and $dU(t)$ represents decreases in the money supply, positive if $f(t)=f^U$. Under these circumstances the exchange rate function establishes a nonlinear relationship between the exchange rate and its fundamental, as illustrated in Figure 1.

Figure 1: Exchange Rate in a Perfectly Credible Target Zone



⁴ Harrison (1985) and Karatzas and Shreve (1997) provide a formal presentation of these processes.

The straight-line FF represents the equilibrium exchange rate in the free floating case. A shock in $v(t)$ leads to a proportional change in $f(t)$ and $s(t)$. The exchange rate target zone function is tangent to the edges of its floating band, where $s_L = s(f_L)$ and $s^U = s(f^U)$, represented by the curve TZ, nonlinear, and S-shape, respectively.

The behaviour of the exchange rate in a target zone with perfect credibility leads to two main results that arise from the slope of the S-shaped exchange rate function, being therefore distinct from the free floating regime.

First, the slope of the curve TZ is always less than one. This feature is called the ‘honeymoon effect’, a reference by Krugman (1987: 19) to a “target zone honeymoon”. Contrary to the linear relationship between the exchange rate and the fundamental, characteristic of the free floating regime, in a perfectly credible target zone, the exchange rate moves along a curve whose slope is always less than or equal to one. It will be equal to one when the exchange rate is on the central parity, i.e., at the origin of the axes in Figure 1.

The S-shape exchange rate function thus appears less sensitive to changes in the fundamental than the corresponding free floating exchange rate. The fluctuations in the fundamental transmit to the exchange rate only partially, contrary to what is observed in the free floating case, where the effect is complete. Moreover, the part of the adjustment supported by the exchange rate in a target zone is not constant, but decreases as the exchange rate moves away from the central parity, as indeed is suggested by the nonlinear S-shaped relationship between the exchange rate and the fundamental represented by the curve TZ.

The intuition behind this result is immediate. In the absence of any shocks, a situation in which $v(t)$ is always equal to zero, the free floating and target zone cases share a single equilibrium, located at the origin of Figure 1. However, in the presence of stochastic fluctuations in the exchange rate, the equilibrium under free floating differs from the target zone equilibrium.

Let us consider the situation where the exchange rate approaches the upper edge of the foreign exchange band. Unlike the free floating case, at the upper edge, the exchange rate in a target zone may just fall or remain constant and the expected rate of change in exchange rate is negative. In fact, when the exchange rate is above the central parity (a situation where the currency is weak) and approaches the upper edge of intervention, the probability that this could eventually reach the edge of the band is high. As a consequence, the prospect of a future intervention by the monetary

authorities to reduce the money supply and thus strengthen the domestic currency is also high. This means that a future appreciation of the domestic currency is expected, and that once such increase is integrated into the behaviour of the exchange rate, it helps to stop its depreciation⁵. For a given level of the fundamental, the equilibrium exchange rate in a target zone will thus be lower than the corresponding free floating exchange rate, and therefore should lie below the straight line FF.

The inverse is true when the exchange rate is near the lower edge of the floating band, where expectations of a future depreciation of the domestic currency implies, for a given level of the fundamental, that the exchange rate for the target zone be located above the line of 45°. This fact will have an effect on the formation of expectations concerning foreign exchange variation for any other levels of the fundamental, producing the S-shaped characteristic in the curve TZ as shown in Figure 1.

The ‘honeymoon effect’ thus implies that a perfectly credible target zone is inherently stabilising⁶. This means that expectations of future interventions by monetary authorities to stabilise the exchange rate within the band make the exchange rate more stable than the underlying fundamental, or as suggested by Krugman (1991), the target zone helps to stabilise fundamentals, but the exchange rate stabilises further. Even when the monetary authorities do not intervene, the existence of an explicit floating band or a firm government commitment in its defence, contributes to stabilising the exchange rate (to reduce its variance) within that⁷. The announcement and fulfilment of a target zone is thus stabilising. Some of the exchange rate stability is ‘free’, representing a free benefit as a result of the announcement of a credible target zone⁸.

⁵ Suppose that there is a positive random shock in $v(t)$. In this case $f(t)$ increases and, to balance the monetary market, the domestic interest rate $i(t)$ must fall. However, according to the uncovered interest rate parity, a reduction in $i(t)$ is only possible if $E_t[ds(t)]/dt$ is negative. Thus, it is expected that the exchange rate appreciates. Given the equation (1) of the behaviour of the exchange rate, it is clear that a negative value of $E_t[ds(t)]/dt$ attenuates the movement of $s(t)$, i.e., the exchange rate in a target zone is less sensitive to changes in the fundamental than what would be if $E_t[ds(t)]/dt$ had not become negative (free floating case, in which the probability of intervention is null).

⁶ Returning to Figure 1, if we consider that a positive random shock in $v(t)$ increases the fundamental from the origin to point a , under a free floating regime the exchange rate increases by the same amount. However, in a target zone, agents recognise that there is a high probability of a future contraction in the money supply. Thus, agents expect the future appreciation of the exchange rate. This results in an equilibrium exchange rate that is less than a , at point b .

⁷ It should however be noted that the stabilising mechanism inherent in the ‘honeymoon effect’ passes through the bias of expectations. As noted by Flandreau and Komlos (2001), a credible floating band, by reducing uncertainty, improves the quality of expectations, thereby increasing the stabilising feature of the target zone.

⁸ See Svensson (1992) and Anthony and MacDonald (1998).

Second, the curve TZ becomes flatter, reaching a zero slope at the edges of the band. At the edges of the target zone, the exchange rate function is tangential to the horizontal dashed lines that represent the edges of the exchange rate band. This result is known as a ‘smooth pasting’ condition, which is nothing more than the boundary or continuity conditions for the solution of the basic model⁹.

The ‘smooth pasting’ result is again an intuitive one. A slope equal to zero in the edges of the band means that at this point the exchange rate is completely insensitive to changes in the fundamental. The equilibrium path permissible for the exchange rate should, therefore, be raised ‘smoothly’ on the upper and lower edges of the target zone, since the expected rate of change in the exchange rate increases continuously as the exchange rate approaches the edges of interventions, thus contradicting its initial dynamic and allowing the exchange rate to be brought back inside the band¹⁰.

In a credible target zone, the relationship between the exchange rate and the fundamental presents itself as a nonlinear S-shaped, essential to obtain a stabilising effect on the exchange rate compared to a free floating regime.

3. Data

We used time series data with daily frequency in an attempt to cover the period from 2 January, 1989, to 31 December, 1998, which gives a total of 2,609 potential observations. The observations corresponding to holidays and weekends were left out of the sample. In addition to the period when a target zone was officially functioning, between 6 April, 1992, and 31 December, 1998, we extended the analysis to a little period in which Portugal adopted a crawling peg and a managed floating system, when the Portuguese escudo was pegged to the Deutschmark.

The exchange rate and interest rates data was taken from the Banco de Portugal (Long Series: Monetary and Financial Statistics of the Banco de Portugal) and the Bundesbank (Bundesbank Time Series Database). We used nominal exchange rates of the Portuguese escudo against the Deutschmark (PTE/DM). This exchange rate is

⁹ See Dumas (1991), Froot and Obstfeld (1991), Dixit (1992) and Svensson (1992).

¹⁰ In a perfectly credible target zone, the agents’ expectations about a future change in the money supply increase when the exchange rate moves infinitely towards the edges of the band, given the increasing probability of intervention by the monetary authorities. This will tend to work against the influence of the fundamentals on the exchange rate as the band is reached. Thus, the exchange rate responds less to movements in fundamental and, ultimately, will become completely insensitive to their changes.

computed by the Banco de Portugal as the average daily currency price. Interest rate data is measured as the average of the daily transactions held in the Money Market. Since we used daily data, we chose overnight interest rates and interest rates with a maturity of 28 to 32 days. Based on the examination of the evolution of the interest rates over time, we left out the outliers, defined as observations with values higher than 25% of the arithmetic average of the previous thirty observations relative to the observation under analysis.

Unless otherwise stated, the exchange rate series have been transformed into natural logarithms. In the case of the interest rates, we used the natural logarithm of 1 plus the interest rate (%), divided by 100. In order to maximise the number of available observations, we were forced to extrapolate missing values whenever there were breaks in the series. The breaks occurred mainly in the Portuguese Money Market interest rates series with a maturity of 28 to 32 days. To compute the missing values, we used an extrapolation method based on an AR1 process with trend.

The five observations immediately before and after the realignments and the date corresponding to the enlargement of the bands were excluded from the sample, in all the analyses. This was to avoid biases in the analysis. Most results were obtained using RATS 6.2¹¹.

4. The Participation of the Portuguese Escudo in the ERM of the EMS

On 6 April, 1992, the framework of the Portuguese monetary and foreign exchange policy changed when the Portuguese escudo joined the ERM of the EMS. This was made possible by the better convergence of the Portuguese inflation rate with the EU's average level and, in particular, with the values recorded by Germany¹².

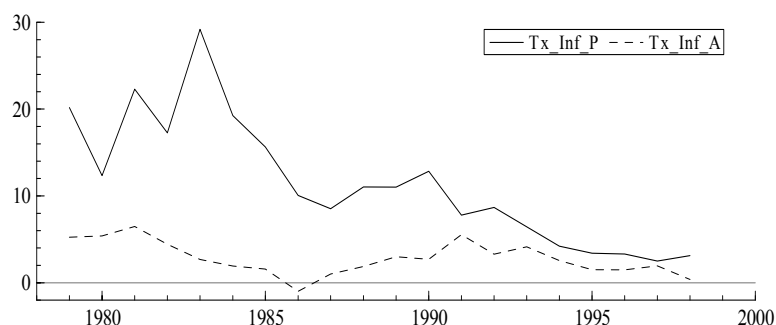
The effect of the nominal stabilisation policy of the Portuguese escudo allowed the Portuguese economy from 1990 to very substantially reduce the inflation deviation against Germany that had remained virtually constant since 1986. This situation was also catalysed by the German reunification process, which led, at least initially, to inflationary pressures in the country, so that Germany started to have an inflation rate higher than some Member-States of the EMS.

¹¹ See www.estima.com, for RATS 6.2, Hendry and Doornik (2001).

¹² See Duarte, Andrade and Duarte (2010).

For a better understanding of this Portuguese disinflation process, Figure 2 shows the evolution of inflation rates, measured as the average annual growth of the Portuguese and German Consumer Price Index (CPI), for the period 1979 to 1998.

Figure 2: Portuguese and German Inflation Rates (1979-1998)



As can be seen, after a rise in inflation rates at the beginning of the 80s, the continuing consequence of the dissipation of the effects of the second oil shock, the Portuguese inflation rate reached a maximum value of about 30% by the end of 1983, also recording at that time the largest differential from Germany. Such a high inflation rate in Portugal led to successive devaluations of the escudo in an attempt to maintain the competitiveness of Portuguese industry abroad, and to fight, through specific adjustments, the speculative movements around the escudo, which were then checked.

Thereafter, the progressive reduction in the devaluation of the escudo, and the large fall in oil and dollar prices, allowed a significant reduction in the inflation rate, to a value close to 9% in 1987. After this data, inflation rose until 1990, when it registered a value of about 13%. Coinciding with the participation of the Portuguese escudo in the exchange rate target zone of the EMS, and the effectiveness of the nominal stabilisation policy of the currency, there has been since 1992, a gradual disinflation process in Portugal, expressed on a continuous decline in the inflation rate¹³.

The central parity was then fixed at 178.735 and 86.9393 escudos for the ECU and for the Deutschmark respectively, and the Portuguese escudo was allowed to fluctuate within a band of $\pm 6\%$.

¹³ For more details about the Portuguese disinflation process, see Duarte (2009).

As there was a formal commitment to keep the Portuguese escudo within the band from this date, the credibility of the disinflation policy increased, facilitating the pursuit of the price stability goal. This foreign exchange policy course was maintained until the end of 1998, in spite of the disturbances that affected the EMS. Table 1 summarises these events, allowing us to identify the main features of the Portuguese exchange rate target zone while the Deutschmark was the reference currency.

Table 1: Bands for the Portuguese Target Zone (PTE/DM)

Period / Date	Band	PTE/DM ^(a)		
		Lower Edge ^(b)	Central Parity	Upper Edge ^(b)
6 April 1992 ^(c)	±6%	81.9	86.9393	92.336
23 November 1992 ^(d)	±6%	87.108	92.488	98.232
13 May 1993 ^(e)	±6%	93.197	98.9177	105.042
2 August 1993 ^(f)	±15%	85.179	98.9177	114.811
6 March 1995 ^(g)	±15%	88.277	102.505	119.033

Note: (a) Portuguese escudos necessary to buy one Deutschmark.

(b) The lower (upper) edge represents the maximum appreciation (depreciation) permitted to the Portuguese escudo against the Deutschmark.

(c) Membership of the Portuguese escudo of the ERM of the EMS with a bandwidth of ±6%.

(d) Realignment in the EMS with devaluation of 6% of the Spanish peseta and the Portuguese escudo.

(e) Realignment in the EMS with devaluation of 8% of the Spanish peseta and 6.5% of the Portuguese escudo.

(f) Enlargement of the bands of the ERM to ±15%, with the exception of the guilder/deutschmark exchange rate that maintained the ±2.25% band.

(g) Realignment in the EMS with devaluation of 7% of the Spanish peseta and 3.5% of the Portuguese escudo.

Source: Banco de Portugal, Annual Reports and Duarte, Andrade and Duarte (2010).

In Figure 3 we depict the behaviour of the Portuguese escudo exchange rate against the Deutschmark and the evolution of the overnight interest rate differential between Portugal and Germany (Dif_O) as part of the PTE/DM band. Besides the target zone period, we simulated, from 2 January, 1987 to 5 April, 1992, an unofficial band of ±6%, with an unofficial central parity (No_C_PTE_DM) and unofficial intervention edges (No_LI_PTE_DM_6 and No_LS_PTE_DM_6) equal to that adopted on joining¹⁴.

¹⁴ See Appendix I for a complete list of variables and their description.

Figure 3: PTE/DM Exchange Rate and Overnight Interest Rate Differential

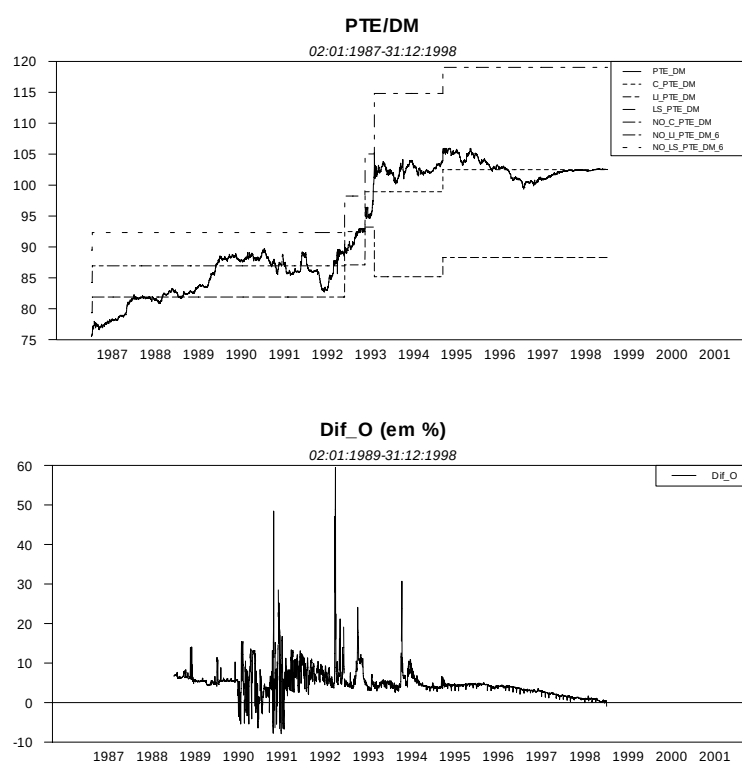


Figure 3 shows that the PTE/DM exchange rate had been relatively stable since the beginning of the 1990s. This was the result of the pegging of the Portuguese escudo to the Deutschmark, which allowed the Portuguese currency to benefit from the credibility, stability and discipline associated with the tacit acceptance of the anti-inflationary stance of the Bundesbank's monetary policy.

Concentrating on the target zone period, it is possible to confirm that after joining the ERM, the Portuguese escudo registered a significant nominal appreciation and an almost immediate decline to a value near the lower edge of its band. Furthermore, everything seems to indicate that the realignments were anticipated, given the high interest rate differential before the realignments. After the widening of the bands, the exchange rate again stabilised, but this time within the implicit band of $\pm 6\%$.

5. The Nonlinear Relationship between the Exchange Rate and its Fundamental

As we said before, the basic target zone model predicts a nonlinear S-shaped relationship between the exchange rate and its fundamental determinants, with ‘smooth adjustment’ in the edges of the floating band, where the exchange rate would be completely insensitive to changes in the fundamental. If there is such a relationship, a target zone would have a stabilising effect on the exchange rate, the so-called ‘honeymoon effect’, following the terminology of Krugman (1987). In a foreign exchange band regime, the part of the adjustment supported by the exchange rate is not constant, but decreases as the exchange rate moves away from the central parity, so we should obtain a nonlinear S-shaped relationship, indicative of the lower sensitivity of the variable in the event of changes in the fundamental. The ‘honeymoon effect’ should thus imply that a credible target zone was inherently stabilising.

The results of the empirical work show, however, the existence of a negative trend in the interest rate differential, so it was not possible to detect the presence of a nonlinear S-shaped relationship between the exchange rate and the aggregate fundamental¹⁵. The fact that there is a negative trend means that during the participation of the Portuguese escudo in the ERM of the EMS, the interest rate differential between Portugal and Germany tended to cancel, thus causing it to become a fundamental variable in the determination of exchange rate behaviour, and precluding any finding of a relationship as predicted by the theory.

For this purpose three models were tested. The first consisted of applying the estimation method of Ordinary Least Squares (OLS) where we took some care in analysing the structure of residues. The second is based on the correction of autocorrelation by maximum likelihood, having been used in the estimation proposed by Beach-Mackinnon for the correction of process AR1 of residues¹⁶. Finally, we used a GARCH (p, q) type model. In all three cases studied, the constant, the trend, and an autoregressive value (the interest rate differential lagged one day), excluded the null hypothesis.

¹⁵ Diebold and Nason (1990), Meese and Rose (1990, 1991), Chinn (1991), Flood, Rose and Mathieson (1991), Mizrach (1992), Lindberg and Soderlind (1994) and Ma and Kanas (2000) also had difficulties in detecting the nonlinear S-shaped relationship between the exchange rate and its fundamental determinants. The authors predominantly observe the presence of a random walk in exchange rate behaviour.

¹⁶ See Beach and Mackinnon (1978).

Table 2 (a-c) shows the results for the overnight interest rate differential for the entire period under study¹⁷.

Table 2: Trend in the Overnight Interest Rate Differential

(a) - OLS Model

Variable (i-i*)_O	Coefficient	Standard Error	T statistic	Significance
1- Constant	8,0311e-03	8,6580e-04	9,27594	0,00000000
2- Trend	-1,6815e-06	2,9663e-07	-5,66866	0,00000002
3- (i-i*) O {1}	0,8754	0,0106	82,96735	0,00000000
LM of AR (1): 45,782 (0,000) ARCH (1): 265,652 (0,000) RESET: 2028,990 (0,000) AIC: -3689,6592. Schwarz: -3672,686 R ² centred 0,819. Rbar ² 0,818 R ² not centred 0,958. T × R ² 2028,654 Mean of Dependent Variable 0,039		Standard Error of Dependent Variable 0,021 Standard Error of Estimate 0,009 Sum of Residuals Squared 0,175 F(2,2114) 4769,077 Significance Level of F 0,000 Log Likelihood 6949,670		

(b) - Correction of Autocorrelation by Maximum Likelihood

Variable (i-i*)_O	Coefficient	Standard Error	T statistic	Significance
1- Constant	5,8784e-03	7,4432e-04	7,89764	0,00000000
2- Trend	-1,2345e-06	2,5349e-07	-4,87003	0,00000120
3- (i-i*) O {1}	0,9088	9,1239e-03	99,60524	0,00000000
4- RHO	-0,1619	0,0230	-7,03373	0,00000000
R ² centred 0,822. Rbar ² 0,822 R ² not centred 0,960. T × R ² 2030,565 Mean of Dependent variable 0,039 Standard Error of Dependent Variable 0,021 Standard Error of Estimate 0,009		Sum of Residuals Squared 0,171 Log Likelihood 6972,807 Q(36-1) 348,792 Significance Level of Q 0,000		

(c) - GARCH (2,1) Model

Variable (i-i*)_O	Coefficient	Standard Error	T statistic	Significance
1- Constant	5,9611e-03	4,7922e-04	12,43913	0,00000000
2- Trend	-1,8329e-06	1,3771e-07	-13,31046	0,00000000
3- (i-i*) O {1}	0,9585	5,0227e-03	190,82835	0,00000000
4- C	1,2936e-07	2,7999e-08	4,62029	0,00000383
5- A	0,4124	0,0442	9,32604	0,00000000
6- B {1}	0,3075	0,0784	3,92306	0,00008743
7- B {2}	0,4147	0,0686	6,05010	0,00000000
Convergence in 62 iterations ¹⁸ Final Criterion was 0,0000000 < 0,0000100		Observations Used 2117 Log Likelihood 8588,944		

¹⁷ For a complementary analysis see Figure A.1 in Appendix II.

¹⁸ The econometric programme RATS uses the method BFGS (Broyden, Fletcher, Goldfarb and Shanno) described in Press, Teukolsky and Vetterling (1988).

As can be seen from the tables, in the three models tested, we verified the presence of a negative trend in the overnight interest rate differential, a situation inhibitive of the confirmation about the existence of a nonlinear S-shaped relationship between the exchange rate and the aggregate fundamental.

Table 3 (a-c) shows the results of empirical analysis in respect of the interest rate differential with a maturity of 28 to 32 days¹⁹.

Table 3: Trend in the Interest Rate Differential with a Maturity of 28 to 32 Days

(a) - OLS Model

Variable (i-i*) ₂₈	Coefficient	Standard Error	T statistic	Significance
1- Constant	3,9447e-03	6,0746e-04	6,49370	0,00000000
2- Trend	-1,0022e-06	1,7330e-07	-5,78314	0,00000001
3- (i-i*) ₂₈ { 1 }	0,9565	6,3533e-03	150,55161	0,00000000
LM of AR (1): 102,364 (0,000) ARCH (1): 136,793 (0,000) RESET: 2107,694 (0,000) AIC: -7784,452. Schwarz: -7767,479 R ² centred 0,972. Rbar ² 0,972 R ² not centred 0,996. T × R ² 2107,596 Mean of Dependent variable 0,047		Standard Error of Dependent Variable 0,021 Standard Error of Estimate 0,003 Sum of Residuals Squared 0,025 F(2,2114) 36897,019 Significance Level of F 0,000 Log Likelihood 8997,067		

(b) - Correction of Autocorrelation by Maximum Likelihood

Variable (i-i*) ₂₈	Coefficient	Standard Error	T statistic	Significance
1- Constant	2,5204e-03	4,8636e-04	5,18212	0,00000024
2- Trend	-6,4842e-07	1,3855e-07	-4,67986	0,00000305
3- (i-i*) ₂₈ { 1 }	0,9723	5,0903e-03	191,01270	0,00000000
4- RHO	-0,2261	0,0216	-10,47962	0,00000000
R ² centred 0,973. Rbar ² 0,973 R ² not centred 0,996. T × R ² 2108,051 Mean of Dependent variable 0,047 Standard Error of Dependent Variable 0,021 Standard Error of Estimate 0,003		Sum of Residuals Squared 0,024 Log Likelihood 9049,515 Q(36-1) 111,236 Significance Level of Q 0,000		

¹⁹ For further analysis see also Figure A.2 in Appendix II.

(c) - GARCH (1,1) Model

Variable (i-i*)_28	Coefficient	Standard Error	T statistic	Significance
1- Constant	3,3590e-03	4,8804e-04	6,88250	0,00000000
2- Trend	-1,0179e-06	1,4567e-07	-6,98774	0,00000000
3- (i-i*)_28 { 1 }	0,9706	4,3305e-03	224,13754	0,00000000
4- C	4,0158e-08	1,0387e-08	3,86612	0,00011058
5- A	0,1551	0,0152	10,20711	0,00000000
6- B	0,8744	9,4141e-03	92,88330	0,00000000
Convergence in 76 iterations Final Criterion was 0,0000008 < 0,0000100		Observations Used 2117 Log Likelihood 9668,914		

The existence of a nonlinear S-shaped relationship between the exchange rate and its fundamental determinants is again far from being confirmed by the empirical analysis of the data. The results of applying the three types of model to evaluate the behaviour of the interest rate differential between Portugal and Germany evidenced the presence of a negative trend in the interest rate differential with a maturity of 28 to 32 days, thus excluding once again, the possibility of finding a relationship as suggested by the theory²⁰.

In an attempt to reach conclusions more conducive with the prediction object of study, we then tried to analyse the behaviour of the exchange rate within LSTAR models (Logistic Smooth Transition Autoregressive) and ESTAR (Exponential STAR), appropriated models to changes in the values of coefficients²¹.

A nonlinear autoregressive model with smooth transition (STAR) of order p , for the exchange rate series s_t , can be defined as follows:

$$s_t = \alpha_0 + \alpha_1 s_{t-1} + \dots + \alpha_p s_{t-p} + \theta(\beta_0 + \beta_1 s_{t-1} + \dots + \beta_p s_{t-p}) + \varepsilon_t, \quad (5)$$

where α_0 is the constant linear term, α_i ($i=1, \dots, p$) are the linear autoregressive parameters; β_0 is the nonlinear constant term, β_i ($i=1, \dots, p$) are the nonlinear autoregressive parameters, θ is the transition function that characterises the smooth transition between two regimes, which may be the appreciation and depreciation of the exchange rate, with a transition velocity governed by the lagged term of the exchange rate, and ε_t is the white noise error term with zero mean and constant variance.

²⁰ We could endogenise this negative trend by introducing other variables as measures of the fundamentals (money supply, output, inflation expectations, etc.), work to be carried out in future research.

²¹ See Granger and Terasvirta (1993), Terasvirta (1994, 1998), Taylor and Peel (2000), Dijk, Terasvirta and Franses (2002) and Liew (2004).

Depending on the specification of the transition function θ , we can have several variants of the STAR model. Granger and Terasvirta (1993) and Terasvirta (1994) suggest two transition functions, the Logistic function (LSTAR) and the Exponential function STAR (ESTAR).

The Logistic function STAR, which results in the designated LSTAR model, characterised by the asymmetry of the nonlinear adjustment process of the exchange rate dynamics:

$$\theta = [1 + \exp\{-\gamma(s_{t-1} - c)\}]^{-1}, \quad (6)$$

where the parameter γ is positive and measures the velocity of transition from one regime to another. The parameter c can be interpreted as the threshold between the two exchange rate regimes. The smaller the parameter γ , the smoother the transition. If $\gamma=0$, the transition function θ becomes constant and the model turns into a linear model.

In turn, the Exponential function STAR, and the corresponding ESTAR model, allows a nonlinear symmetrical adjustment of the exchange rate for deviations above or below the equilibrium level, i.e., it has a symmetric dynamic depending on the difference $(s_{t-1}-c)$:

$$\theta = 1 - \exp\{-\gamma[s_{t-1} - c]^2\}, \quad (7)$$

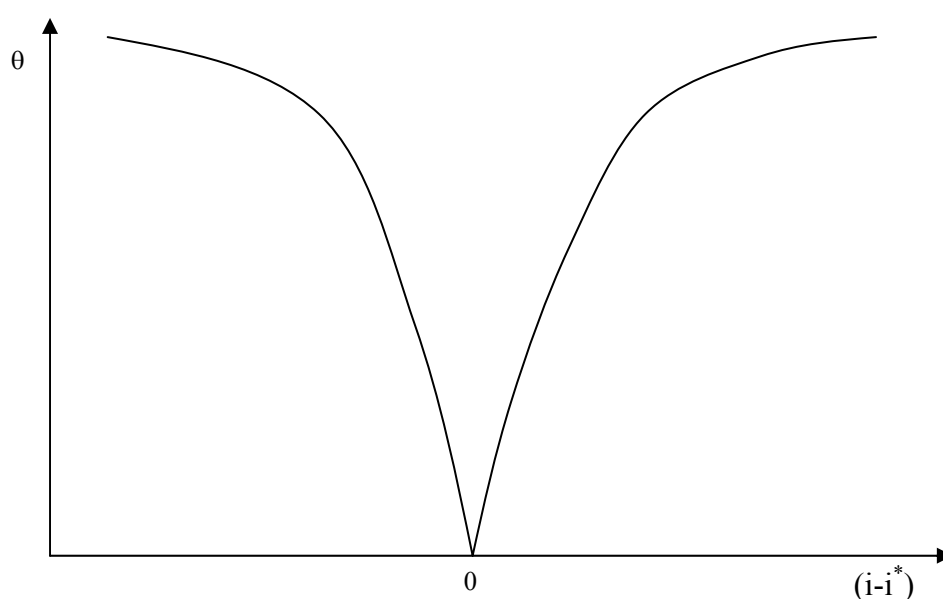
whereas in the function LSTAR, the parameter γ is positive and measures the velocity of the adjustment process.

In our study, for modelling the behaviour of the exchange rate, the strategy of linearity vs. LSTAR and LSTAR vs. ESTAR, as suggested by Enders (2004), was followed. The two models have quite different implications in terms of the dynamic of exchange rate behaviour, hence the attempt to select the most appropriate transition function for the change in the values of the coefficients. The Logistic STAR (LSTAR) model describes a nonlinear asymmetric adjustment process, while the Exponential STAR (ESTAR) model captures the nonlinear symmetrical adjustment of the exchange rate dynamics.

As it is theoretically assumed that the adjustment process of the exchange rate is symmetric, the LSTAR model would not, in principle, be appropriate for the modelling of exchange rate movements. However, despite the LSTAR model with AR (p) being asymmetrical in its original form, becomes symmetrical (LSTARS) with appropriate transformations, which makes this model also very interesting for applications in markets as the foreign exchange market²².

In our case, the transition function for the symmetric LSTAR model with ‘smooth adjustment’ (LSTARS) would have a shape similar to that shown in Figure 4.

Figure 4: Transition Function in a LSTARS Model



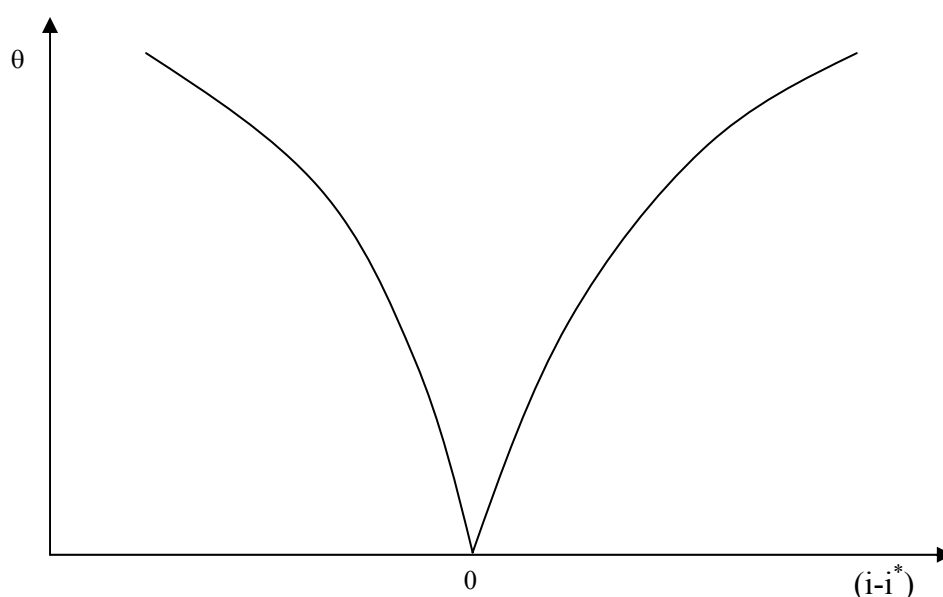
The transition function associated with the exponential STAR (ESTAR) model is illustrated in Figure 5.

Based on these two variants of the STAR model proposed by Granger and Terasvirta (1993), it was not possible to construct a model for the exchange rate dynamics that present the features compatible with the nonlinear S-shaped behaviour, with ‘smooth adjustment’ in the edges of the floating band, as suggested by the theory on exchange rate target zones.

Using Enders (2004) methodology with the estimates achieved, the null hypothesis of appropriate coefficients is never excluded.

²² See Sarantis (1999), Escribano and Jordá (2001), Liew and Baharumshah (2002) and Liew (2004).

Figure 5: Transition Function in an ESTAR Model



Despite the lack of conformity in relation to the theoretical predictions, it should not be assumed that there is no stabilising effect on the exchange rate as a result of the existence of a foreign exchange floating band. Portugal's current participation in the EMU is demonstrative of this reality. The literature on target zones appears to have overestimated the extent of the 'honeymoon effect', so the difficulty in detecting a strong nonlinear relationship between the exchange rate and the aggregate fundamental can lead to the unjustified dismissal of the basic target zone model.

The presence of a negative trend in interest rate differentials, however, reflects increased credibility in the conduct of foreign exchange and monetary policy by the Portuguese authorities, and this in turn causes changes in interest rate differentials such that they tend to zero and, therefore, fail to influence the exchange rate behaviour.

This result consequently testifies to the high degree of credibility achieved within the Portuguese target zone and the importance that an exchange rate regime with floating bands can have in the creation of macroeconomic stability conditions conducive to the transition to a single currency regime. However, since this kind of option allows for the combination of monetary policy autonomy with macroeconomic stability, the idea is also supported that a target zone regime should be considered a feasible solution for 'tomorrow' for countries that 'today' can be forced to abandon the Euro Zone.

6. Conclusion

Based on the participation of Portugal in the ERM of the EMS and one of the main predictions of the basic target zone model of Krugman (1991), according to which the exchange rate behaviour in a credible target zone should lead to a nonlinear S-shaped relationship between the exchange rate and its fundamental determinants, we tried to analyse to what extent the adoption of such an exchange rate regime would have had a stabilising effect on exchange rate dynamics. If such relationship is verified, we can talk about the existence of a ‘honeymoon effect’, by which the simple expectation that the Portuguese monetary authorities defend the target zone would exercise a stabilising effect on exchange rate behaviour.

To this end, three models were tested — OLS, Auto-correlation by Maximum Likelihood, and GARCH (p, q). However, the evidence of a negative trend in the interest rate differential prevented the empirical confirmation of a nonlinear S-shaped relationship between the exchange rate and its fundamental determinants. The use of LSTAR and ESTAR models to analyse the behaviour of the exchange rate also failed to reconcile the theory with the data.

Nonetheless, this does not mean that a stabilising effect on the exchange rate did not occur following the adoption of a foreign exchange regime with a floating band. Indeed, notwithstanding the current problems facing the Portuguese economy in the context of its participation in the Euro Area, the simple fact of it be inserted is well demonstrative of the macroeconomic stabilisation process achieved by the adoption of a target zone during the transitionary exchange rate regime to a monetary union.

The literature on exchange rate target zones may have overestimated the size of the ‘honeymoon effect’, so the consistent failure to empirically detect a strong nonlinear S-shaped relationship between the exchange rate and the aggregate fundamental may have led to the unjustified dismissal of the basic target zone model.

The existence of a negative trend in the interest rate differential ends up reflecting the increase of credibility in the conduct of monetary and foreign exchange policy. The evolution of the Portuguese money market interest rates was characterised by the maintenance of a downward trend, reflecting a climate of exchange rate stability and the reduction of the intervention interest rates. This evolution led to a significant reduction of the differential against German interest rates, thus allowing exchange rate

stability to be pursued, framed by the final objective of the maintenance of price stability.

Hence, the European integration process of the Portuguese economy can serve as an example to other small open economies in the sense in that they all have an interest in being part of the large dominant monetary areas. If they do not participate, they will be more exposed to speculative attacks in the case of real appreciation of their currencies, increasing the risk of currency crises.

For small open economies, exchange rate stability, relatively to a basket of currencies with high nominal exchange rate stability, is an effective way of achieving, in the medium-term, the primary objective of price stability. The adoption of an exchange rate target zone regime thus appears as a very plausible option, since it allows reconciling the necessary exchange rate stability with some autonomy in the conduct of monetary policy.

Acknowledgments

The authors thank Marta Simões for their helpful comments and suggestions. The GEMF is financially supported by the Foundation for Science and Technology. The usual disclaimer applies.

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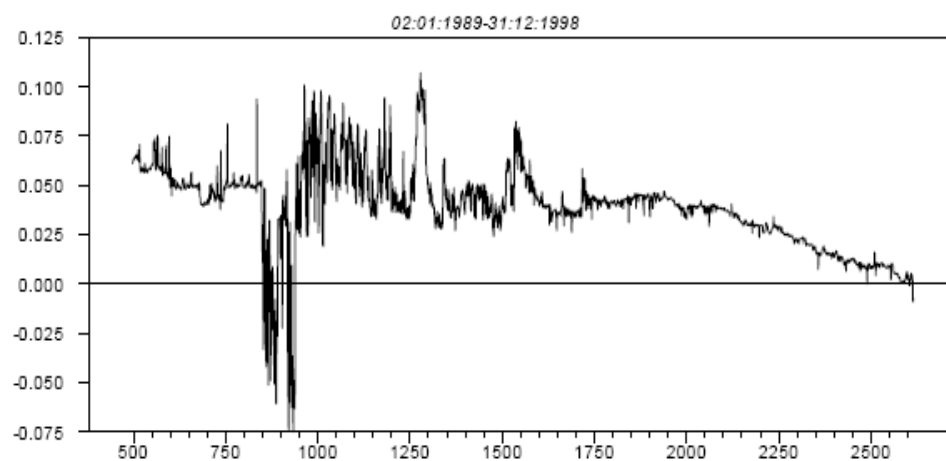
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Appendix I: List of Variables and their Description

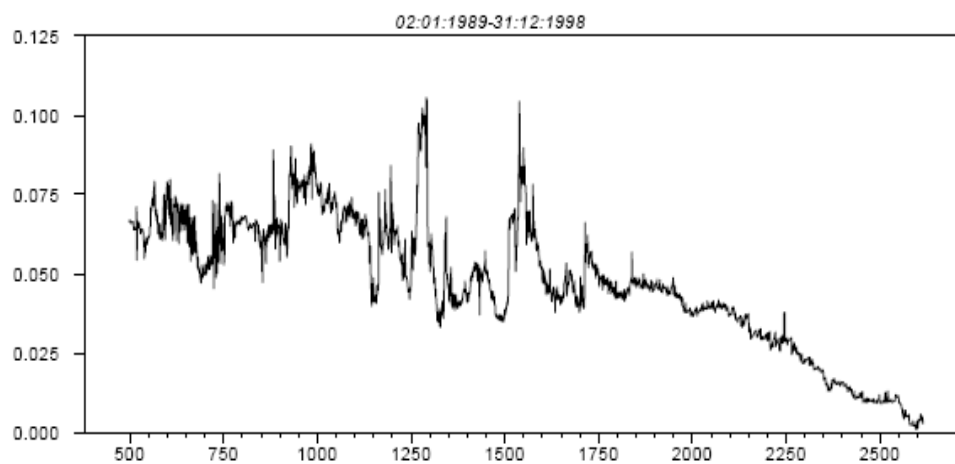
Tx_Inf_P	Inflation rate in Portugal, measured by the annual average change in the Consumer Price Index
Tx_Inf_A	Inflation rate in Germany, measured by the annual average change in the Consumer Price Index
PTE/DM	Nominal exchange rate of the Portuguese escudo against the Deutschmark
C_PTE_DM	Official central parity of the Portuguese escudo against the Deutschmark
LI_PTE_DM	Official lower edge for PTE/DM
LS_PTE_DM	Official upper edge for PTE/DM
No_C_PTE_DM	Unofficial central parity of the Portuguese escudo against the Deutschmark
No_LI_PTE_DM_6	Unofficial lower edge for PTE/DM and an unofficial exchange rate band of $\pm 6\%$
No_LS_PTE_DM_6	Unofficial upper edge for PTE/DM and an unofficial exchange rate band of $\pm 6\%$
Dif_O	Differential between the Portuguese overnight interest rate and the German overnight interest rate (%)
Dif_28	Differential between the Portuguese interest rate with a maturity of 28 to 32 days and the German interest rate with a maturity of 28 to 32 days (%)
$(i-i^*)_O$	Differential between the Portuguese overnight interest rate and the German overnight interest rate (log)
$(i-i^*)_{28}$	Differential between the Portuguese interest rate with a maturity of 28 to 32 days and the German interest rate with a maturity of 28 to 32 days (log)
DC_PTE/DM	Deviation of the PTE/DM exchange rate from the central parity

Appendix II: Figures

**Figure A.1: Trend in the Overnight Interest Rate Differential
(Effective Values of $(i-i^*)_O$)**



**Figure A.2: Trend in the Interest Rate Differential with a Maturity
of 28 to 32 Days (Effective Values of $(i-i^*)_{28}$)**



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