Exchange Rate and Interest Rate Volatility in a Target Zone: The Portuguese Case

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António Portugal Duarte
(portugal@fe.uc.pt)

João Sousa Andrade
(jasa@fe.uc.pt)

Adelaide Duarte
(maduarte@fe.uc.pt)

Faculdade de Economia da Universidade de Coimbra
Grupo de Estudos Monetários e Financeiros (GEMF)
Av. Dias da Silva, 165
3004-512 Coimbra, Portugal
Tel. +351 239790500
Fax +351 239403511
I. INTRODUCTION

- This work examines
  - Participation of the Portuguese economy in the ERM of the EMS
  - Based on some of the main predictions of the target zone literature

- Target Zone Literature
  - The literature has known a revival with the introduction of the Krugman (1991) model

- The basic target zone model
  - Has quite interesting implications
  - Behaviour of the exchange rate and the interest rates differential
I. INTRODUCTION

- The model predicts
  - Statistical exchange rate distribution must be U-shaped or bimodal
  - Exchange rate will be much less variable near the edges of the band
  - Negative relationship between the exchange rate and the interest rate differential
  - Trade-off between the volatility of the exchange rate and the volatility of the interest rates differential

- Our main aim
  - Study the behaviour and volatility of exchange and interest rates
  - Based on the predictions of the first generation of target zones models

- Our contribution to the literature
  - Stems from the fact that we are analysing a currency from the periphery of the system, the Portuguese escudo
II. DATA

- We used time series data with daily frequency: January, 1987 to December, 1998

- The observations corresponding to holidays and weekends were left out of the sample

- The exchange rate and interest rates data was taken from the Banco de Portugal and the Bundesbank

- We used nominal exchange rates of the Portuguese escudo against the Deutschmark (PTE/DM)

- Since we used daily data, we chose overnight interest rates and interest rates with a maturity of 28 to 32 days

- 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 AR1 process with trend

- Most results were obtained using RATS 6.2, PcGive 10, and Jmulti 4.1
III. THE PORTUGUESE EXCHANGE RATE TARGET ZONE

In Figure 1 we represent the:

- Behaviour of the Portuguese escudo exchange rate against the Deutschmark
- Evolution of the overnight interest rates differential between Portugal and Germany

Figure 1 shows:

- The exchange rate had been relatively stable since the beginning of the 1990s
- The Portuguese escudo registered a significant nominal appreciation
- The realignments were anticipated, given the high interest rates differential before the realignments
- After the widening of the bands, the exchange rate again stabilises
IV. DISTRIBUTION AND VOLATILITY

Figure 2: Frequency Distribution and Kernel Estimation of the Probability Density Function of the PTE/DM Exchange Rate (Regime 1)

- Figure 2 shows
  - The frequency distribution and the Kernel estimation of the exchange rate
  - As we can see:
    - Most of the observations of the exchange rate lie close to the central parity
    - The U-shaped or bimodal density of the exchange rate is rejected by the statistical analysis of data
IV. DISTRIBUTION AND VOLATILITY

- We also evaluated the distribution of the exchange rate in specific intervals of exchange variation of identical width.

- From this analysis, we proceeded to study the exchange rate and the interest rates volatility in each sub-interval.

As can be seen from Figure 3 (top):

- Most of the observations lie close to the central parity.
- Thus rejecting once again one of the key predictions of the Krugman (1991) model.
IV. DISTRIBUTION AND VOLATILITY

Table 1 summarizes the fundamental nature of these results:

Table 1: Relative Frequency of PTE/DM Exchange Rate Observations in Twelve Sub-Intervals of the Band

<table>
<thead>
<tr>
<th>Regime</th>
<th>Lower Edge (a) (%)</th>
<th>Centre of the Band (b) (%)</th>
<th>Upper Edge (c) (%)</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.50</td>
<td>53.17</td>
<td>33.33</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>48.18</td>
<td>33.58</td>
<td>18.24</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>46.67</td>
<td>53.33</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9.44</td>
<td>6.78</td>
<td>83.78</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6.42</td>
<td>77.74</td>
<td>15.84</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>53.31</td>
<td>37.28</td>
<td>9.41</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4.58</td>
<td>57.03</td>
<td>38.39</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50.33</td>
<td>31.79</td>
<td>17.88</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9.56</td>
<td>55.45</td>
<td>34.99</td>
<td></td>
</tr>
<tr>
<td>10'</td>
<td>49.61</td>
<td>48.31</td>
<td>2.08</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>94.71</td>
<td>5.29</td>
<td></td>
</tr>
</tbody>
</table>

As we can see the U-shape in the distribution of the exchange rate is clearly rejected by the analysis of the histograms.
IV. DISTRIBUTION AND VOLATILITY

- This lack of conformity with theoretical predictions:
  - May be due to the existence of intra-marginal interventions
  - To the fact that the Portuguese escudo floated within a wide band of ±6%, which implied a lower probability that the edges of the target zone would be reached

- In terms of volatility, we can see that:
  - Exchange rate volatility tends to increase as the exchange rate approaches the edges of the band, contrary to theoretical predictions
  - Interest rates differential volatility seems to behave more in accordance with the implications of the theory
V. TRADE-OFF BETWEEN EXCHANGE RATE VOLATILITY and INTEREST RATES DIFFERENTIAL VOLATILITY

Finally, in a further attempt to validate the theoretical predictions:

- We examined the correlation between the estimated values of the conditional variances of the exchange rate and interest rates differentials.
- We used a M-GARCH (Multivariate Generalized-AutoRegressive Conditional Heteroscedasticity) model.

Table 2: Correlation between CVr_TxV_PTE/DM and CVr_(i-i*)_O

( Variant 1; Whole Period )

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T statistic</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Constant</td>
<td>1.9783e-06</td>
<td>1.1429e-05</td>
<td>0.17310</td>
<td>0.863</td>
</tr>
<tr>
<td>2- Constant</td>
<td>6.2772e-03</td>
<td>4.7366e-04</td>
<td>13.25257</td>
<td>0.000</td>
</tr>
<tr>
<td>3- Trend</td>
<td>-1.9301e-06</td>
<td>1.3781e-07</td>
<td>-14.00585</td>
<td>0.000</td>
</tr>
<tr>
<td>4- (i-i*)_O {1}</td>
<td>0.9567</td>
<td>4.7862e-03</td>
<td>199.88852</td>
<td>0.000</td>
</tr>
<tr>
<td>5- C (1, 1)</td>
<td>-5.7192e-11</td>
<td>0.0000</td>
<td>0.00000</td>
<td>0.000</td>
</tr>
<tr>
<td>6- C (2, 1)</td>
<td>-2.2643e-08</td>
<td>7.6961e-09</td>
<td>-2.94210</td>
<td>0.003</td>
</tr>
<tr>
<td>7- C (2, 2)</td>
<td>9.5160e-08</td>
<td>1.7838e-08</td>
<td>5.33458</td>
<td>0.000</td>
</tr>
<tr>
<td>8- A (1, 1)</td>
<td>0.0556</td>
<td>5.5260e-03</td>
<td>10.06433</td>
<td>0.000</td>
</tr>
<tr>
<td>9- A (2, 1)</td>
<td>9.2753e-03</td>
<td>0.0206</td>
<td>0.44953</td>
<td>0.653</td>
</tr>
<tr>
<td>10- A (2,2)</td>
<td>0.2894</td>
<td>0.0280</td>
<td>10.31747</td>
<td>0.000</td>
</tr>
<tr>
<td>11- B (1, 1)</td>
<td>0.9528</td>
<td>3.6375e-03</td>
<td>261.93571</td>
<td>0.000</td>
</tr>
<tr>
<td>12- B (2, 1)</td>
<td>-0.2363</td>
<td>0.5336</td>
<td>-0.44279</td>
<td>0.658</td>
</tr>
<tr>
<td>13- B (2, 2)</td>
<td>0.8041</td>
<td>0.0129</td>
<td>62.17371</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: GARCH Model – BFGS Estimation; Observations used 2117; Convergence in 632 iterations; Final criterion was 0.00000005 \( \approx 0.0000100 \); Log Likelihood 19183.473.
V. TRADE-OFF BETWEEN EXCHANGE RATE VOLATILITY and INTEREST RATES DIFFERENTIAL VOLATILITY

- The results of this analysis allow us to conclude that:
  - There is a negative correlation between the estimated values of the conditional variances of the Portuguese escudo rate of change against the Deutschmark and the overnight interest rate differential.
  - It is also worth mentioning that there is a trade-off between the exchange rate volatility and the overnight interest rate differential volatility.
  - Figure 4 illustrates this.

*Figure 4: Correlation between the Conditional Variances of the Exchange Rate and Overnight Interest Rate Differential*
V. TRADE-OFF BETWEEN EXCHANGE RATE VOLATILITY and INTEREST RATES DIFFERENTIAL VOLATILITY

Possible explanations for this situation are:

- The modernisation of the banking and financial system

- The progress made in terms of disinflation policy, which allowed the interest rate to serve as an alternative variable to the exchange rate in the adjustment process following a monetary shock

- In this context, the participation of the Portuguese escudo in a target zone was crucial to create the conditions of stability, credibility, and confidence, necessary for the adoption of the single currency.
VI. CONCLUSION

- Although the results do not support the theoretical predictions, this does not mean that the participation in a target zone did not exercise a stabilizing effect on the exchange rate.

- This is particularly interesting given the presence of a negative trend in the interest rate differential which, instead of representing inefficient actions in the foreign exchange market, reveals the high degree of macroeconomic stability achieved in the Portuguese economy.
VI. CONCLUSION

- The integration process of the Portuguese economy should therefore be used as an example by other small open economies in the sense that they may benefit from participating in one of the dominant monetary areas, otherwise they will be more exposed to speculative attacks, especially in the case of real appreciation of their currencies.

- But from eight years of EMU, winner members have to conduct solid real convergence policies. Overappreciation currencies can be fatal for new members.
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