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Evaluating target zone models in EMS data

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Abstract

Existing empirical analyses of target zone models in EMS data are flawed. They fail to allow for the multilateral nature of EMS institutions. This paper outlines briefly the shortcomings of existing tests, focusing on the so-called fat-tailed distribution result.

Keywords: Exchange rates; Target zones; European Monetary System (EMS)

JEL classification: F33; F31

1. Introduction

Following the seminal theoretical contributions of Krugman (1991) and Froot and Obstfeld (1991), simple target zone models of exchange rate behavior within fluctuation bands have been subjected to a battery of empirical tests (for example, Flood et al., 1991). The focus of such testing has been data from the exchange rate mechanism of the European Monetary System (EMS). Target zone models have not proved robust in the face of such tests. Consequently, a considerable derived literature has emerged evaluating the implications of relaxing the two central assumptions of the original Krugman (1991) model, namely perfect credibility of the authorities' commitment to the fluctuation band (Bertola and Caballero, 1992) and the absence of foreign exchange intervention by the authorities other than when the boundary of the band is reached (Dominguez and Kenen, 1990; Lewis, 1991).

This paper suggests an alternative explanation for the empirical failure of simple target zone models in EMS data. The institutions of the EMS do not correspond to the simple bilateral exchange rate pegs assumed by the Krugman (1991) model. As will be demonstrated below, the multilateral nature of the EMS ensures that member exchange rates will not exhibit the

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behavior suggested by the theoretical target zone literature. The reported empirical failures are logically implied by the nature of the EMS itself and cannot necessarily be attributed to imperfect credibility or intra-marginal intervention as has been the case in other analyses.

2. An implication of the simple target zone model

For reasons of brevity and clarity, I choose to focus on only one of the empirical implications of the target zone model, namely the so-called *fat-tailed distribution* result. Assuming perfect credibility and the absence of intra-marginal intervention, the frequency density of an exchange rate constrained to a fluctuation band will be concentrated at the margins of that band. Krugman (1991) demonstrates this result in the context of a simple monetary model of the exchange rate.

The economic intuition is straightforward. An exchange rate at the upper boundary of a perfectly credible fluctuation band offers an arbitrage opportunity – the proverbial one-way bet – to private speculators. The rate can only appreciate in the future; given that the band is perfectly credible, the authorities must prevent any further depreciation. In anticipation of a risk-free profit, private sector capital is attracted into the currency, off-setting any fundamental shocks driving further depreciation. Fundamental shocks are damped at the edge of the band by the stabilizing effects of private speculative capital and the exchange rate becomes 'stuck' there. Therefore, the frequency distribution of the exchange rate is denser near the boundaries of the band than would be the case under a floating rate regime.

Testing for fat-tailed frequency distributions has been central to empirical evaluations of the target zone literature in EMS data. The failure to find fat tails has led to the rejection of simple target zone models.

3. The institutional structure of the EMS

The target zone literature assumes a bilateral exchange rate peg. In an n currency exchange rate system, $(n-1)$ currencies define their fluctuation bands in relation to the nth, numeraire currency. No additional restrictions are imposed on the cross rates between non-numeraire currencies. The restrictions imposed on members of the system are fully described by an $(n-1)$ vector of central parities and band widths against the numeraire currency. In the bilateral system, it is the *marginal* distribution of fundamental shocks relative to the numeraire that determines exchange rate behavior.

These models do not describe the EMS correctly. As discussed in Giavazzi and Giovannini (1989, p 33), the central institutional feature of the EMS is a multilateral parity grid (for an example, see Adams, 1990). Rather than simply declaring fluctuation bands in relation to a numeraire currency (the Deutschmark), each member defines bands *of equal size* against all other currencies in the system. In an n currency system, the exchange rate commitments implied by the system are thus described by an $n \times n$ matrix rather than an $(n-1)$ vector. Compared with the bilateral system, additional restrictions have been placed on cross rates against non-numeraire currencies. Since fundamental shocks to other non-numeraire curren-

cies can now affect exchange rate behavior, it is the *joint* distribution of shocks to all currencies in the system that matters.

In the existing empirical target zone literature, the EMS has been incorrectly characterized as a system defined by bilateral pegs against the Deutschmark. I demonstrate below that this error has led to mis-specified tests of the fat-tailed proposition. In consequence, erroneous conclusions may have been drawn.

4. A simple three-currency example

For simplicity, and to permit a diagrammatic representation, I illustrate the distinction between bilateral and multilateral exchange rate systems in a three-currency framework, with an arbitrarily chosen numeraire. s_i and s_j are the two exchange rates against the numeraire, and, using triangular arbitrage (with exchange rates defined as logarithms), $(s_i - s_j)$ is the cross rate between the non-numeraire currencies.

In a bilateral system, central parities are defined solely against the numeraire currency. Call these CP_i and CP_j for s_i and s_j, respectively. Assuming a common width $\pm w$ for the fluctuation band, the constraints imposed by the system are:

$$CP_k - w \leq s_k \leq CP_k + w\,, \quad k = i \text{ or } j\,. \tag{1}$$

I call the fluctuation band defined by this restriction the *notional band*. The permitted combinations of exchange rates are described by the area inside the box $ABCD$ in Fig. 1.

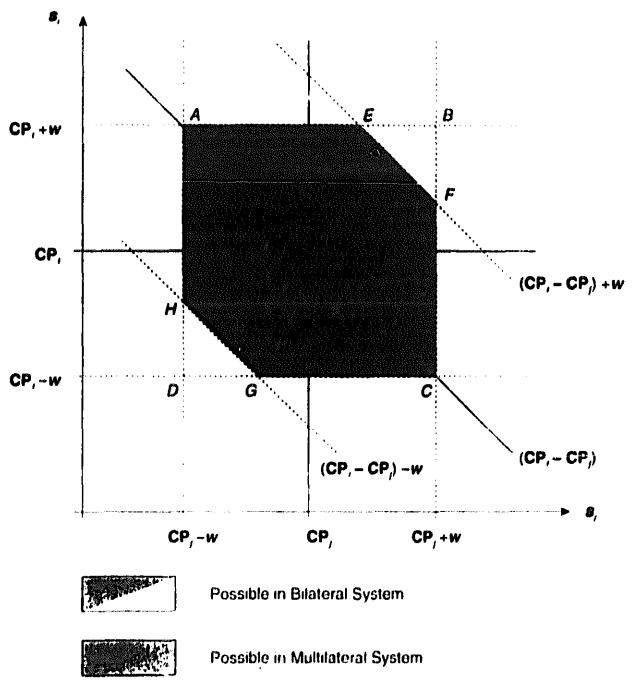

Fig. 1. Notional and effective bands in a three-currency system.

Note that the maximum permitted deviation of the cross rate $(s_i - s_j)$ from its implicit central parity $(CP_i - CP_j)$ – which occurs when the configuration of exchange rates is at point B or D – is greater than the band width w for the exchange rates against the numeraire (in geometric terms, this follows from the diagonal of a square being greater in length than one of its sides).

In a multilateral system such as the EMS, an explicit restriction is placed on the cross rate between the non-numeraire currencies. Consequently, in addition to the constraint (1) from above, the system requires:

$$(CP_i - CP_j) - w \leq (s_i - s_j) \leq (CP_i - CP_j) + w\,. \tag{2}$$

In Fig. 1, the configuration of exchange rates permitted by the system is now defined by the area enclosed within $AEFCGH$. Note that this is a smaller area than $ABCD$ – the restrictions imposed by the multilateral system are more onerous than those of the bilateral system.

Equivalently, Fig. 1 demonstrates that for certain values of the cross rate, the exchange rate against the numeraire cannot exploit the full width of its notional band. For example, if s_j is at its upper bound $(CP_j + w)$, s_i is constrained to the range FC, which is narrower than its notional band width, BC. The *effective band* is the permitted fluctuation range for an exchange rate against the numeraire that incorporates the additional restrictions imposed on cross rates by the multilateral nature of the system.

5. Implications for empirical tests of target zone models in EMS data

The exchange rate mechanism of the EMS is more complex than the simple three-currency system described above. The number of member currencies has varied through time, but has always exceeded seven. Moreover, the fluctuation bands vary in width across different currencies. Nevertheless, the issues raised by the multilateral nature of the EMS are identical to those identified above. Restrictions on cross rates between non-numeraire currencies impose additional constraints on the behavior of member currencies' Deutschmark exchange rates. Rates are confined to effective bands; these are narrower than the notional bands used in existing studies.

Fig. 2 illustrates this point. It compares the notional and effective bands for the Deutschmark exchange rate of members of the EMS narrow band during the (arbitrarily chosen) period 14 March–23 May 1988. Note that the effective band is narrower than the notional band; furthermore, the position of its center and its width both vary through time.

Existing empirical analyses of target zone models have analyzed the fat-tailed distribution result with respect to the notional bands against the Deutschmark. The models have failed such tests. However, this paper has demonstrated that the institutions of the EMS confine member exchange rates to effective bands that are necessarily narrower than the notional bands. Fig. 2 shows that an exchange rate confined to the effective band cannot be close to the edge of its notional band. Failure to observe fat-tailed frequency distributions with respect to notional bands is a logical implication of the institutional structure of the EMS. It cannot be

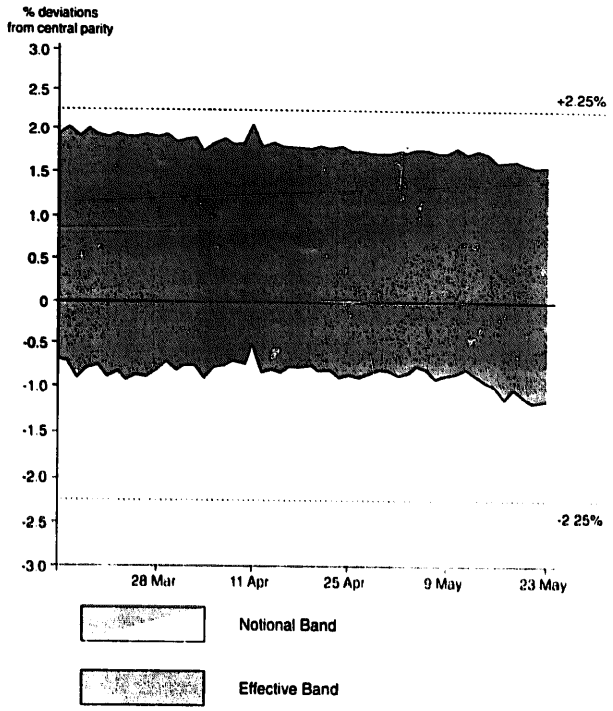

Fig. 2. Notional and effective bands for the narrow band members of the EMS 14 March–23 May 1988.

used as evidence against the applicability of simple, high credibility target zone models to EMS data.

The multilateral nature of the EMS has similar implications for alternative tests of target zone models such as the distribution of exchange rate volatility across the band. Failure to address these institutional issues correctly has resulted in tests of other theoretical restrictions being similarly mis-specified.

6. Conclusions

Existing empirical analyses of target zone models in EMS data are seriously flawed. They fail to incorporate correctly the multilateral nature of EMS institutions. Consequently, previous tests have been mis-specified. For example, failure to observe the fat-tailed distribution result with respect to the notional bands (that have been the focus of earlier studies) is a logical implication of the institutional structure of the EMS. It cannot be used as evidence against the simple target zone models and their assumption of perfect credibility and no intra-marginal intervention. Future empirical work using EMS data needs to address institutional issues more thoroughly. More widely, this paper highlights the importance of understanding the institutional context as we move from necessarily abstract models to confronting the data.

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