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# Border costs and real exchange rate dynamics in Europe☆

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## 1. Introduction

In the purchasing power parity (PPP) literature, it was traditionally assumed that transaction costs were incompatible with strong PPP or, alternatively, stationary real exchange rates (RERs). In recent years, however, the role of transaction costs has been reformulated so that they are viewed as leading to nonlinearities in RER adjustment by creating a no-arbitrage band around PPP equilibrium. A growing literature has emerged, which models nonlinearities in RER adjustment as either smooth transition autoregressive (STAR) or threshold autoregressive (TAR) processes.[1] In the TAR specification adopted below, RERs are conceptualised as exhibiting persistent dynamics within a no-arbitrage band of small deviations from equilibrium but mean reverting behaviour in the outer bands where large deviations trigger profitable arbitrage activity.

This paper seeks to provide a reconciliation between transaction costs and long-run PPP in a nonlinear framework. A TAR model is chosen since it squares

☆ This paper seeks to provide a reconciliation between transaction costs and long-run PPP in Europe by means of a nonlinear, TAR model. The threshold estimates, broadly interpreted as border costs, average six percent and can explain most RER volatility, while transport costs play only a minor role. Thus, a considerable degree of market segmentation still persists in Europe, especially in the peripheral economies.

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[1] For a sample of applications, see Baum, Caglayan, and Barkoulas (2000), Enders and Falk (1998), Michael, Nobay and Peel (1997), Obstfeld and Taylor (1997), O'Connell (1998), and Taylor, Peel and Sarno (2000). Obstfeld and Rogoff (2000) provide a general theoretical basis for the role of transactions costs in international economics and finance.


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better with theoretical exchange rate models such as the sticky price monetary model and with observed exchange rate behaviour such as volatility and overshooting or jumps in the short run. The model adopted is empirically vindicated by a parametric bootstrap test, which rejects the linear AR null against the TAR alternative at the 5% level. Moreover, the parameter estimates suggest widespread support for mean reverting RERs in contrast with the results from existing linear and TAR studies.

Ongoing capital and goods market integration make Europe an ideal testing ground for the continued significance of border costs for long-run PPP prior to the introduction of the single currency. Despite progress towards integration, perceived evidence of market segmentation has prompted policy responses such as the "rip-off" Britain campaign. The focus on European RERs is further justified by adopting an approach applied to North America by Engel and Rogers (1996). Using city-level disaggregated data, they show that national borders and distance still matter for the law of one price in North America and that transaction costs account for most RER volatility. However, the lack of comparable disaggregated European data dictates an initial focus on aggregate price indices and PPP.

The persistence of significant transaction—transport and border or menu—costs provides one rationale for applying TAR models to financial variables such as RERs. We posit symmetric TAR models for RERs in which the assumption of mirror image dynamics about parity can be justified by the idea that a true PPP definition must satisfy the base country invariance principle (Coakley & Fuertes, 2000a). The RER is defined as $q_t = s_t + p_t^* - p_t$, where $s_t$, $p_t^*$, and $p_t$ are the logarithms of the nominal exchange rate, foreign and domestic price indices, respectively. Given the use of price indices, the sample mean of $q_t$ is used to proxy parity as in Enders and Falk (1998). For the latter reason and to facilitate comparison of the estimated thresholds, the demeaned variable is analysed. The following Band-TAR specification is adopted (Eq. (1)):

$$\Delta z_t = A(t)^{\mathrm{L}} I_t(z_{t-d} < -\theta) + B(t) I_t(-\theta \le z_{t-d} \le \theta) + A(t)^{\mathrm{U}} I_t(z_{t-d} > \theta) + e_t \qquad (1)$$

$$A(t)^{\mathrm{L}} = \alpha_1(z_{t-1} + \theta) + \ldots + \alpha_p(z_{t-p} + \theta)$$

$$A(t)^{\mathrm{U}} = \alpha_1(z_{t-1} - \theta) + \ldots + \alpha_p(z_{t-p} - \theta)$$

$$B(t) = \beta_0 + \beta_1 z_{t-1} + \ldots + \beta_q z_{t-q}$$

where the superscripts U and L refer to the upper and lower bands, respectively, $I_t$ represents a Heaviside indicator function, which equals 1 when the relevant condition is fulfilled and 0 otherwise, $\theta$ is the threshold value, $d$ is the delay