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The behaviour of the real exchange rate: Evidence from regression quantiles

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Abstract

We test for mean reversion in real exchange rates using a recently developed unit root test for non-normal processes based on quantile autoregression inference in semi-parametric and non-parametric settings. The quantile regression approach allows us to directly capture the impact of different magnitudes of shocks that hit the real exchange rate, conditional on its past history, and can detect asymmetric, dynamic adjustment of the real exchange rate towards its long run equilibrium. It, therefore provides a detailed mapping of the real exchange rate behaviour, while being a robust alternative to previous unit root tests. The latter is confirmed by a simulation analysis comparing the power of the alternative tests. As concerns the real exchange rate, our results suggest that large shocks tend to induce strong mean reverting tendencies in the exchange rate, with half lives less than one year in the extreme quantiles. Mean reversion is faster when large shocks originate at points of large real exchange rate deviations from the long run equilibrium. However, in the absence of shocks no mean reversion is observed. Finally, we report asymmetries in the dynamic adjustment of the RER.

JEL classification: F31

Keywords: Real exchange rate; Purchasing power parity; Quantile regression

1. Introduction

Purchasing power parity (PPP) suggests that, in the absence of arbitrage, aggregate price levels of tradeable goods between two countries should be equal, if expressed in the same currency. It is a fundamental arbitrage relationship in international asset pricing and the simplest model of exchange rate determination. In this ability, PPP provides an equilibrium relationship for the real exchange rate (RER), which is the nominal exchange rate, adjusted for relative price levels. If PPP holds, the relative price levels and/or the bilateral nominal exchange rate would adjust in such a way so that the RER remain constant. In that sense, variations in the RER would suggest deviations from PPP.

Although intuitive theoretically, in practice the RER exhibits high variability over time and spends long periods away from its suggested PPP equilibrium. The ambiguity surrounding the persistence of the RER and the validity of PPP was evident in the early empirical attempts, which were clearly rejecting PPP. Nevertheless, it soon became obvious that a potential reason for this apparent failure was the underlying assumption of constant dynamics for the RER process. More specifically, the speed of adjustment towards the PPP equilibrium would be constant, no matter how far the RER is from its equilibrium value, or how big is the shock that hits the RER.

This belief was soon challenged by both theoretical and empirical research, which relied on arbitrage arguments to

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show that the speed of adjustment should vary according to the degree of disequilibrium from PPP (see amongst others Dumas, 1992; Michael et al., 1997; Obstfeld and Taylor, 1997; Taylor et al., 2001). Allowing for the RER to assume different speeds of adjustment spurred a large literature of increasingly sophisticated RER models, frequently relying on competing theoretical arguments about the causes and specification of the dynamic RER adjustment. Empirical evidence from this literature favours PPP. It shows that the speed of adjustment is much faster when the RER is far away from its PPP equilibrium, or when the RER is hit by large shocks. Under this reasoning, the early tests were only capturing an average behaviour of the RER and were therefore suffering from an upward bias when measuring the persistence of the RER.

Another relevant issue in the PPP literature concerns the potentially different speeds of adjustment for positive or negative deviations of the RER from its PPP equilibrium, i.e. the possibility of asymmetric mean reversion towards the RER equilibrium. Although the traditional arbitrage considerations suggest symmetric mean reversion, a more recent strand argues that asymmetries may arise as a result of intervention policies directed at the RER (Dutta and Leon, 2002; Leon and Najarian, 2005).

Against this backdrop, we introduce the recently developed semi- and non-parametric quantile regression inference in the context of the RER as an alternative robust unit root test, which, moreover, provides complimentary information on the RER behaviour. This is achieved because it does not focus on the conditional mean function – i.e. does not assume constant speed of adjustment. It rather studies a whole range of conditional quantile functions – i.e. allows for different and potentially asymmetric speed of adjustment at the different quantiles, depending primarily on the size of the shock that hits the RER and potentially also on the size of the RER deviation.[1] The robustness of the quantile unit root tests versus parametric, standard and non-standard unit root test alternatives is supported by a power simulation analysis.

The quantile approach offers novel contribution to the previous literature for various reasons. It adopts an agnostic approach towards the potential RER distribution and, consequently, an a-theoretical treatment of the causes and specification of the dynamic adjustment of the RER. This allows a more flexible and refined analysis of the RER behaviour. Furthermore, the shocks analysed are actual, observed shocks, whose sizes are determined endogenously by the model. This offers an original view into the role of shocks on the RER and enriches anecdotal evidence from the previous literature. In addition, the quantile approach reveals asymmetries in both the distribution of RER shocks and their impact on the RER mean reverting behaviour in a simple, intuitive and yet effective manner. In this way, the quantile unit root test is modified to incorporate the (potentially asymmetric) effects of various sizes of RER shocks and is therefore a robust alternative in cases of non-gaussian innovations compared to previous unit root tests. This suggestion is supported by a simulation exercise testing the power of the quantile unit root tests versus standard and non-standard unit root tests, when the true process is non-linear mean reverting.

More specifically, our results suggest that: (a) the dynamic behaviour of the RER is affected by the magnitude of RER shocks, with large RER shocks inducing potentially strong mean reverting tendencies. (b) When large shocks to the RER originate at large RER disequilibrium levels (i.e. far away from its PPP equilibrium), the effect can be even stronger. (c) On the contrary, small shocks to the RER considerably weaken mean reversion tendencies, irrespective of the disequilibrium point of the RER at the time of the shock. (d) There are marked asymmetries in the behaviour of the RER, i.e. extreme positive shocks (depreciations) can generate different reversion patterns than extreme negative shocks (appreciations) (e) The quantile unit root tests are robust alternatives to standard and non-standard unit root tests, when the data generating process is non-linear mean reverting. Overall, the quantile analysis provides original insights into the PPP literature while further refining and enhancing up-to-date results.

The paper proceeds as follows. Section 2 highlights the important aspects of the previous PPP literature with respect to the quantile method. Section 3 introduces the quantile regression techniques employed. Section 4 describes the data and performs some preliminary data analysis. Section 5 presents the empirical results from the semi-parametric and non-parametric quantile approach, and Section 6 concludes.

2. RER previous literature and the quantile approach

The stylised facts of the RER can be well summarized into two puzzles. The first one relates to the persistence of the RER process and, therefore, whether PPP could be seen, at least, as a long term anchor for the RER equilibrium value. The second puzzle (Rogoff, 1996) is trying to rationalise the persistence of the RER and reconcile its extremely volatile nature with the extremely slow rate at which shocks appear to damp out. This puzzle raises the

[1] Note that there is a delicate, but strong relationship between RER shocks and RER deviations from equilibrium. A shock hits the RER at a time t and has an observable impact on the RER at time $t+j$. A shock is equal to a RER deviation if they both occur at the same time interval studied and if the shock originates at equilibrium. However, shocks conditional on the past history of the RER can occur at any point of the RER distribution with respect to the equilibrium (i.e. can occur when the RER is below or above its long run equilibrium). Because of that, RER deviations can be the additive result of cumulative shocks to the RER and their values may no longer be equal.

The role of shocks in the RER behaviour is important and brought forward by both the second PPP puzzle (See Section 2) and previous empirical the literature (Taylor et al., 2001; Engel and Kim, 1999). The quantile approach, offers a more refined analysis on the effect of different shock sizes on RER behaviour – irrespective or not of the original disequilibrium point (size of deviation) – compared to previous models.