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Why panel tests of purchasing power parity should allow for heterogeneous mean reversion

Kees G. Koedijk [a,*], Ben Tims [b], Mathijs A. van Dijk [b]

[a] Tilburg University and CEPR, PO Box 90153, 5000 LE Tilburg, The Netherlands
[b] Rotterdam School of Management, Erasmus University, PO Box 1738, 3000 DR Rotterdam, The Netherlands

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A B S T R A C T

Recent studies of purchasing power parity (PPP) use panel tests that fail to take into account heterogeneity in the speed of mean reversion across real exchange rates. In contrast to several other severe restrictions of panel models and tests of PPP, the assumption of homogeneous mean reversion is still widely used and its consequences are virtually unexplored. This paper analyzes the properties of homogeneous and heterogeneous panel unit root testing methodologies. Using Monte Carlo simulation, we uncover important adverse properties of the panel approach that relies on homogeneous estimation and testing. More specifically, power functions are low and assume irregular shapes. Furthermore, homogeneous estimates of the mean reversion parameters exhibit potentially large biases. These properties can lead to misleading inferences on the validity of PPP. Our findings highlight the importance of allowing for heterogeneous estimation when testing for a unit root in panels of real exchange rates.

1. Introduction

Since the early 1990s, researchers interested in testing the hypothesis of purchasing power parity (PPP) have turned to panel tests to increase the statistical power.[1] Initial applications of panel models to real exchange rates imposed severe restrictions on the structure of the model. Two of these restrictions have

* Corresponding author. Tel.: +31 10 40 82300; fax: +31 10 40 89017.
E-mail addresses: c.koedijk@uvt.nl (K.G. Koedijk), btims@rsm.nl (B. Tims), madijk@rsm.nl (M.A. van Dijk).

[1] Examples of early panel PPP studies include Abuaf and Jorion (1990), Frankel and Rose (1996), and Jorion and Sweeney (1996). We refer to Rogoff (1996) and Taylor and Taylor (2004) for reviews of the literature.

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been successfully challenged. First, O'Connell (1998) questions the common assumption in panel PPP studies that the real exchange rates are cross-sectionally independent. He shows that spurious rejections of the unit root null can occur when cross-sectional dependence is neglected. In response to this critique, nearly all subsequent researchers relax this restriction and take cross-sectional dependence into account. Second, Papell and Theodoridis (2001) and Wu and Wu (2001) criticize the common restriction that the serial correlation properties of all real exchange rates in the panel are the same. Both papers show that assuming a restrictive homogeneous serial correlation structure weakens the evidence against the unit root null. In line with these findings, recent panel studies on PPP abandon this second restriction as well.

Yet, the use of a third important restriction on the structure of panel models of real exchange rates is still widespread in the academic literature on PPP. The vast majority of recent panel studies assume a common mean reversion coefficient across all real exchange rates.[2] From an economic perspective, the justification for the assumption that PPP holds equally well for all country pairs is weak. The speed of mean reversion of a real exchange rate between two countries should depend on, for example, their relative proximity, their mutual trade regulations, and the openness of their economies. The econometric consequences of imposing homogeneous mean reversion for the properties of panel PPP tests have not been thoroughly investigated to date. Exploratory research on the statistical properties of panel data models (notably Pesaran and Smith, 1995; Robertson and Symons, 1992) suggests that the homogeneity assumption in dynamic panel models may have serious consequences. Pooling heterogeneous panel data can lead to biases in the parameter estimates, as a result of which estimated half-lives are potentially misleading. An important question is to what extent this affects the inferences drawn from panel studies on the PPP hypothesis.

This paper compares the properties of three different panel estimation and testing methodologies for investigating PPP. The first involves homogeneous estimation of the mean reversion parameters and a unit root test on the validity of PPP for the full panel of real exchange rates. This methodology, or a variation thereof, is applied by a large number of recent empirical papers on PPP.[2] The second involves estimating the model heterogeneously, but still testing the PPP hypothesis jointly for all series in the panel. This means that while any inferences about PPP still concern the panel as a whole, the test allows for differences in mean reversion across countries. This approach is followed by, among others, Im et al. (2003), Taylor and Sarno (1998), and Wu and Wu (2001). In addition, we propose a third methodology in which both estimation and testing are heterogeneous.

We employ Monte Carlo simulation to examine the performance of the three panel methodologies. Our Monte Carlo experiments are based on a sample of the real exchange rates between five of the world's largest economies (Canada, the Euro area, Japan, the U.K., and the U.S.) over the period 1978:12–2003:12. Our simulations include "mixed" panels (consisting of stationary and non-stationary series) as well as "heterogeneous" panels (consisting of stationary series with different mean reversion parameters).

We show that when the mean reversion is heterogeneous across real exchange rates, the methodology with homogeneous estimation and testing suffers from important adverse properties. First, the homogeneous estimates of the mean reversion parameter exhibit serious biases. Second, large estimation uncertainties arise as a result of the homogeneity restriction. This implies that the statistical power of the homogeneous test against the unit root null is generally limited. Third, the power function is not monotonically increasing when the mean reversion parameters generated under the alternative hypothesis move away from the unit root null. These properties are observed in both mixed and heterogeneous panels and are robust to the number and the composition of real exchange rates in the panel.

We are among the first to carry out a systematic examination of the estimation biases and the power properties of panel tests of PPP under homogeneous mean reversion.[3] Our finding of non-monotonic

[2] Recent examples include Choi (2004), Fleissig and Strauss (2000), Frankel and Rose (1996), Jorion and Sweeney (1996), Levin et al. (2002), Lopez and Papell (2007), O'Connell (1998), Papell (1997, 2002, 2006), and Papell and Theodoridis (2001). Lothian (1997) also reports the results of panel tests with homogeneous mean reversion, but the focus of his study is on cross-country regressions of real exchange rate changes on nominal exchange rate changes.

[3] Breuer et al. (2001, 2002) also study the properties of panel unit root tests to assess the PPP hypotheses. However, they do not present power functions and they mainly focus on comparing heterogeneous panel unit root tests with univariate unit root tests.