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Purchasing Power Parity and unit root tests using panel data

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This paper reports the results of unit root tests for real exchange rates using a panel framework. This panel approach provides greatly improved power compared to conventional univariate time series unit root tests. We obtain evidence supporting PPP over the recent flexible exchange rate period for G-6 and OECD countries. We show explicitly that failure to find such evidence in previous research was due to the low power of the tests. (JEL F31). Copyright © 1996 Elsevier Science Ltd

Does Purchasing Power Parity (PPP) hold in exchange rate determination? Many papers have investigated this question. In recent years, as techniques for handling non-stationary data have rapidly developed, it has become natural to use such econometric tools in dealing with the long-run relationship between prices and the exchange rate.

Although almost universal agreement exists that PPP does not provide a good description of short-term exchange rate movements, no definitive evidence has been found as to whether PPP holds in the long run. In particular, many researchers who have used the cointegration framework or unit root tests of real exchange rates for the floating exchange rate period failed to find favorable evidence supporting PPP.[1] Using different samples and various testing methods, many papers have attempted to ascertain the reasons why PPP has not been supported in floating rate data.[2]

In this paper we are going to investigate PPP from the point of view of test power. As Dickey and Fuller (1979) and many other time series papers have shown, unit root tests have very low power unless the number of observations is large. As for PPP, Hakkio (1986) showed, using simulation, that when the real exchange rate has a near unit root, it is possible that the tests do not reject the null hypothesis of unit root.

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There may be several ways to overcome this low power problem.[3] One of them is to increase the amount of data by using very long time-series data. Kim (1990), Johnson (1990), Diebold *et al.* (1991) and Lothian and Taylor (1996) obtained some evidence for PPP from longer span data with various methodologies.[4]

In our study, we make use of panel data.[5] Pooled panel data sets for economic research possess several major advantages over conventional single time-series or cross sectional data sets (see Hsiao (1986)). Furthermore, panel analysis can provide dramatic improvement in the power of unit root tests by increasing the number of observations.[6] We will test whether PPP holds in the long run in panel data by investigating whether the real exchange rate has a unit root. The simple comparison of the power size for the tests will be illustrated for various numbers of observations and individuals. We will see how low the power of the unit root tests is and how much we can improve on it by using panel data.

In our investigation, favorable results for PPP are obtained with increased power of the test for G-6 and OECD countries during the flexible exchange rate period (1973–90). Using panel unit root tests, we show explicitly that the failure to find evidence of PPP in the previous research was due to lack of testing power.

In Sections I and II, we explain the asymptotic properties and small-sample-size analysis of unit root test statistics in the panel data. Next, in Section III we explain our testing method and the results from our investigation. In Section IV, comparison with the results from the conventional unit root test is provided to confirm our conclusion. The final section presents some brief conclusions.

I. Unit roots in panel data

In panel data, if the individual time series are weakly stationary, we have standard and normal asymptotic properties of regression analysis. But it is well known that if time series data are non-stationary, the asymptotic properties of standardized statistics are some functions of Brownian motion (see Phillips, 1987; Park and Phillips, 1989; and Hamilton, 1994).

Furthermore, we often see non-stationary time series data in the macroeconomics field (see Nelson and Plosser, 1982 or Stock, 1991). Therefore, it is natural to allow for non-stationary time series when we are dealing with panel data.

A few researchers have investigated unit roots in panel data. Breitung and Meyer (1991) and Quah (1992, 1994) derived the asymptotic distribution of the t-statistic for a model which has unit roots in the individual time series and have obtained standard normality from the model with i.i.d. disturbances and no individual specific effects. Levin and Lin (1992, 1993) have developed asymptotic theory under a more general model in the sense that it includes various models, especially with individual specific intercepts and time trends. Because we are going to use the model with individual specific intercepts, their papers serve as useful references.

In individual time series with unit roots, standard regression estimators and