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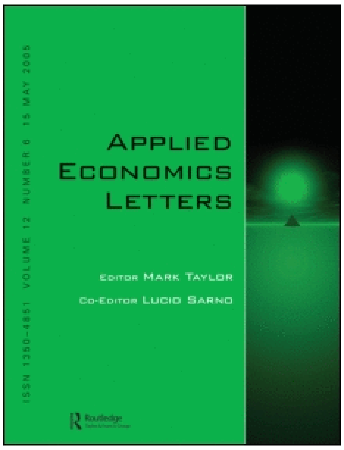

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Ruhul Salim [a]; Kamrul Hassan [a]
[a] School of Economics & Finance, Curtin University of Technology, Bently, Perth, Australia

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Does the relative population growth affect purchasing power parity?

Ruhul Salim* and Kamrul Hassan

School of Economics & Finance, Curtin University of Technology, Kent Street, Bently, Perth 6845, Australia

Relative population growth affects price levels through its effect on money demand and that in turn impacts Purchasing Power Parity (PPP). Standard time series econometrics is used to investigate this issue using data from 30 selected countries. The empirical results show that there is stable relationship between PPP exchange rate and relative population growth in selected countries in the long run. These findings demonstrate that population growth influences exchange rate determination through PPP.

> Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate
>
> Dornbusch and Krugman (1976, p. 540)

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I. Introduction

Purchasing Power Parity (PPP) is one of the most researched topics in International Finance. Majority of previous studies mostly focus on testing whether PPP holds in the long run. The recent developments in panel unit root and panel cointegration techniques accentuate further research on the mean reversion hypothesis of PPP (e.g. Taylor, 1988; Lothian and Taylor, 1996, 2000; Taylor, 2006; Narayan *et al.*, 2007; Narayan, 2008). However, this article aims to explain the behaviour of PPP exchange rate because of the movement of relative population growth. Stationarity of PPP in the long run implies cointegrating relationship between domestic and foreign price levels, which are functions of demand for and supply of money in any country. This article argues that relative population growth affects price levels through its effect on money demand and that in turn impacts PPP. There are a few studies which examine the relationship between population dynamics and real exchange rate. Aloy and Gente (2005) and Andersson and Österholm (2005) investigated that population structure affects real exchange rate through its impact on saving as postulated in the *life-cycle hypothesis*. Aloy and Gente used the overlapping generation model while Andersson and Österholm estimated the reduced form single equation in order to test their hypotheses empirically. However, this article intends to examine different hypothesis with regard to PPP exchange rate and relative population growth in a panel of 30 selected countries of the world.

This article proceeds as follows. Theoretical framework is developed in Section II followed by the econometric methodology in Section III. Section IV provides estimation and analysis of empirical findings. Concluding remarks and policy implications are given in the final section.

II. Theoretical Framework

The literature on PPP is heavily influenced by the so-called Harrod–Balassa–Samuelson (HBS) hypothesis. Although this hypothesis has been ruling the research works on PPP and real exchange rate since long, empirical results in favour of the HBS hypothesis

*Corresponding author. E-mail: ruhul.salim@cbs.curtin.edu.au

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are not convincing. Apart from a few exceptions, such as Lothian's (1990) work on Japanese exchange rate, the empirical evidence does not provide unique support for the HBS hypothesis (Sarno and Taylor, 2002). Earlier studies, such as Officer (1982), found little support for the HBS effect (Taylor and Taylor, 2004). Later studies also found only weak evidence in favour of the HBS effect. For example, Lothian and Taylor (2008), using data for nearly two centuries on sterling–dollar and franc–sterling real exchange rates, found that the HBS effect is present in case of only sterling–dollar, but not for franc–sterling real exchange rate. Given this mixed performances of the HBS hypothesis, this article aims to look into the issue of PPP exchange rate from a different perspective. This article argues that the behaviour of PPP exchange rate can sufficiently be explained by the movement of relative population growth.

The hypothesized relationship between PPP exchange rate and relative population growth is based on Monetary Approach to Exchange Rate (MAER). Monetary approach of exchange rate is a long-run theory as it does not allow for the price rigidities that seem to be important in explaining short-run macroeconomic fluctuations. Population growth rate and its impact on money demand is also a long-term process that justifies the possible link between population growth and PPP exchange rate. According to PPP, exchange rate between two countries' currencies is equal to the ratio of price levels of those countries. Let us consider two countries: Australia and the United States. Hence, PPP exchange rate of Australian dollar in terms of US dollars ($E_{AUS/\$}$) would be equal to the ratio of price level of Australia (P_{AUS}) to that of the United States (P_{USA}), i.e. $E_{AUS/\$} = P_{AUS}/P_{USA}$. According to MAER the price levels can be expressed in terms of supply of and demand for domestic monies. In Australia this is expressed as $P_{AUS} = M^S_{AUS}/L(Y_{AUS}, r_{AUS})$ and in the United States it is $P_{USA} = M^S_{USA}/L(Y_{USA}, r_{USA})$. Therefore, the exchange rate can be expressed as follows:

$$E_{AUS/\$} = \frac{M^S_{AUS}/L(Y_{AUS}, r_{AUS})}{M^S_{USA}/L(Y_{USA}, r_{USA})} = \left(\frac{M^S_{AUS}}{M^S_{USA}}\right)\left(\frac{L(Y_{USA}, r_{USA})}{L(Y_{AUS}, r_{AUS})}\right) \tag{1}$$

From Equation 1 it is apparent that the effects of demand for and supply of money in these two countries will have the following effect on Australia's exchange rate: (i) an increase in Australian money supply, other things equal, will cause Australia's exchange rate to depreciate; (ii) an increase in the US money supply, other things equal, will cause exchange rate to appreciate; (iii) an increase in the US money demand will depreciate the exchange rate; and (iv) an increase in Australian money demand will appreciate the exchange rate. Thus, the factors that affect demand for and supply of money and thereby price levels of respective countries are expected to have considerable impact on PPP exchange rate in the long run.

This article argues population growth as one of the factors that affect money demand. The most obvious channel through which population growth affects demand for money is transaction motive of holding money. Increase in the number of economic agents in the economy because of high population growth leads to increase in the transaction demand for money. In terms of Equation 1, if population growth of Australia relative to the United States is high so will be the demand for money in Australia. This will lead to the appreciation of PPP exchange rate of Australian dollar, i.e. number of Australian dollar per US dollar will decrease. Therefore, it can be argued that the relative population growth between two countries affects PPP exchange rate between their currencies considerably through its impact on money demand.

According to Baumol (1952) and Tobin (1956), there is a positive relationship between the transaction costs associated with obtaining money and the optimal amount of money held by individuals. Fair and Dominguez (1991) hypothesized that if the opportunity cost of bank visits is higher for prime age people, which seem likely, then people in their prime working years will demand more money relative to their transactions because the opportunity cost of their time is higher. Fair and Dominguez found statistically significant result in favour of this hypothesis on US data. Recently, Sterken (2004) found a significant positive association between population growth and money demand in Ethiopian economy. Higher population growth results in higher share of working age people which will give rise to higher demand for money and appreciation of PPP exchange rate. Thus, a negative relationship is hypothesized between PPP exchange rate and Relative Population Growth Rate (RPOPGR). This hypothesized negative relationship is also evident in the observed correlation coefficient between RPOPGR and PPP exchange rate (Appendix Table 1).

III. Methodology and Data

Unit root

There are several panel unit root tests in the standard time series econometrics. The three most widely popular methods are those proposed by Maddala and Wu

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(1999) [hereafter MW], Levin *et al*. (2002) [hereafter LLC] and Im *et al*. (2003) [hereafter IPS]. All these tests have their own limitations, such as LLC is applicable for homogeneous panel, where the Autoregressive (AR) coefficients for unit roots are assumed to be the same across cross-sections. Although IPS allows heterogeneous panels, a major criticism of both LLC and IPS tests is that they both require cross-sectional independence. Another problem with IPS test is that it is applicable for balanced panel. It appears that MW test, also called *Fisher*'s test, is suitable for the panel data under consideration, because it can also be used for unbalanced panel.

Panel cointegration

In the literature, residual-based approach and system approach have been suggested for testing cointegration in panel data set. Two widely used residual-based panel cointegration tests are those suggested by Kao (1999) and Pedroni (1999, 2004) and the system approach was suggested by Larsson *et al*. (2001). However, Monte Carlo comparison by Gutierrez (2003) showed that in homogeneous panels Kao's (1999) test has higher (lower) power than Pedroni's (1999) test when a small-T (high-T) is included in the panel. Gutierrez also showed that both these tests outperform Larsson *et al*.'s (2001) test. Based on this finding this study follows residual-based cointegration tests suggested by Pedroni.

Data source

A panel of 30 countries is used in this study (Appendix Table 2). While selecting the countries attention has been given so that countries from all stages of economic development are included in the sample. This is done to ensure that the phenomenon under study is not biased to any specific group of countries. Annual data series have been obtained from the Penn World Table (PWT) – 2006 over the period 1951 to 2005. PWT calculates PPP exchange rate over Gross Domestic Product (GDP), i.e. the PPP exchange rate is the national currency value of GDP divided by the real value of GDP in US dollars.

IV. Analysis of Empirical Results

This section reports and analyses panel unit root and cointegration test results. This article uses the two most popular panel unit root tests, namely, MW and Phillips-Person (PP) tests for testing unit roots in PPP exchange rates (PPP) and RPOPGRs. MW test results based on both Augmented Dickey and Fuller (ADF) and PP are shown in Table 1. In case of ADF, optimum lag length is chosen on the basis of Schwartz Information Criteria (SIC) and in case of PP Newey–West bandwidth is selected using Bartlett kernel.

Test results show that the variables under consideration contain unit root at their level. However, their first difference are stationary, i.e. the variables are $I(1)$. When variables are integrated to order 1, the next issue of interest in empirical research is to search for long-run relationship between them. Therefore, the cointegration analysis proposed by Pedroni (1999, 2004) is used next and the results are shown in Table 2.

Cointegration results are encouraging and show that the variables are cointegrated under both

Table 1. Panel unit root test

	Level		First difference	
Test	PPP	RPOPGR	PPP	RPOPGR
Fisher (ADF)	46.5110 (0.8607)	68.5811 (0.1612)	367.408 (0.000)	400.148 (0.000)
Fisher (PP)	29.2751 (0.9994)	61.7440 (0.3438)	356.245 (0.000)	442.902 (0.000)

Notes: Figures in the first line are test statistics and figures in the second line in parentheses are respective probabilities which are computed using an asymptotic Chi-square distribution.

Table 2. Panel cointegration test

Null hypothesis: No cointegration	Statistic	Probabilities	Weighted statistic	Probabilities
Alternative hypothesis: Common AR coefficients (within-dimension)				
Panel v-statistic	15.27340	0.0000	−3.61459	0.0006
Panel rho-statistic	7.5957	0.0000	4.9235	0.0000
Panel PP-statistic	16.2626	0.0000	3.7085	0.0004
Panel ADF-statistic	3.1332	0.0029	3.1059	0.0032
Alternative hypothesis: Individual AR coefficient (between-dimension)				
Group rho-statistic	6.6858	0.0000		
Group PP-statistic	6.1020	0.0000		
Group ADF-statistic	4.8489	0.0000		

Notes: Authors' calculations.

homogeneous and heterogeneous alternatives. All 11 test statistics are highly significant indicating a long-run equilibrium relationship between PPP exchange rate and relative population growth. This result suggests that there is a common stochastic trend between PPP exchange rate and relative population growth that makes it likely that these two variables move together in the selected countries.

V. Conclusion and Policy Implications

This article argues that RPOPGR has important role in explaining movement in national price levels through its impact on money demand and thus it affects the PPP exchange rate. This article relies on panel data and recent advances in panel unit root and panel cointegration in testing the long-run equilibrium relationship between RPOPGRs and PPP exchange rates for 30 countries and provides strong results supporting the hypothesis. This result has various major implications in International Economics in general and policy decisions in particular. Among others, the RPOPGRs have important role in explaining real exchange rate behaviour (Aloy and Gente, 2005). Moreover, it could also affect the international competitiveness of a country's goods and services. Hence, the role of relative population growth should be taken into account in dealing with issues in International Economics.

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Appendix

Table 1. Correlation between PPP and relative population growth

Country	Correlation	Country	Correlation
Algeria	−0.382 (0.01)	Singapore	−0.312 (0.037)
Japan	0.588 (0.000)	South Africa	−0.75 (0.000)
Australia	−0.568 (0.000)	Spain	−0.585 (0.000)
Bangladesh	−0.694 (0.00)	Sri Lanka	−0.847 (0.000)
Canada	−0.690 (0.000)	Sweden	−0.234 (0.088)
China	−0.127 (0.365)	Syria	−0.555 (0.000)
Italy	−0.528 (0.000)	Taiwan	−0.448 (0.001)
Luxembourg	−0.389 (0.004)	Tanzania	−0.462 (0.002)
Malaysia	−0.573 (0.000)	Thailand	−0.781 (0.000)
Mexico	−0.637 (0.000)	Tunisia	−0.451 (0.002)
New Zealand	−0.366 (0.006)	Turkey	−0.407 (0.002)
Norway	−0.275 (0.044)	UK	−0.108 (0.436)
Philippines	−0.345 (0.011)	Venezuela	−0.631 (0.000)
Qatar	−0.281 (0.10)	Zambia	−0.386 (0.006)
Romania	−0.464 (0.001)	Zimbabwe	−0.355 (0.012)

Notes: Authors' calculation using data from the Penn World Table – 2006. Figures in the parentheses are *p*-values.

Table 2. Country list

Algeria (1960–2003)	South Africa (1951–2003)
Australia (1951–2003)	Spain (1951–2003)
Bangladesh (1972–2003)	Sri Lanka (1951–2003)
Canada (1951–2003)	Sweden (1951–2003)
China (1952–2004)	Syria (1960–2003)
Italy (1951–2003)	Taiwan (1951–2003)
Luxembourg (1951–2004)	Tanzania (1960–2003)
Malaysia (1951–2004)	Thailand (1951–2003)
Mexico (1951–2004)	Tunisia (1961–2004)
New Zealand (1951–2004)	United Kingdom (1951–2003)
Norway (1951–2004)	Venezuela (1951–2004)
Japan (1951–2004)	Zambia (1955–2003)
Philippines (1951–2004)	Zimbabwe (1954–2003)
Qatar (1970–2003)	Turkey (1951–2003)
Singapore (1960–2004)	Rumania (1960–2004)

Notes: Data reference periods are given in parentheses.

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