1997

Purchasing Power Parity and Equilibrium Real Exchange Rate

Sarita Mohapatra
Utah State University

Basudeb Biswas
Utah State University

UtahStateUniversity
MERRILL-CAZIER LIBRARY

PURCHASING POWER PARITY AND EQUILIBRIUM

REAL EXCHANGE RATE

by

SARITA MOHAPATRA

BASUDEB BISWAS

Department of Economics
3530 University Boulevard
Utah State University
Logan, UT 84322-3530

PURCHASING POWER PARITY AND EQUILIBRIUM

REAL EXCHANGE RATE

Sarita Mohapatra, Lecturer
Basudeb Biswas, Professor

Department of Economics
3530 University Boulevard
Utah State University
Logan, UT 84322-3530

The analyses and views reported in this paper are those of the author. They are not necessarily endorsed by the Department of Economics or by Utah State University.

Utah State University is committed to the policy that all persons shall have equal access to its programs and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

Information on other titles in this series may be obtained from: Department of Economics, 3530 University Boulevard, Utah State University, Logan, Utah 84322-3530.

PURCHASING POWER PARITY AND EQUILIBRIUM

REAL EXCHANGE RATE

Sarita Mohapatra and Basudeb Biswas

ABSTRACT

The literature on the purchasing power parity (PPP) theory reports that all versions of the PPP theory do badly in explaining exchange rate movements in terms of changes in national price levels. If purchasing power parity holds true, the real exchange rate remains constant over time. The negative empirical results point to the failure of PPP. This paper contends that if the equilibrium real exchange rate has shifted over time due to real shocks, then what is interpreted as the failure of the PPP may not actually be so.

This paper investigates the issue and econometric tests indicate that the variable trend/cointegration implication is broadly consistent with the quarterly movements of bilateral exchange rates for the period 1973Q1 to 1993Q4 between the U.S. and other countries like Germany, Japan, U.K., and Switzerland. One implication of this study is that it can serve as a benchmark for determining the limits of the band of target zone models.

PURCHASING POWER PARITY AND EQUILIBRIUM
REAL EXCHANGE RATE

I. Introduction

The purchasing power parity (PPP) is Cassel's (1922) notion that exchange rates should tend to equalize relative price levels in different countries (Froot and Rogoff 1995). PPP states that any change in the nominal exchange rate between two currencies is determined by the countries' relative inflation rates. The implication is that if PPP holds, the real exchange rate remains constant over time. However, large short-run failures of PPP have been observed empirically. The objective of this paper is to assert that if the equilibrium has shifted over time due to real disturbances, then what is interpreted as the failure of the PPP may not actually be so. That is, the PPP may still hold within the framework of the equilibrium exchange rate. If there have been structural shifts in the real exchange rate due to real factors, then the conventional empirical tests for PPP, which do not account for these shifts, could give misleading results.

In recent literature, there have been numerous studies on PPP. We find three different specifications of the model to test for PPP. The univariate specification requires that the real exchange rate should be a stationary process. The unit root process is used to check for stationarity of the series. The second and third (bivariate and trivariate) specifications use the cointegration method to check for a long-run relationship between the exchange rate and price levels. The studies find evidence for PPP when the most general specification is used.

II. Tests of Simple PPP

The real exchange rate is empirically measured using the purchasing power approach. According to this approach, real exchange rate e_{PPP} is equal to the nominal exchange rate (E)

corrected by the price index. This is based on the law of one price. The law of one price implies that $P = EP^*$. Thus PPP-determined real exchange rate is calculated by multiplying the nominal exchange rate by the ratio of the foreign price (P^*) to the domestic price level (P), i.e.,

$$e_{ppp} = \frac{EP^*}{P}.$$ (1)

It has been observed that the nominal exchange rate changes, but this change is not preceded by changes in the price level. This is regarded as an example of the failure of the PPP theory. Empirical tests of PPP have been unable to reject the hypothesis that the real exchange rate follows a random walk. Studies by Roll (1979), Adler and Lehman (1983), Baillie and Selover (1987), Corbae and Ouliaris (1988), Enders (1988), Layton and Stark (1990), and Mark (1990) found the existence of unit roots in the real exchange rates or noncointegration between the nominal exchange rates and price ratio. However, Frenkel (1978, 1981), McNown and Wallace (1989), Taylor and McMohan (1988), Kim (1990), Canarella, Pollard, and Lai (1990), Cheung and Lai (1993), and Pippenger (1993) found evidence supporting the PPP. In these studies that find evidence supporting the PPP, the most general specification for the test of PPP is used. However, in most of these studies, the traditional concept of PPP is not actually being tested as these studies do not impose any restrictions on the coefficients of the cointegrating regression (Breuer 1994; and Edison, Gaynon, and Malick 1994).

Price Stickiness and Overshooting: An Alternative to PPP Assumption

Dornbusch's model (1976) explains the overshooting of the nominal exchange rate and the real exchange rate within a variant of the Mundell-Fleming model with perfect capital mobility. The model traces the consequences of an increase in the domestic money supply on the nominal

exchange rate and the real exchange rate both in the short run and the long run. In the short run, because of stick prices, there is a liquidity effect following a monetary expansion. That is, the interest rate falls and, as the interest parity theorem suggests, there is a capital inflow. With perfect capital mobility, demand for foreign currency increases and the domestic currency depreciates. The extended Mundell-Fleming model with perfect capital mobility, sluggish price adjustment, and rapid asset market or interest rate adjustment (Dornbusch 1976) explains this overshooting as a consequence of the combination of perfect foresight and instantaneous asset market adjustment. In the long run, the goods market adjusts, prices increase, and the exchange rate returns to its equilibrium value. Therefore, PPP may not hold in the short run due to instantaneous adjustment in the asset market and sluggish adjustment in the goods market. In a flexible price model, PPP should hold. But empirical studies have shown that PPP does not hold in the long run.

Speculative Bubbles

Excessive fluctuations in the exchange rates is also caused by "speculative bubbles." The exchange rates have fluctuated even when there are no movements in the macroeconomic fundamentals. Some economists have attributed the cause of the excessive variability of the exchange rates to the expectations of the speculators (Caves, Frankel, and Jones 1996). According to Caves et al., when the exchange rate is on the speculative bubble path, it wanders away from the equilibrium value dictated by macroeconomic fundamentals because of self-confirming expectations. In the long run, however, the bubble bursts and the exchange rate returns to its equilibrium value.

PPP Deviations are Permanent

However, if the variations are caused by permanent or real shocks, the real exchange rate will

not be a stationary process. The equilibrium exchange rate theory states that variability of real factors, rather than the variability in monetary factors, has been a major source of fluctuations (Stockman 1987). Empirically, the implication is that the data will be a nonstationary series. The real exchange rate changes in response to real shocks, such as changes in productivity, oil prices, and terms of trade.

The PPP theory helps us understand only the impact of monetary factors on fluctuations of the real exchange rate. The nominal factors would have a transitory effect on the real exchange rate. If there are changes in nominal factors, such as the money supply, the exchange rate will change to adjust to this shock. In the presence of real shocks, we need to find the equilibrium real exchange rate and then check for deviations from this equilibrium. The real exchange rate, as implied by the PPP theory, is constant and equal to one. However, in a dynamic world, changing conditions such as technological improvements and changes in terms of trade will determine the equilibrium real exchange rate. This equilibrium real exchange rate, rather than being constant, will be a path that the real exchange rate follows as the economy achieves equilibrium after a real shock. The real exchange rate is defined as the ratio of the price of tradables to the price of nontradables.

$$\frac{r_T}{P_{NT}}.$$

The "fundamentals" or the real factors, such as productivity shocks and terms of trade changes, determine the prices of tradables and nontradables. Therefore, these factors will also determine the equilibrium real exchange rate.

III. Empirical Framework

The Empirical Model

The unit root and cointegration tests are the two tests that have been used by these empirical studies to check the existence of a long-run relationship between the nominal exchange rate and the price levels. If the real exchange rate data series contains unit roots, then that implies that the real exchange rate is a random walk process and this is taken as evidence against PPP (Adler and Lehman 1983; Baillie and Selover 1987; Corbae and Ouliaris 1988; Enders 1988; Layton and Stark 1990; Mark 1990; and Roll 1979). According to the PPP definition of the real exchange rate given by equation (1), the log of the real exchange rate will be zero and

$$\ln E + \ln P - \ln P^* = \text{Ln } e = 0 \tag{2}$$

$$\ln E + \ln \frac{P}{P^*} = \text{Ln } e = 0. \tag{3}$$

If PPP holds, then there exists a linear long-run relationship between the nominal exchange rate and the price levels of the two countries. This is tested by using the method of cointegration. Two variables are cointegrated, if there exists a linear combination of these two variables integrated of order one, which is stationary. The recent empirical studies on PPP have used the trivariate specification (E, P, P^*) in equation (2) or the bivariate specification (E, P/P^*) in equation (3). The presence of cointegration is taken as evidence of the PPP theory, as it indicates the existence of a long-run relationship between these variables.

However, it should be noted here that PPP holds when (i) there is cointegration, and (ii) the cointegrating vector is unique and equal to (1,1,-1) for the trivariate specification, and for the bivariate specification the cointegrating vector is equal to (1,-1). Further, absence of cointegration

should not be taken as evidence against PPP as many of the previous studies discussed above have done. In earlier studies, if the results did not find cointegration between the exchange rate and price levels, it was taken as evidence against PPP. The failure to reject the null hypothesis of noncointegration could be due to structural or permanent shifts in the variables. The cointegration tests could be misleading due to the presence of time-varying parameters. Most of these tests have been carried out in a time invariant framework. Canarella et al. (1990) point out that the acceptance of the null hypothesis may arise from structural instability of the cointegration regression, even when the relevant variables are cointegrated. Flynn and Boucher (1993) perform the cointegration tests while accounting for structural breaks in the data. They identify three structural breaks in the series and apply the Perron tests to check for unit root behavior. Canarella et al. (1990) have shown that the failure of the tests to reject the null hypothesis of no cointegration between the nominal exchange rate and the relative prices could be the outcome of structural changes. They also show that if the intertemporal instability is accounted for while testing for PPP, results support the long-run validity of the PPP theory. In the presence of a variable trend, the series could mimic a unit root process and thus give misleading results. So conventional tests that do not account for the variable trend may not give very accurate results.

Conventional Tests of PPP and Empirical
Results: Unit Root and Cointegration Tests
the Real Exchange Rate as Random Walk

In current literature, as mentioned earlier, results of empirical studies on PPP differ based on the model specification used. The studies that use a univariate approach always found evidence of unit roots in the real exchange rate series and thus concluded that PPP does not hold. In the bivariate and trivariate cases, we find presence of cointegrating vectors that contradicts the findings

of the univariate studies. In this paper, the unit root tests were performed on the univariate series and the cointegration tests were performed using the bivariate and trivariate specifications. The bivariate specification imposes the symmetry restriction. In the trivariate case, there is neither the symmetry nor the proportionality restriction. The symmetry restriction implies that the price coefficients are of the same magnitude but of opposite sign. The proportionality restriction implies that the price coefficients are (1,-1). The definition of PPP requires that these restrictions need to be imposed. In the absence of these restrictions the PPP theory is not actually being testes (Breuer 1994; and Edison et al. 1994). Cheung and Lai (1993) tested the three different specifications and found that in the univariate case the data did not provide any evidence for PPP. In the case of the bivariate and trivariate specifications, they found evidence of cointegration. The restrictions for proportionality were rejected in all but one case. The restriction of symmetry was rejected in three of the five cases. Cheung and Lai (1993) argue that when the symmetry and proportionality restriction is not supported by the data, its imposition, which leads to a bivariate or univariate model, can bias the test towards finding no cointegration.

So from the results obtained from studies, we get two distinctly different conclusions. The results from the univariate analyses using unit root tests provides evidence against PPP. The unrestricted cointegration results, on the other hand, provide better support for PPP holds. And the cointegration tests using the trivariate specification almost always find cointegration between price levels and exchange rates. The results from the bivariate specification are more ambiguous and to not offer quite as much support for the PPP. The methods used and conclusions derived from different empirical studies on PPP have been summarized in the flow chart (Chart 1) presented below.
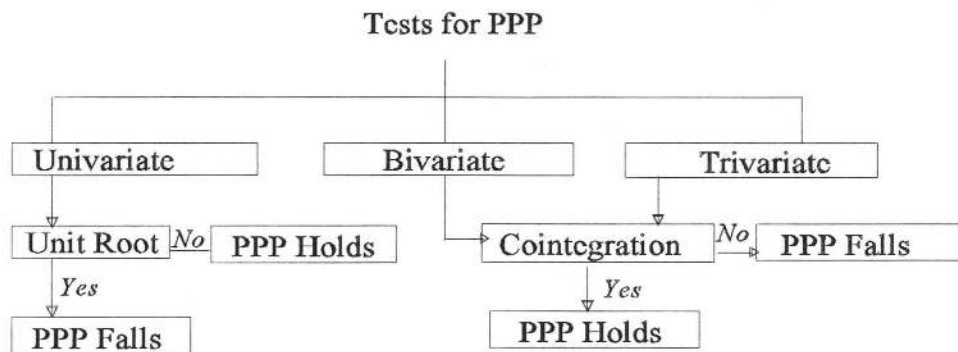
Tests for PPP

```
                    Tests for PPP
                         │
        ┌────────────────┼────────────────┐
  ┌───────────┐    ┌───────────┐    ┌───────────┐
  │ Univariate│    │ Bivariate │    │ Trivariate│
  └───────────┘    └───────────┘    └───────────┘
        │                │                │
        ▼                │                ▼
  ┌──────────┐ No ┌───────────┐    ┌─────────────┐ No ┌──────────┐
  │ Unit Root│───►│ PPP Holds │    │ Cointegration│──►│ PPP Falls│
  └──────────┘    └───────────┘    └─────────────┘    └──────────┘
      │ Yes                            │ Yes
      ▼                                ▼
  ┌──────────┐                   ┌───────────┐
  │ PPP Falls│                   │ PPP Holds │
  └──────────┘                   └───────────┘
```

Chart 1.

This paper tries to explain this issue of the discrepancy in the results of these different specifications. For the univariate results (Mohapatra, Biswas, and Snyder 1995), this can be attributed to incorrect modelling of the time series. Further, the study finds evidence of a variable trend in the data, thus implying structural changes in the time series. The presence of these structural or permanent shocks have been interpreted as random walk behavior of the real exchange rate. The finding is that PPP holds in the framework of a shifting equilibrium. The equilibrium real exchange rate is determined by real factors and changes due to real shocks to the system, such as oil price shocks.

The results from the cointegration tests do not tell us anything unless we find a unique cointegrating vector that satisfies the symmetry and proportionality restrictions. Thus finding cointegration between the nominal exchange rate and the price levels does not necessarily mean that PPP holds. Thus, what are perceived as contradictory results are not actually so. Unless we use an appropriate model to test our theory, the results that we obtain will be spurious. The modified flow chart (Chart 2) summarizes the methods and the conclusions from the findings, if we test for PPP using the appropriate models.
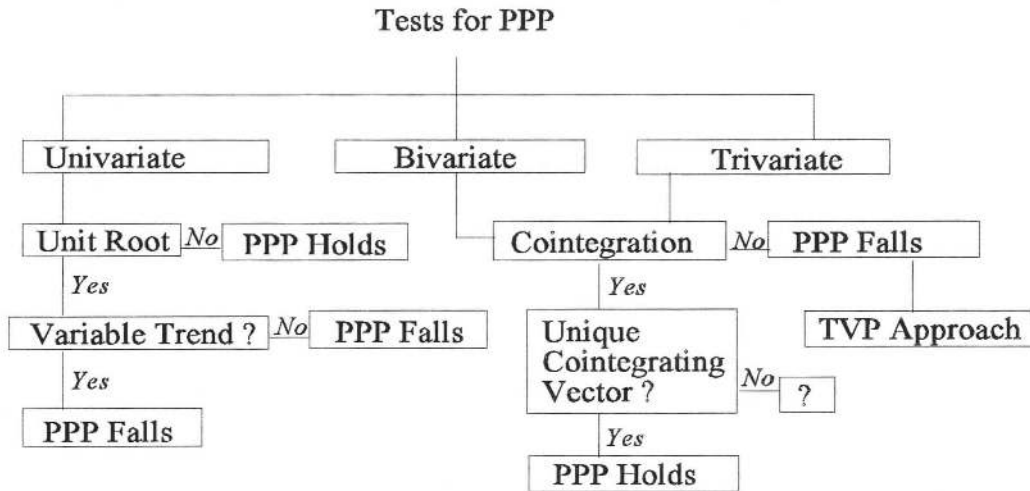
Tests for PPP

Chart 2.

IV. Data

The real exchange rate is measured as

$$e_1 = \frac{E\,WPI^*}{CPI} \tag{4}$$

$$e_2 = \frac{E\,CPI^*}{CPI} \tag{5}$$

where WPI* = wholesale price index of the foreign country (Germany, Japan, U.K., and Switzerland); CPI* = the consumer price indexes of the foreign country; and CPI = the consumer price index of domestic country (U.S.A.). The real exchange rate indexes have been constructed using quarterly data on nominal exchange rate (E) and price indexes of the two countries (P and P*) for the period 1973q1 to 1993q4 from DRI (1994).

V. Estimation Results and Analysis

Unit Root Tests

The unit root tests on the real exchange rate data were conducted. To test for unit root, we used the augmented Dickey Fuller (ADF) test. The summary of the results are reported in Table 1. The null hypothesis is that the variable has unit root. MacKinnon (1990) test statistics, which have been used as the test statistic, does not follow a standard *t*-distribution. The results of the ADF tests are reported in Table 1.

The results show that we fail to reject the null hypothesis at the 1% significance level. The results for the first differences of the variables show that the null hypothesis can be rejected. Thus the real exchange rate is integrated of the order one or are I(1).

The univariate specification used for this test is the most restrictive and therefore tests for PPP in the true Casselian sense. The empirical results suggest that PPP does not hold. However, if the series contains a variable trend, then the results form the unit root tests could be misleading. As the evidence (Mohapatra, Biswas, and Snyder 1995) shows that real exchange rate data does contain variable trend, we can say that once the structural shocks are accounted for, the data is really

Table 1. Augmented Dickey-Fuller Test for a Unit Root

Variable	Germany	Japan	Switzerland	U.K.
Le	-1.4275	-1.6449	-1.7243	-0.8596
	(-3.4696)	(-3.4704)	(-3.4696)	(-3.4730)
D(Le)	-4.5448*	-5.0886*	-4.7646*	-4.5273*
	(-3.4704)	(-3.4713)	(-3.4704)	(-3.4739)

*Dickey-Fuller *t*-statistic significant at 5%.

stationary. The implication of this finding is, if we model the equilibrium as a shifting one, the deviations from the equilibrium are not very large. Thus PPP holds, but as the equilibrium changes over time, we need a model that allows for the real exchange rate to adjust to real shocks. the use of a stochastic or variable trend does that.

The cointegration tests were then conducted using the bivariate and the trivariate specifications. The models used are as follows:

$$\ln E = \alpha_1 + \alpha_2 \ln P - \alpha_3 \ln P^* + u_t \tag{6}$$

$$\ln E = \alpha_1 + \alpha_2 \ln \frac{P}{P^*} + u_t \tag{7}$$

where E is the nominal exchange rate, and α_1 is a constant. In the presence of transportation costs, it will be a positive number. The regression coefficients α_2 and α_3 in equations (6) and (7) should be equal to 1 if PPP holds. Testing for cointegration means looking for a stable linear relationship among economic variables. If the results indicate the absence of cointegration, it means that there is no linear long-run stable relationship between the variables. Further, if symmetry holds, then in equation (6), α_2 should be equal to $-\alpha_3$. And if proportionality holds, then $\alpha_2 = -\alpha_3 = 1$.

Tests for Cointegration

Engle and Granger (1987), Stock and Watson (1988), and Johansen (1988) have suggested alternative tests for cointegration and methods of estimating cointegrating vectors. The common factor in each of these tests is that each one tries to find the most stationary linear combinations of the vector time series. The Johansen cointegration test is used in this paper. The Johansen method uses the maximum-likelihood method of estimation. This method was chosen over the

Engle-Granger two-step method, because, in the latter, the results vary depending on the variable specified as the dependent variable (Dickey, Jensen, and Thornton 1991). This problem does not arise in the Johansen method as all variables are treated as endogenous, and an a priori specification of the direction is not required. The Johansen method estimates the cointegrating vector and the common trends based on the lagged levels of the variables. The Engle-Granger method does not use the lag information.

The cointegration specifications of equations (6) and (7) are

$$\beta_1 \ln E - \beta_2 \ln P - \beta_3 \ln P^* = \ln u_t \tag{8}$$

$$\beta_1 \ln E - \beta_2 \ln \frac{P}{P^*} = \ln u_t \tag{9}$$

Empirical Results of the Cointegration Tests
of PPP

The results of the cointegration tests are reported in Tables 2 and 3. There are two test statistics for the number of cointegrating vectors: the trace and the maximum eigen value statistics. In the trace test, the null hypothesis is that the number of cointegrating vectors is less than or equal to k. In this case, k = 0, 1, 2, or 3. In each case, the null hypothesis is tested against the general alternative. In the case of the eigen value test, the null hypothesis k = 0 is tested against k = 1, 2, etc. In the case of the trivariate case, we reject the null hypothesis for k = 0 for the trace as well as the max. eigen values. For the null hypothesis k = 1 and k = 2, we fail to reject in all the cases except for United Kingdom. However, for United Kingdom, we fail to reject k = 1. This indicates that the variables are cointegrated and there are two cointegrating vectors except for United Kingdom, which has one cointegrating vector. However, when the restrictions are imposed and the

Wald test is conducted, the results reject the symmetry and proportionality restrictions and thus the existence of a unique cointegrating vector.

In the bivariate case, we are unable to reject the null hypothesis for k = 0 for the trace as well as the max. eigen values in all cases except Switzerland. However, for Switzerland data, we fail to reject k = 1. This indicates that the variables are not cointegrated except for Switzerland, which has one cointegrating vector. However, when the restrictions are imposed and the Wald test is conducted, the results reject the symmetry and proportionality restrictions and thus the existence of a unique cointegrating vector.

Conclusion

The results imply that PPP may hold within a framework of a shifting equilibrium. The presence of a variable trend in the real exchange rate implies that there have been structural changes

Table 2. Empirical Results from the Trivariate Cointegration Tests

	Null	Alt	Maximal Eigen Value Test Statistic		Trace Test Statistic Statistics		Restrictions $(\beta_1=\beta_2=\beta_3=1)$ χ^2 Test	
Germany e_1	r = 0	r = 1	97.74	(20.97)	119.56	(29.68)	12.869	(0.000)
	r ≤ 1	r = 2	21.82	(14.07)	29.84	(15.41)		
Germany e_2	r = 0	r = 1	55.36	(20.98)	74.89	(29.68)	16.081	(0.000)
	r ≤ 1	r = 2	19.15	(14.07)	19.53	(15.41)		
Japan e_1	r = 0	r = 1	80.50	(20.97)	103.79	(29.68)	17.312	(0.000)
	r ≤ 1	r = 2	22.78	(14.07)	23.28	(15.41)		
Japan e_2	r = 0	r = 1	49.18	(20.97)	74.53	(29.68)	13.163	(0.000)
	r ≤ 1	r = 2	25.30	(14.07)	25.34	(15.41)		
Switzerland e_1	r = 0	r = 1	95.58	(20.97)	111.75	(29.68)	10.487	(0.001)
	r ≤ 1	r = 2	14.88	(14.07)	16.17	(15.41)		
Switzerland e_2	r = 0	r = 1	73.72	(20.97)	77.52	(29.68)	64.479	(0.000)
United Kingdom e_1	r = 0	r = 1	67.43	(20.97)	74.80	(29.68)	60.199	(0.000)

Table 3. Empirical Results from the Bivariate Cointegration Tests

	Null	Alt	Maximal Eigen Value Test Statistic		Trace Test Statistic		Restrictions $(\beta_1=\beta_2=1)$ χ^2 Test	
Germany e_1	$r=0$	$r \geq 1$	12.83	(14.07)	13.51	(15.41)	---	
Germany e_2	$r=0$	$r \geq 1$	13.67	(14.07)	15.40	(15.41)	---	
Japan e_1	$r=0$	$r \geq 1$	4.20	(14.07)	4.76	(15.41)	---	
Japan e_2	$r=0$	$r \geq 1$	10.70	(14.07)	11.68	(15.41)	---	
Switzerland e_1	$r=0$	$r \geq 1$	10.14	(14.07)	12.11	(15.41)	---	
Switzerland e_2	$r=0$	$r \geq 1$	14.45	(14.07)	17.00	(15.41)	11.869	(0.001)
United Kingdom e_1	$r=0$	$r \geq 1$	3.87	(14.07)	5.42	(15.41)	---	

in the series. Thus, if we account for these real shocks, using the variable trend, we find that the real exchange rate follows an equilibrium path that shifts over time. The absence of a unique cointegrating vector in a time invariant model does not contradict this finding. It suggests that, in a time invariant model, the real shocks cannot be captured nor can the concept of a shifting equilibrium. As Canarella et al. (1990) show, when parameter instability is accounted for, the data support PPP.

The objective of this analysis was to look at the various empirical studies on PPP and to provide an explanation about the vast discrepancies in the results. The different methods were examined and the conclusion was that all these studies point in one direction. The PPP theory may hold given an equilibrium real exchange rate that shifts over time in response to real shocks. Thus, as Frenkel (1976) suggested, rather than viewing PPP as a theory of exchange rate behavior, we should view it as a long-run relationship between exchange rate and price levels. Another important

conclusion of this study is that the equilibrium real exchange rate is not constant as PPP implies, but shifts over time with the variations in the real factors. The equilibrium level of the real exchange rate is determined by the "fundamentals" or the real factors. Within the framework of the equilibrium real exchange rate model, PPP, as a long-run relationship, holds.

These conclusions have important policy implications. The misalignment of the exchange rate cannot be corrected using monetary or other policy tools unless we understand the extent of the misalignment. We may end up overcorrecting if we do not account for adjustments to the changes int eh real factors, such as terms of trade, productivity, and oil price shocks. Another implication of this study is that it can serve as a benchmark for determining the limits of the band of target zone models. Williamson and Miller (1987) prescribe that the real exchange rate should not deviate more than 10% from the "fundamental equilibrium exchange rate." We are suggesting that the concept of shifting equilibrium will provide a reference point and hence a range for the notion of the "fundamental equilibrium exchange rate." Countries should agree that the exchange rates be kept within the zone limiting excessive fluctuations by adopting appropriate exchange rate-oriented policies.

References

Adler, Michael; and Bruce Lehman. "Deviations from Purchasing Power Parity in the Long Run." *J. Finance* 38(1983):1471-87.

Baillie, Richard T.; and David D. Selover. "Cointegration and Model of Exchange Rate Determination." *Internat. J. Forecasting* 3(1987):43-51.

Breuer, Janice Boucher. "An Assessment of the Evidence on Purchasing Power Parity." In John Williamson (ed.), *Estimating Equilibrium Exchange Rate*, Washington, D.C.: Institute for International Economics, 1994.

Canarella, Giorgio; Stephen K. Pollard; and Kon Lai. "Cointegration Between Exchange Rates and Relative Prices: Another View." *European Econ. Rev.* 34(1990):1303-22.

Cassel, Gustav. *Money and Foreign Exchange after 1914*. New York: Macmillan, 1922.

Caves, Richard; Jeffrey A. Frankel; and Ronald W. Jones. "World Trade and Payments: An Introduction." New York: Harper Collins, College Publishers, 1996.

Cheung, Yin Wong; and Kon S. Lai. "Long Run Purchasing Power Parity During the Recent Float." *J. Internat. Econ.* 34(1993):181-92.

Corbae, Dean; and Sam Ouliaris. "Cointegration and Tests of Purchasing Power Parity." *Rev. of Econ. and Stat.* 70(Aug. 1988):508-11.

Dornbusch, Rudiger. "Expectations and Exchange Rate Dynamics." *J.P.E.* 84(Dec. 1976):1161-76.

DRI. *The DRI/McGraw-Hill Encyclopedia of World Economics on CD-ROM*. New York: McGraw-Hill, 1994.

Edison, Hali; Joseph E. Gagnon; and William R. Malick. "Understanding the Empirical Literature on Purchasing Power Parity: The Post-Bretton Woods Era." International Finance Discussion Paper No. 465, Board of Governors, Washington, D.C., 1994.

Engle, Robert F.; and Charles W.J. Granger. "Co-Integration and Error Correction: Representation, Estimation and Testing." *Econometrica* (March 1978):251-76.

Enders, Walter. "Arima and Cointegration Tests of Purchasing Power Parity Under Fixed and Flexible Exchange Rate Regimes." *Rev. Econ. and Stat.* (Aug. 1988):504-8.

Flynn, N. Alston; and Janine L. Boucher. "Testing of Long-Run Purchasing Power Parity Using Alternative Methodologies." *J. Macroecon.* 15(Winter 1993):109-22.

Frenkel, Jacob A. "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence." *Scandinavian J. Econ.* 78(1976):200-24.

_____. "Purchasing Power Parity: Doctrinal Perspective and Evidence from the 1920s." *J. Internat. Econ.* 8(May 1978):169-91.

_____. "Collapse of the Purchasing Power Parity During the 1970s." *European Econ. Rev.* 16(Nov. 1981):145-65.

Froot, Kenneth A.; and Kenneth Rogoff. "Perspectives on PPP and Long-Run Real Exchange Rates." In G. Grossman and K. Roggoff, *Handbook Internat. Econ.*, Vol. III, Amsterdam: North Holland, 1995.

Johansen, Soren. "Statistical Analysis of Cointegration Vectors." *J. Econ. Dynamics and Control* (1988):231-54.

Kim, Yoonbai. "Purchasing Power Parity in the Long Run: A Cointegration Approach." *J. Money, Credit and Banking* 22(Nov. 1990):491-503.

Layton, Allan P.; and Jonathan P. Stark. "Cointegration as an Empirical Test of Purchasing Power Parity." *J. Macroecon.* 12(Winter 1990):125-36.

MacKinnon, James. "Critical Values for Cointegration Tests." In Robert Engle and Charles Granger, *Long Run Economic Relationships: Readings in Cointegration*, New York: Oxford Univ. Press, 1991.

Mark, Nelson C. "Real and Nominal Exchange Rates in the Long Run: An Empirical Investigation." *J. Internat. Econ.* 28(Feb. 1990):115-36.

McNown, Robert; and Mykes S. Wallace. "National Price Levels, Purchasing Parity and Cointegration: A Test of Four High Inflation Countries." *J. Internat. Money and Fin.* 8(Dec. 1989):533-45.

Mohapatra, Sarita; Basudeb Biswas; and Donald L. Snyder. "Variable Trend in the Real Exchange Rate." Paper presented at 70th Annual Conference of the Western Economic Association, San Diego, California, June 5-9, 1995.

Pippenger, Michael K. "Cointegration Tests of Purchasing Power Parity: The Case of Swiss Exchange Rates." *J. Internat. Money and Fin.* 12(1993):46-61.

Roll, Richard. "Violations of Purchasing Power Parity and the Implication for Efficient International Commodity Markets." In Marshall Sarnat and Giorgio Szego (eds.), *International Finance and Trade*, Cambridge, Mass.: Ballinger, 1979.

Stock, James H.; and Mark W. Watson. "Variable Trends in Economic Time Series." *J. Econ. Perspectives* 2(1988):147-74.

Stockman, Alan C. "The Equilibrium Approach to Exchange Rates." *Econ. Rev.* (Mar./Apr. 1987):12-30.

Taylor, Mark P.; and Patrick C. McMohan. "Long-Run Purchasing Power Parity in the 1920s." *European Econ. Rev.* 32(Jan. 1988):1369-81.

Williamson, John; and Marcus H. Miller. "Targets and Indicators: A Blueprint for the International Coordination of Macroeconomic Policies." *Policy Analyses in International Economics* 22 (Washington, D.C.: Institute for International Economics, 1987).