AN INTERNATIONAL COMPARISON OF PRICES AND
EXCHANGE RATES:
A NEW TEST OF PURCHASING POWER PARITY

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Discussion Paper No. 86.05

May 1986

ISSN 0811-6067

ISBN 0-86422-618-7

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1. INTRODUCTION

The relationship between exchange rates and prices that is depicted by the purchasing power parity (PPP) hypothesis is one of the oldest and the most controversial in the theory of exchange rate determination. The hypothesis in its 'absolute version' states that the exchange rate (the domestic currency cost of a unit of foreign currency) equals the ratio of domestic to foreign prices. The 'relative version' of the hypothesis states that the change in the exchange rate is equal to the inflation differential. Historically, the hypothesis has been subjected to varied interpretations. Some authors have held that PPP provides a basis for the determination of exchange rates with useful policy implications. Others have argued that PPP is an equilibrium relationship that leaves much to be explained. On an empirical level, many authors have found that PPP does not appear to hold very well, particularly over recent times since the return to flexible exchange rates among major currencies in the early 1970s.

The usual test of PPP found in the literature is to regress the spot exchange rate on relative prices for pairs of countries, and then test the hypothesis that the slope coefficient equals unity. In this paper we introduce a new methodology for testing PPP based on Divisia index numbers which has a number of attractive features. First, our approach is based on the experience of all major currencies jointly, rather than taking pairs of countries in isolation from the rest of the world. This multi-country approach is capable of capturing the effects of global shocks which might hit a number of currencies simultaneously. A second attractive feature of our methodology is

that it provides a test of PPP for each observation of the sample period, whereas the regression method provides a test for only the entire period. Finally, our test of PPP emerges as a natural extension of Theil's (1967) well-known methodology of Divisia moments of prices and quantities.

We commence in Section 2 by providing a brief history of the development of PPP theory together with a review of some recent empirical studies concerning the validity of the theory. Section 3 presents the analytical framework of the study, followed by its application to PPP in Section 4. The description of the data is given in Section 5. The empirical results are contained in Sections 6 and 7. Our empirical findings indicate that during the recent period of floating rates (i) PPP holds quite well as a long-run phenomenon; (ii) PPP does not hold in the short run; (iii) PPP holds even better among the European countries; and (iv) the long run in so far as PPP is concerned is about five years. The last section contains concluding comments.

2. A BRIEF HISTORY OF PURCHASING POWER PARITY AND SOME RECENT EMPIRICAL TESTS

As indicated in Dornbusch's (1985) recent survey, rudiments of the PPP doctrine date back to the Salamanca school in 16th century Spain and to the works of Gerrard de Malynes, writing in England at the end of the Tudor period, in 1601. During the mid-18th century and in the early part of the 19th century the Swedish, French and English bullionists made further statements of PPP theory. Some qualified PPP views have also been developed in the writings of the 19th century classical economists, including

in particular Ricardo, Wheatley and Mill. But it is Cassel, writing mainly during the 1920s, whose name is almost invariably the first connected to the theory. This history is reviewed exhaustively in Officer (1984).

The early writings on PPP are characterised by a diversity of opinions and a lack of professional consensus based, to a large extent, on a priori analytical considerations rather than on empirical grounds (Frenkel, 1978). It was not until the early 1960s that interest in the theory was revived with some empirical flavour. Based on the Ricardo-Harrod concepts of divergent international productivity levels and international real income comparisons, Balassa (1964) provided explicitly the hypothesis of a systematic bias in absolute PPP as a measure of the equilibrium exchange rate. Balassa's criticism of the absolute PPP theory is that the price of nontraded commodities in terms of traded commodities may differ systematically between countries. According to Balassa, the higher relative price of service at higher income levels leads to systematic differences between purchasing power parities and equilibrium exchange rates. This effect has found considerable support in empirical research on international real income and price comparisons (Kravis and Lipsey, 1978, 1983; Isard, 1977; Bhagwati, 1984). Officer (1984), however, raises some questions as to the validity of Balassa's thesis.

The PPP doctrine started receiving considerable attention with the move to flexible exchange rates in the early 1970s. Flood (1981) and Mussa (1982) hold that PPP cannot be expected to hold in the presence of real shocks. They consider domestic and foreign goods to be imperfect substitutes and that the terms of trade (the

real exchange rate) must adjust to the shock, and this will require divergent movements in the exchange rate and domestic and foreign price levels. In explaining PPP deviations, Dornbusch (1976) argues that if goods prices are sticky, then PPP deviations will arise.

Genberg (1978) analysed the relationship between exchange rates and relative price levels in a sample of 14 countries for periods of fixed and floating exchange rates. The comparison of PPP deviations in the two cases reveals that both the average size of the deviations and their duration are smaller under the fixed rate period 1957-66 than under the recent period of floating rates; and that the adjustable peg years of the late '60s fall in between.

Frenkel (1978) views the PPP doctrine as one which specifies a relationship between two variables (prices and exchange rates) without providing the details of the process which brings about such a relationship. He empirically examines the absolute and relative versions of PPP for alternative price indices, the homogeneity postulate, the relation between the short run and the long run, and the patterns of causality between prices and exchange rates covering the flexible exchange rate period of the 1920s. His estimates indicate that in most cases the data are consistent with the hypothesis that the elasticity of the exchange rate with respect to the price ratio is about unity, i.e., PPP theory held up reasonably well during the 1920s. There is, however, some controversy about this evidence as Krugman (1978), Bernholz (1982) and Junge (1984) have shown.

Frenkel (1981) has another study on the empirical record of

PPP during the 1970s. He finds that the predictions of the simple versions of PPP do not hold up. He examines the hypothesis that the departures from PPP are a US phenomenon, as well as the hypothesis that the departures are due to large changes in intersectoral relative price changes within the various economies. He proceeds to examine the question of whether national price levels have been independent of each other and, further, addresses the question of whether exchange rates and national price levels are comparable. Frenkel emphasises that there is an important intrinsic difference between exchange rates and national price levels which stem from the 'asset market theory' of exchange rate determination. This theory implies that the exchange rate, like the prices of other assets such as bonds and shares, is much more sensitive to expectations concerning future events than are national price levels. Consequently, deviations from PPP are likely to be the rule rather than the exception' (Frenkel, 1981, p.146). Frenkel's results are supported by Miller (1984).

Using a time series-cross sectional estimation procedure, Hakkio (1984) has been unable to reject the hypothesis that PPP holds in several currencies simultaneously. His results indicate that PPP is a long-run proposition, but one must allow for short-run deviations from PPP. The existence of long-run PPP has also been evidenced in the bilateral exchange rates of the US, Canada, Japan, and several European countries in the work of Rush and Husted (1985).

3. THE ANALYTICAL FRAMEWORK

Let there be n major countries in the world and let the price levels in these countries in terms of domestic currencies be

$$p_1', \dots, p_n'.$$

These price levels in terms of US dollars are

$$(3.1) \quad p_1'/s_1, \dots, p_n'/s_n,$$

where s_i is the exchange rate of country i , i.e., the domestic currency cost of \$US1. We write (3.1) as

$$p_1, \dots, p_n.$$

Let the US be the first country, so that $p_1 = p_1'$ as $s_1 = 1$.

Consider a consumer who purchases

$$q_1, \dots, q_n$$

from the n countries. The cost of this basket in US dollars is

$$p_1 q_1 + \dots + p_n q_n = M.$$

The share of country i in total expenditure is

$$w_i = \frac{p_i q_i}{M}, \quad i = 1, \dots, n.$$

Writing D for log-change operator [$Dx_t = \log x_t - \log x_{t-1}$], we define the Divisia price index for the n countries in terms of US dollars as

$$(3.2) \quad DP_t = \sum_{i=1}^n \bar{w}_{it} Dp_{it} = \sum_{i=1}^n \bar{w}_{it} Dp_{it}' - \sum_{i=1}^n \bar{w}_{it} Ds_{it},$$

where $\bar{w}_{it} = (w_{it} + w_{i,t-1})/2$ is the arithmetic average of w_i in periods t and $t-1$ and where the second step follows from $p_i = p'_i/s_i$ (so that $Dp_{it} = Dp'_{it} - Ds_{it}$). Let

$$(3.3) \quad DP'_t = \sum_{i=1}^n \bar{w}_{it} Dp'_{it}$$

be the Divisia index of inflation measured in terms of domestic currencies and

$$(3.4) \quad DS_t = \sum_{i=1}^n \bar{w}_{it} Ds_{it}$$

be the weighted average depreciation of the n currencies relative to the US dollar. Thus, from the third member of (3.2), we have

$$(3.5) \quad DP_t = DP'_t - DS_t.$$

Equation (3.5) states that world inflation measured in terms of US dollars (DP) equals the corresponding concept measured in terms of the domestic currencies (DP') minus the average depreciation of the n currencies.

The indexes defined above are weighted means of the price and exchange rate log-changes, $Dp_{1t}, \dots, Dp_{nt}, Dp'_{1t}, \dots, Dp'_{nt}, Ds_{1t}, \dots, Ds_{nt}$, the weights being the $\bar{w}_{it}$'s. These are the first-order Divisia moments of the Dp_i 's, Dp'_i 's and Ds_i 's. The corresponding second-order moments are the Divisia price and exchange rate variances which measure the degree to which the prices and exchange rates vary disproportionately across countries. We define the Divisia variance of prices in terms of US

dollars as

$$(3.6) \quad v_t^{pp} = \sum_{i=1}^n \bar{w}_{it} (Dp_{it} - DP_t)^2.$$

The corresponding concept in terms of domestic currencies is

$$(3.7) \quad v_t^{p'p'} = \sum_{i=1}^n \bar{w}_{it} (Dp'_{it} - DP'_t)^2.$$

Likewise, we define the Divisia exchange rate variance as

$$(3.8) \quad v_t^{ss} = \sum_{i=1}^n \bar{w}_{it} (Ds_{it} - DS_t)^2.$$

To measure the co-movement of prices and exchange rates across countries, we define the Divisia covariance of prices in US dollars and exchange rates as

$$(3.9) \quad v_t^{ps} = \sum_{i=1}^n \bar{w}_{it} (Dp_{it} - DP_t)(Ds_{it} - DS_t).$$

The corresponding measure in terms of domestic currencies is

$$(3.10) \quad v_t^{p's} = \sum_{i=1}^n \bar{w}_{it} (Dp'_{it} - DP'_t)(Ds_{it} - DS_t).$$

Substituting in (3.6) $Dp'_{it} - Ds_{it}$ for Dp_{it} and $DP'_t - DS_t$ for DP_t , we obtain

$$(3.11) \quad v_t^{pp} = v_t^{p'p'} + v_t^{ss} - 2v_t^{p's}.$$

In words, (3.11) states that the Divisia variance of prices in US

dollars equals the corresponding concept in terms of domestic currencies, plus the Divisia variance of exchange rates, minus twice the Divisia covariance between prices in domestic currencies and exchange rates. Similarly, we can express V_t^{PS} as follows:

$$(3.12) \quad V_t^{PS} = V_t^{p's} - V_t^{SS}.$$

Equation (3.12) states that the Divisia price-exchange covariance in US dollars equals the corresponding measure in domestic currencies minus the Divisia exchange rate variance.

4. APPLICATION TO PPP

We now apply the above concepts to PPP. The relative version of PPP states that the percentage change in the exchange rate is equal to the inflation differential. Thus we have

$$(4.1) \quad Ds_{it} = Dp'_{it} - Dp_{1t} + e_{it},$$

where Dp_{1t} is inflation in the US and e_{it} is the deviation from PPP. Under PPP the deviation e_{it} is zero,

$$(4.2) \quad e_{it} = 0 \quad i = 1, \dots, n.$$

Substituting (4.1) in (3.4), we obtain

$$(4.3) \quad DS_t = DP'_t - Dp_{1t} + E_t,$$

where $E_t = \sum_{i=1}^n \bar{w}_{it} e_{it}$ is the Divisia mean (or weighted mean) of the deviations from PPP. Equation (4.3) states that the n-country average change in exchange rates is equal to the difference between the n-country average inflation rate in terms of domestic currencies and that in the US, plus an average deviation.

We use (4.3) in (3.5) to obtain

$$(4.4) \quad DP_t = Dp_{1t} - E_t.$$

In view of (4.2), under PPP the second term of (4.4), E_t , vanishes. Thus under PPP, the n-country average inflation rate in US dollars (DP) equals inflation in the US (Dp_{1t}).

Subtracting (4.3) from (4.1), we have

$$(4.5) \quad Ds_{it} - DS_t = Dp'_{it} - DP'_t + e_{it} - E_t.$$

The left-hand side of this equation, $Ds_{it} - DS_t$, is the deviation of the change in the i^{th} exchange rate from the n-country average. We shall refer to this as the relative change in the exchange rate of country i . According to equation (4.5), this relative change equals the deviation of inflation in i from the n-country average, which is an inflation differential, plus a relative deviation, $e_{it} - E_t$. Note that the Divisia mean of the relative deviations is zero,

$$(4.6) \quad \sum_{i=1}^n \bar{w}_{it} (e_{it} - E_t) = 0.$$

We can derive the following testable implications of PPP

involving the Divisia variances of prices and exchange rates and their covariances. Substituting (4.5) in (3.8) we obtain

$$(4.7) \quad v_t^{ss} = v_t^{p'p'} + v_t^{ee} + 2v_t^{ep'},$$

where

$$(4.8) \quad v_t^{ee} = \sum_{i=1}^n \bar{w}_{it} (e_{it} - E_t)^2$$

is the Divisia variance of the PPP deviations, and

$$(4.9) \quad v_t^{ep'} = \sum_{i=1}^n \bar{w}_{it} (e_{it} - E_t) (Dp'_{it} - DP'_t)$$

is the Divisia covariance between the domestic currency prices and the PPP deviations. In view of (4.2), both (4.8) and (4.9) become zero under PPP, so that (4.7) reduces to

$$(4.10) \quad v_t^{ss} = v_t^{p'p'}.$$

In words, the exchange rate and domestic currency price variances coincide under PPP.

By definition, $Dp_{it} = Dp'_{it} - Ds_{it}$. Thus

$$(4.11) \quad Dp_{it} - DP_t = Dp'_{it} - Ds_{it} - DP_t.$$

Under PPP, equation (4.1) becomes

$$(4.12) \quad Ds_{it} = Dp'_{it} - Dp_{1t},$$

and (4.4) becomes

$$(4.13) \quad DP_t = DP_{1t}.$$

Combining (4.11)-(4.13), we obtain

$$(4.14) \quad DP_{it} - DP_t = 0.$$

In view of equation (3.6), (4.14) implies that

$$(4.15) \quad v_t^{pp} = 0.$$

Consequently, the PPP hypothesis implies that the Divisia variance of prices in US dollars vanishes.

Substituting (4.5) in (3.10) we get

$$v_t^{p's} = v_t^{p'p'} + v_t^{ep'}$$

which, in view of (4.2), reduces to

$$(4.16) \quad v_t^{p's} = v_t^{p'p'}.$$

Further, substituting (4.10) in (4.16) yields

$$(4.17) \quad v_t^{p's} = v_t^{ss},$$

so that (3.12) becomes

$$(4.18) \quad v_t^{PS} = 0$$

under PPP. Therefore, the PPP hypothesis implies (i) that the Divisia covariance between exchange rates and domestic currency prices coincides with the domestic currency price variance; and (ii) that the Divisia covariance between exchange rates and prices in terms of US dollars is zero.

The Divisia correlation coefficient between domestic currency prices and exchange rates, which measures the strength of the magnitude of the relationship between prices and exchange rates, is

$$(4.19) \quad \rho_t^{p's} = \frac{v_t^{p's}}{\sqrt{v_t^{ss} v_t^{p'p'}}} = \frac{v_t^{p'p'}}{\sqrt{v_t^{p'p'} v_t^{p'p'}}} = 1,$$

where the second step is based on (4.16) and (4.10). Thus PPP implies that domestic prices and exchange rates are perfectly correlated.

5. THE DATA

Our data consists of $n=7$ countries, namely, the US, the UK, France, West Germany, Canada, Japan and Italy. The data are quarterly, for the period 1973(3), which is generally viewed as start of floating, to 1982(4). Prices for each country (p_i') are measured by consumer prices and for the weights ($\bar{w}_i$) we use the GDP shares. Table 1 gives a summary of the data. Full details of the data sources are given in the Appendix.

TABLE 1

SUMMARY STATISTICS OF QUARTERLY EXCHANGE RATE CHANGES, INFLATION
RATES (CPI) AND GDP FOR 7 COUNTRIES, 1973(3)-1982(4)

Country	Average exchange rate log- change Ds_i	Standard deviation of exchange rate log- change	Average price log-change Dp'_i	Average inflation differential $(Dp'_i - Dp_i)$	Standard deviation of inflation differential	Exchange rate (domestic currency units per \$US 1)			Mean GDP share $\bar{w}_i$
						Maximum	Mean	Minimum	
	$\times 100$	$\times 100$	$\times 100$	$\times 100$	$\times 100$				$\times 100$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
United States	—	—	2.11	—	—	—	—	—	47.93
United Kingdom	1.09	.07	3.35	1.24	.02	.61	.49	.41	1.82
France	1.24	.08	2.69	.58	.01	7.14	4.85	4.04	8.89
West Germany	-.04	.08	1.20	-.91	.01	2.53	2.25	2.02	13.19
Canada	.54	.03	2.33	.22	.01	1.29	1.10	.97	4.81
Japan	-.33	.08	1.94	-.17	.02	305.15	252.85	189.50	17.78
Italy	2.40	.07	3.96	1.85	.02	1422.50	884.39	564.10	5.57

6. EMPIRICAL RESULTS

This section starts by using the data given in Table 1 to analyse the performance of PPP over the longer term. We then provide a similar analysis for every quarter of the sample period which can be interpreted as a test with short-run data. Finally, to analyse the role of the location of the countries we eliminate the non-European countries from the sample and redo the computations.

Long-run Data

As the data in Table 1 refer to averages over almost a decade, they can be used for analysing the long-run relationship between exchange rate changes and the inflation rates. PPP implies that the exchange rate changes should coincide with the inflation differentials. Columns (2) and (5) of Table 1 present data on these two variables. It is observed that these two variables are quite closely related for the six countries. This relation can be seen even more clearly when we plot these two variables in a scattergram, as in Figure 1. As can be seen, the points are scattered around a 45° line, suggesting a fairly close relationship between prices and exchange rates over a longer period of time.

We now compute the Divisia moments of these two variables, and the results are presented in the upper part of Table 2. Column (1) of the table gives the Divisia index of exchange rates, defined by equation (3.4). We substitute in this equation the average of Ds_{it} , given in column (2) of Table 1, and the average

Figure 1

Average Exchange Rate Log-change against
Average Inflation Differential: Long-run Data

TABLE 2

DIVISIA MOMENTS OF EXCHANGE RATES AND PRICES (CPI): LONG-RUN DATA

Exchange rate	Price index (domestic currency)	Price index (\$US)	US price log-change	Deviation from PPP	Variance of			Price-exchange rate	
					Exchange rate	Domestic currency price	\$US price	Covariance	Correlation coefficient
DS	DP'	DP	Dp ₁	E	v ^{ss}	v ^{p'p'}	v ^{pp}	v ^{p's}	ρ ^{p's}
× 100	× 100	× 100	× 100	× 100	× 10000	× 10000	× 10000	× 10000	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

7 Countries

.23	2.15	1.92	2.11	.19	.47	.36	.13	.35	.85
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4 European Countries

.88	2.31	1.43	2.11	.68	.86	1.18	.06	.99	.97
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of $\bar{w}_{it}$, given in column (10) of that table; a similar procedure is used for the application of the other measures to the long-run data. Columns (2) and (3) present the Divisia indexes for prices in domestic currencies and in US dollars, defined by equations (3.3) and (3.2), respectively. As can be seen, exchange rates depreciated by .23 percent per quarter on average over the decade, while prices in domestic currencies and in US dollars increased by 2.15 percent and 1.92 percent, respectively. Using equation (4.3), we calculate the average deviation from PPP as $E = DS - DP' + Dp_1 = .23 - 2.15 + 2.11 = .19$ percent per quarter, which is given in column (5) of Table 2.

Next, we calculate the Divisia variances of exchange rates and prices, defined in equations (3.6)-(3.8). Columns (6)-(8) give these variances. The domestic currency price-exchange rate covariance, defined in equation (3.10), and the corresponding correlation coefficient are presented in columns (9) and (10).

The results in the upper part of Table 2 lend themselves to the following interpretations. First, the figure of .13 for the variance of prices in US dollars, given in column (8), is small in comparison with the two other variances, .47 for V^{ss} and .36 for $V^{P'P'}$. This provides support to the prediction contained in equation (4.15) that $V^{PP} = 0$ under PPP. Second, the figures of .47 and .36 for the variances of exchange rates and domestic currency prices, given in columns (6) and (7), are quite close together, again in accordance with the implication of PPP contained in equation (4.10). Third, the value of the domestic currency price-exchange rate covariance of .35, given in column (9), is almost exactly

equal to that of the domestic currency price variance of .36. This covariance is also not too different from the exchange rate variance. This is also quite favourable to the implications of PPP contained in equations (4.16) and (4.17). Finally, from column (10), the value of the domestic currency price-exchange rate correlation coefficient is .85. This is obviously quite close to unity, as required by equation (4.19). In summary, the long-run data are certainly not inconsistent with the PPP hypothesis. The results in the lower part of Table 2 will be discussed subsequently.

Quarterly Data

In Table 3 we present in column (2) the 7-country average exchange rate change, and in column (3) the domestic currency average inflation rate. Column (4) of the table gives US inflation and (5) the Divisia mean of PPP deviations, defined below equation (4.3). As can be seen, on average exchange rates depreciated by about .19 percent per quarter while prices increased by about 2.12 percent. In the US prices rose by 2.11 percent on average. Consequently, the average deviation from PPP is $.19 - 2.12 + 2.11 = .18$ percent per quarter, as indicated by the last entry in column (5).

Figure 2 is the time-series version of Figure 1 with DS_t replacing the average exchange rate change for country i and similarly for the inflation differentials. As can be seen, there is almost no relation between the exchange rate changes and the inflation differential. Figure 3 plots these two variables against time. Although the relationship between the two variables is weak with the quarterly data, the above-mentioned long-run link between

TABLE 3

DIVISIA MOMENTS OF EXCHANGE RATES AND PRICES (CPI):
7 COUNTRIES, QUARTERLY DATA

Year/ Quarter	Exchange rate change	World inflation (domestic currencies)	US inflation	Deviation from PPP
	DS	DP'	Dp ₁	E
(1)	(2)	(3)	(4)	(5)
1973(4)	3.75	2.63	2.37	3.49
1974(1)	-1.08	3.90	2.66	-2.32
1974(2)	.95	3.07	2.81	.70
1974(3)	1.33	2.95	3.06	1.44
1974(4)	-1.91	2.99	2.86	-2.03
1975(1)	-1.42	2.56	1.76	-2.22
1975(2)	.07	2.08	1.53	-.48
1975(3)	3.64	1.87	2.20	3.98
1975(4)	-.22	1.83	1.57	-.49
1976(1)	.63	1.60	.97	.00
1976(2)	.22	1.93	1.25	-.47
1976(3)	-.72	1.43	1.51	-.64
1976(4)	.23	1.86	1.12	-.51
1977(1)	-.46	1.92	1.75	-.63
1977(2)	-1.01	2.20	2.16	-1.04
1977(3)	-.33	1.27	1.42	-.18
1977(4)	-3.59	1.31	1.14	-3.77
1978(1)	-2.21	1.35	1.64	-1.92
1978(2)	-1.56	2.16	2.62	-1.10
1978(3)	-3.09	1.68	2.31	-2.46
1978(4)	-.53	1.38	1.94	.03
1979(1)	2.01	1.88	2.52	2.65
1979(2)	.41	2.83	3.37	.95
1979(3)	-1.07	2.57	3.26	-.39
1979(4)	.93	2.49	2.87	1.31
1980(1)	4.35	3.34	3.75	4.77
1980(2)	-5.53	3.25	3.62	-5.17
1980(3)	.49	1.86	1.83	.45
1980(4)	1.55	2.29	2.61	1.88
1981(1)	3.28	2.33	2.61	3.55
1981(2)	4.85	2.37	2.30	4.78
1981(3)	.19	2.22	2.84	.80
1981(4)	-1.31	1.69	1.39	-1.61
1982(1)	4.30	1.14	.86	4.02
1982(2)	1.83	1.66	1.47	1.63
1982(3)	1.59	1.63	1.89	1.84
1982(4)	-3.64	.81	.22	-4.24
Mean	.19	2.12	2.11	.18

All entries are multiplied by 100.

Figure 2
Average Exchange Rate Change (DS) against
Average Inflation Differential ($DP' - DP_1$): Quarterly Data

Figure 3
Time Series of Average Exchange Rate Change (DS) and
Average Inflation Differential ($DP' - DP_1$): Quarterly Data

exchange rates and inflation can still be seen in Figure 3. If we smooth the exchange rate changes to take out the short-run variability, we get something that can be interpreted as the long-run change. Looking at Figure 3, this long-run, or underlying, change approximates the inflation differential.

Figure 4 presents a scattergram of the average exchange rate changes against the average deviation from PPP. As can be seen, there is a very strong relationship between the two variables. Under PPP, of course, there should be no relationship between these two variables.

In Table 4 column (2) gives the Divisia exchange rate variance, column (3) provides the Divisia variance of prices in terms of US dollars and the corresponding measure in terms of domestic currency is given in column (4). In columns (5) and (6) we present the Divisia covariance and correlation coefficient between exchange rates and prices in domestic currencies.

The following results emerge from Table 4. First, the US dollar price variance, instead of approaching zero as it should be under PPP, approximates exchange rate variance. Second, the exchange rate-price correlation is negative in 13 out of 37 cases. Third, average correlation coefficient of .15, while positive, is far away from unity. One can conclude from these results that the short-run variability in the exchange rates that took place during the 1970s does not reflect inflation differentials.

In summary, the results indicate that, in sharp contrast to the findings with the long-run data, PPP does not hold in the 1970s with quarterly data. This finding conforms to that of Frenkel (1981) and others.

Figure 4

Average Exchange Rate Change (DS)
against Average PPP Deviation (E): Quarterly Data

TABLE 4

DIVISIA VARIANCES AND COVARIANCES OF EXCHANGE RATES
AND PRICES (CPI): 7 COUNTRIES, QUARTERLY DATA

Year/ Quarter	Divisia variance of			Divisia price-exchange rate	
	Exchange rate	Prices (\$US)	Prices (domestic currency)	Covariance	Correlation coefficient
	v^{ss}	v^{pp}	$v^{p'p'}$	$v^{p's}$	$\rho^{p's}$
(1)	(2)	(3)	(4)	(5)	(6)
1973(4)	20.82	20.86	.65	.31	.08
1974(1)	6.36	11.51	5.98	.41	.07
1974(2)	1.60	2.07	1.06	.30	.23
1974(3)	4.65	6.07	.74	-.34	-.18
1974(4)	13.44	9.98	.82	2.14	.64
1975(1)	3.32	11.14	5.48	-1.17	-.27
1975(2)	3.77	2.76	1.14	1.07	.52
1975(3)	25.23	28.93	.61	-1.55	-.39
1975(4)	.51	.41	.36	.23	.54
1976(1)	25.78	20.61	.71	2.94	.69
1976(2)	1.50	3.00	1.50	.00	.00
1976(3)	7.49	5.70	.13	.96	.97
1976(4)	2.80	3.13	1.39	.53	.27
1977(1)	6.09	7.11	.67	-.18	-.09
1977(2)	1.98	2.44	.77	.16	.13
1977(3)	.38	.28	.47	.28	.68
1977(4)	20.45	19.21	.31	.77	.31
1978(1)	10.32	7.53	.34	1.57	.83
1978(2)	13.15	15.04	.82	-.53	-.16
1978(3)	14.19	9.26	.89	2.91	.82
1978(4)	7.69	8.40	.77	.03	.01
1979(1)	8.48	16.20	1.43	-3.15	-.91
1979(2)	2.95	3.74	.53	-.13	-.10
1979(3)	8.34	10.25	1.28	-.31	-.10
1979(4)	8.36	11.37	1.16	-.92	-.30
1980(1)	23.43	25.94	1.26	-.63	-.12
1980(2)	29.98	27.17	.57	1.69	.41
1980(3)	3.63	2.89	.90	.82	.45
1980(4)	19.08	17.96	1.09	1.10	.24
1981(1)	15.42	15.56	.61	.23	.08
1981(2)	31.88	30.30	.59	1.08	.25
1981(3)	4.34	7.92	1.25	-1.17	-.50
1981(4)	7.06	5.51	.77	1.16	.50
1982(1)	22.41	22.78	1.04	.34	.07
1982(2)	5.94	4.27	.43	1.05	.66
1982(3)	7.14	10.27	.69	-1.22	-.55
1982(4)	28.02	31.55	1.03	-1.25	-.23
Mean	11.30	11.87	1.09	.26	.15

All entries except those in the last column
are multiplied by 10,000.

The Intra-European Experience

Some authors have attempted to explain the departures from PPP as a US phenomenon. In doing that, they have carried out analyses with the European currencies only. These analyses produce a vastly improved performance for PPP during the 1970's (Frenkel, 1981; Miller, 1984). A number of explanations can be advanced why the performance of PPP should be better within Europe. The first is the geographical location leading to lower transactions costs between the neighbouring European countries. A second explanation involves commercial policies and other trade practices which, because of the existence of such agencies as the EEC, have been more stable within Europe. Another argument emphasises the various institutional arrangements in Europe such as the EMS which contribute to a more integrated European economy and a lower volatility of exchange rates (Frenkel, 1981). The implication of these considerations is that PPP is expected to hold better between the European countries.

We investigate the above hypothesis using our methodology by dropping the US, Canada and Japan from our sample and redoing the calculations for the UK, France, West Germany and Italy with both the long-run and quarterly data. The exchange rates for the European countries continue to be relative to the US dollar and US prices are still used as the foreign price in the computations. The results with the long-run data are presented in the lower part of Table 2. To compute, for example, DS [given in column (1) of the table] we use in equation (3.4) the averages of the Ds_{it} 's for the European countries, given in column (2) of Table 1, and the corresponding averages of the $\bar{w}_{it}$'s, given in column (10) of that

table; these average weights are now renormalised within Europe so that they sum to unity. A similar procedure is used to compute the other measures in Table 2. The long-run results indicate that PPP holds better for the European countries. The price-exchange rate correlation, for example, has increased from .85 to .97.

Table 5 presents the quarterly results for the European countries. Comparing these with Table 4 (7 countries), it can be seen that on average the 7 country exchange rates have changed more disproportionately than have the European rates (as the average value of v^{ss} in Table 4 is much larger than that in Table 5). The main result, however, is that the price-exchange rate correlation has more than doubled from an average of .15 for the 7 countries to .35 for the Europeans. Consequently, again the evidence supports the idea that PPP performs better between the European countries.

7. ADDITIONAL RESULTS

We also used the quarterly data to compute the Divisia correlation between exchange rates and deviations from PPP.¹ The results (not reported here in detail) indicated that the two variables are highly positively correlated, having an average correlation coefficient of .90. In addition, the correlation between domestic prices and the deviations turned out to be negative in most cases with an average of approximately zero.² Thus, on average, the quarterly deviations from PPP reflect exchange rate changes rather than inflation differentials.

Further, we also used alternative price indices and country

TABLE 5

DIVISIA VARIANCES AND COVARIANCES OF EXCHANGE RATES
AND PRICES (CPI): 4 EUROPEAN COUNTRIES, QUARTERLY DATA

Year/ Quarter	Divisia variance of			Divisia price-exchange rate	
	Exchange rate	Prices (\$US)	Price (domestic currency)	Covariance	Correlation coefficient
	v^{ss}	v^{pp}	$v^{p'p'}$	$v^{p's}$	$\rho^{p's}$
(1)	(2)	(3)	(4)	(5)	(6)
1973(4)	3.90	4.74	.15	-.34	-.44
1974(1)	17.19	11.01	.89	3.53	.90
1974(2)	1.18	4.44	1.86	-.69	-.47
1974(3)	5.69	11.88	1.85	-2.17	-.67
1974(4)	10.06	3.63	1.78	4.10	.97
1975(1)	1.46	12.75	13.79	1.25	.28
1975(2)	10.07	5.90	2.69	3.43	.66
1975(3)	2.56	5.42	.79	-1.03	-.73
1975(4)	.36	.21	.76	.45	.87
1976(1)	72.26	57.81	.87	7.65	.97
1976(2)	2.24	6.42	3.19	-.49	-.18
1976(3)	21.04	15.93	.38	2.74	.97
1976(4)	4.44	2.06	2.65	2.51	.73
1977(1)	.47	2.74	2.21	-.02	-.02
1977(2)	.63	.69	2.53	1.24	.98
1977(3)	.27	.24	.88	.46	.94
1977(4)	10.09	6.22	.56	2.21	.94
1978(1)	2.35	1.73	.39	.50	.53
1978(2)	3.44	10.39	2.07	-2.44	-.91
1978(3)	2.16	.12	1.52	1.78	.98
1978(4)	5.85	2.17	1.16	2.42	.93
1979(1)	1.05	2.49	.57	-.43	-.56
1979(2)	.93	2.09	.92	-.12	-.13
1979(3)	1.45	.06	1.84	1.62	.99
1979(4)	.66	2.79	2.82	.34	.25
1980(1)	4.20	8.77	2.56	-1.00	-.31
1980(2)	1.57	.85	1.30	1.01	.71
1980(3)	.95	3.07	1.88	-.12	-.09
1980(4)	3.70	6.04	2.57	.12	.04
1981(1)	4.00	2.00	.36	1.18	.98
1981(2)	.45	1.23	1.40	.31	.39
1981(3)	7.89	9.42	1.23	-.15	-.05
1981(4)	9.59	5.21	1.84	3.11	.74
1982(1)	1.34	.02	1.06	1.19	1.00
1982(2)	8.22	5.41	.62	1.72	.76
1982(3)	.51	2.43	1.64	-.14	-.15
1982(4)	8.79	9.87	2.16	.54	.12
Mean	6.30	6.17	1.83	.98	.35

All entries except those in the last column
are multiplied by 10,000.

weights. It is sometimes argued that PPP performs better with the wholesale price index (WPI). The reason is that the WPI gives a smaller weight to services which are nontraded goods. Of course, when the structure of relative prices in the economy remains stable, as is likely to be the case when most of the shocks are of monetary origin, the choice of the price index in the computation is immaterial (Frenkel, 1981).

Since the WPI is more heavily weighted towards traded goods, we also used exports as weights to reflect traded goods, rather than GDPs which also include nontraded goods. Table 6 gives a summary of the exports and WPI data. For ease of comparison, this table reproduces the exchange rates from Table 1. The data in this table again indicate a close long-run relationship between exchange rates and inflation rates. The information of this table is used to compute the Divisia moments of these two variables, as before, and the results are presented in Table 7 for the 7 countries as well as the 4 European countries. The price-exchange rate correlation for the 7 countries is .90 which is slightly higher than the corresponding figure in Table 2 (.85). On the other hand, for the European countries, the correlation in Table 7 is slightly below that in Table 2. Consequently, the use of the WPI does not significantly improve the performance of PPP with long-run data. The reason probably is that over the longer term real shocks to the economy tend to be reversed leaving the structure of relative prices more or less unchanged, so that the choice of the price index is basically immaterial.

The results involving the WPI and exports with the quarterly data are presented in Table 8. It may be seen that the average

TABLE 6

SUMMARY STATISTICS OF QUARTERLY EXCHANGE RATE CHANGES,
INFLATION RATES (WPI) AND EXPORTS FOR 7 COUNTRIES, 1973(3)-1982(4)

Country	Average exchange rate log- change Ds_i × 100	Standard deviation of exchange rate log- change × 100	Average price log- change Dp_i' × 100	Average inflation differential $(Dp_i' - Dp_1)$ × 100	Standard deviation of inflation differential × 100	Mean export share - w_i × 100
(1)	(2)	(3)	(4)	(5)	(6)	(7)
United States	-	-	2.12	-	-	24.28
United Kingdom	1.09	.07	3.51	1.39	.02	10.87
France	1.24	.08	2.32	.20	.03	12.18
West Germany	-.04	.08	1.36	-.75	.02	21.63
Canada	.54	.03	2.35	.23	.01	8.05
Japan	-.33	.08	1.63	-.49	.03	14.69
Italy	2.40	.07	4.01	1.90	.03	8.31

TABLE 7

DIVISIA MOMENTS OF EXCHANGE RATES AND PRICES (WPI): LONG-RUN DATA

Exchange rate	Price index (domestic currency)	Price index (\$US)	US Price log- change	Deviation from PPP	Variance of			Price-exchange rate	
					Exchange rate	Domestic currency price	\$US price	Covariance	Correlation coefficient
DS	D ^p	DP	Dp ₁	E	v ^{ss}	v ^{p'p'}	v ^{pp}	v ^{p's}	p ^{p's}
× 100	× 100	× 100	× 100	× 100	× 10000	× 10000	× 10000	× 10000	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<hr/>									
<u>7 Countries</u>									
.46	2.23	1.79	2.12	.35	.58	.66	.17	.56	.90
<u>4 European Countries</u>									
.87	2.44	1.57	2.12	.55	.75	1.10	.21	.83	.91

TABLE 8

DIVISIA VARIANCES AND COVARIANCES OF EXCHANGE RATES
AND PRICES (WPI): 7 COUNTRIES, QUARTERLY DATA

Year/ Quarter	Divisia variance of			Divisia price-exchange rate	
	Exchange rate	Prices (\$US)	Prices (domestic currency)	Covariance	Correlation coefficient
	V^{SS}	V^{PP}	$V^{P'P'}$	$V^{P'S}$	$\rho^{P'S}$
(1)	(2)	(3)	(4)	(5)	(6)
1973(4)	22.13	23.25	6.77	2.82	.23
1974(1)	9.42	9.28	12.60	6.37	.58
1974(2)	1.53	4.65	4.77	.83	.31
1974(3)	4.59	13.29	6.90	-.90	-.16
1974(4)	17.39	13.32	4.35	4.21	.48
1975(1)	3.41	6.12	5.15	1.22	.29
1975(2)	11.31	8.02	2.81	3.05	.54
1975(3)	27.82	33.36	1.34	-2.11	-.35
1975(4)	.73	.83	.70	.30	.42
1976(1)	39.44	23.57	2.86	9.36	.88
1976(2)	5.43	9.80	5.71	.67	.12
1976(3)	13.80	9.61	1.28	2.73	.65
1976(4)	4.37	5.87	3.20	.85	.23
1977(1)	6.49	7.76	4.68	1.71	.31
1977(2)	1.79	.67	1.87	1.50	.82
1977(3)	.60	2.01	1.31	-.05	-.06
1977(4)	20.16	15.28	.80	2.84	.71
1978(1)	11.44	5.74	1.19	3.45	.93
1978(2)	11.83	9.66	1.40	1.79	.44
1978(3)	14.37	9.40	1.78	3.38	.67
1978(4)	9.22	10.98	1.62	-.07	-.02
1979(1)	7.40	11.54	1.30	-1.42	-.46
1979(2)	4.45	4.63	.67	.24	.14
1979(3)	8.56	5.14	1.35	2.39	.70
1979(4)	7.03	5.30	1.62	1.67	.50
1980(1)	23.26	30.73	1.70	-2.89	-.46
1980(2)	21.87	28.83	1.56	-2.70	-.46
1980(3)	4.07	6.54	1.31	-.58	-.25
1980(4)	20.54	13.83	1.78	4.24	.70
1981(1)	15.81	17.69	1.95	.04	.01
1981(2)	36.64	30.93	1.27	3.49	.51
1981(3)	9.93	13.08	1.18	-.99	-.29
1981(4)	9.34	8.45	1.54	1.22	.32
1982(1)	15.99	15.17	.84	.83	.23
1982(2)	7.08	3.83	.76	2.00	.86
1982(3)	7.87	7.12	.53	.64	.31
1982(4)	30.42	30.34	.28	.18	.06
Mean	12.64	12.31	2.51	1.41	.28

All entries except those in the last column
are multiplied by 10,000.

value of the correlation coefficient is .28, higher than the corresponding figure in Table 4 (.15). This finding thus confirms the idea that PPP holds better with quarterly data when the WPI is used as a measure of prices and exports as weights.

Finally, we computed the Divisia price-exchange rate correlation coefficient with changes in prices and exchange rates over two quarters, three quarters and so on, up to thirty seven quarters.³ The reason for doing this is that as the changes involve periods which are further apart, we get closer to the long-run. Thus, going from one-quarter changes to the 37-quarter changes represents the transition from the short-run to the long-run. The results (using the CPI and GDP weights for the 7 countries) are presented in Table 9. We plot the averages of the correlation coefficients against the length of the change in Figure 5. It can be seen that the values increase with the length of the change and seem to stabilise in the range .80-.85 after about twenty quarters. It is to be noted that this upper asymptote is in agreement with the long-run value of the correlation given in Table 2 of .85. Thus, the results tend to identify 5 years as being a broad measure of the length of the long-run and provide further support to PPP as a long-run proposition.

8. CONCLUSION

This paper introduced a new approach to test the empirical content of the purchasing power parity doctrine. Instead of applying regression analysis for pairs of countries in isolation from the rest of the world, we formulated the PPP hypothesis in

TABLE 9

DIVISIA PRICE-EXCHANGE RATE CORRELATION COEFFICIENTS FOR
VARIOUS COUNTRIES (CPI): 7 COUNTRIES, QUARTERLY DATA

Year/ Quarter	Length of change (Quarters)																																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37			
1973(4)	.08																																							
1974(1)	.07	.26																																						
1974(2)	.23	.43	.35																																					
1974(3)	-.18	.11	.84	.46	.85																																			
1974(4)	.64	.63	.67	.82	.85	.94																																		
1975(1)	-.27	-.03	.19	.40	.61	.33	.85																																	
1975(2)	.52	-.07	.05	.17	.33	.53	.85	.64																																
1975(3)	-.39	.18	.34	.58	.32	.40	.86	.64	.70																															
1975(4)	.54	-.32	.21	.33	.57	.33	.85	.92	.87	.81	.85																													
1976(1)	.69	.67	.53	.61	.68	.80	.90	.87	.84	.86	.93	.91	.84																											
1976(2)	.00	.73	.72	.81	.70	.69	.71	.75	.84	.87	.91	.89	.96	.97	.89																									
1976(3)	.97	.41	.70	.69	.74	.75	.84	.87	.71	.89	.96	.97	.89	.90	.80	.79																								
1976(4)	.27	.51	.49	.74	.75	.84	.87	.71	.89	.96	.97	.89	.90	.80	.79	.74	.74																							
1977(1)	-.09	.13	.39	.31	.65	.65	.73	.76	.79	.81	.89	.90	.80	.79	.74	.74	.74																							
1977(2)	.13	.09	.10	.38	.28	.39	.59	.67	.69	.72	.74	.75	.76	.83	.85	.85	.85	.85																						
1977(3)	.68	.52	.21	.27	.52	.39	.67	.65	.72	.74	.75	.76	.83	.85	.85	.85	.85	.85	.85																					
1977(4)	.31	.39	.50	.35	.43	.30	.52	.50	.65	.64	.61	.60	.56	.55	.50	.48	.48	.48	.48	.48																				
1978(1)	.83	.65	.70	.60	.47	.34	.47	.33	.51	.48	.63	.60	.56	.55	.50	.48	.48	.48	.48	.48	.48																			
1978(2)	-.16	.44	.62	.67	.52	.41	.33	.45	.31	.46	.43	.53	.50	.48	.48	.48	.48	.48	.48	.48	.48	.48																		
1978(3)	.82	.44	.62	.70	.72	.61	.51	.42	.52	.38	.49	.45	.54	.50	.47	.46	.47	.46	.47	.46	.47	.46	.47	.46	.47	.46	.47	.46	.47	.46	.47	.46	.47	.46	.47	.46	.47			
1978(4)	.01	.69	.72	.76	.78	.77	.70	.62	.54	.62	.51	.61	.57	.66	.62	.57	.56	.57	.56	.57	.56	.57	.56	.57	.56	.57	.56	.57	.56	.57	.56	.57	.56	.57	.56	.57	.56			
1979(1)	-.91	-.67	.08	.72	.81	.82	.80	.77	.71	.63	.71	.62	.73	.71	.79	.76	.69	.67	.69	.70	.72	.74	.75	.76	.77	.76	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77		
1979(2)	-.10	-.80	-.55	-.02	.50	.74	.79	.78	.76	.70	.63	.72	.64	.77	.74	.83	.79	.73	.71	.73	.74	.75	.76	.77	.76	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77		
1979(3)	-.10	-.10	-.61	-.46	-.08	.28	.56	.69	.68	.69	.68	.61	.70	.65	.78	.76	.87	.84	.76	.72	.74	.75	.76	.77	.76	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77		
1979(4)	.30	.29	.24	.56	.45	.19	.03	.31	.54	.33	.59	.66	.67	.62	.73	.88	.87	.84	.76	.72	.74	.75	.76	.77	.76	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77		
1980(1)	-.12	-.35	-.54	-.54	-.67	-.57	-.41	-.29	.12	.59	.59	.66	.67	.62	.73	.88	.87	.84	.76	.72	.74	.75	.76	.77	.76	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77		
1980(2)	.41	.27	.32	.27	.04	-.39	-.25	.09	.38	.60	.69	.69	.67	.62	.73	.88	.87	.84	.76	.72	.74	.75	.76	.77	.76	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77	.77		
1980(3)	.45	.36	.31	.27	.42	-.06	-.42	-.25	.14	.46	.65	.71	.71	.70	.66	.63	.71	.68	.80	.79	.86	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84	.84		
1980(4)	.24	.36	.40	.39	.23	.33	.17	.20	.13	.38	.55	.68	.75	.75	.73	.67	.66	.73	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80		
1981(1)	.08	.30	.30	.53	.35	.26	.27	.12	.13	.13	.25	.44	.46	.40	.81	.80	.72	.67	.71	.78	.77	.86	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85		
1981(2)	.25	.17	.21	.28	.39	.26	.16	.12	.01	.16	.17	.01	.14	.36	.66	.70	.72	.67	.71	.78	.77	.86	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85		
1981(3)	-.50	-.23	.10	.09	.19	.41	.26	.14	.08	-.04	-.21	-.24	-.05	.12	.38	.58	.81	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83		
1981(4)	.50	.70	.40	.33	.39	.43	.60	.44	.35	.33	.22	.03	.02	.25	.38	.58	.81	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83		
1982(1)	.07	.59	.06	.19	.22	.31	.37	.53	.40	.38	.21	.11	-.06	-.09	.05	.17	.36	.67	.70	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75		
1982(2)	.66	.28	.41	.26	.28	.30	.37	.41	.55	.43	.32	.25	.15	-.01	-.04	.08	.19	.36	.67	.70	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75		
1982(3)	-.66	.28	.41	.26	.28	.30	.37	.41	.55	.43	.32	.25	.15	-.01	-.04	.08	.19	.36	.67	.70	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75		
1982(4)	-.55	-.14	-.05	.28	.00	.10	.16	.25	.30	.44	.35	.24	.16	.07	-.07	-.10	.00	.09	.23	.52	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55		
1983(1)	-.23	.17	.61	.52	.79	.60	.49	.47	.51	.54	.67	.56	.47	.44	.35	.19	.17	.32	.42	.56	.79	.81	.84	.82	.85	.89	.88	.88	.88	.88	.88	.88	.88	.88	.88	.88	.88			
Mean	.15	.21	.30	.35	.40	.42	.44	.46	.48	.53	.53	.53	.52	.52	.55	.57	.60	.63	.66	.71	.75	.78	.79	.81	.82	.83	.83	.84	.84	.85	.87	.87	.87	.87	.86	.85	.85			

Figure 5

Divisia Price-Exchange Rate Correlation Coefficient

terms of restrictions on the first and second-order moments of prices and exchange rate changes across countries. Our methodology, which is an extension of Thiel's (1967) Divisia index number analysis, is based on the joint experience of all major currencies simultaneously and provides a test of PPP for each observation of the sample period.

We used the new approach to test PPP with both short-run (quarterly) and long-run data from the 1970s and early 1980s. The evidence with the long-run data lends considerable support to PPP, in agreement with Hakkio (1984). Our empirical results also tend to identify five years as being a broad measure of the length of the long-run as far as PPP is concerned. The empirical results with the quarterly data, however, indicate that the predictions of PPP do not hold up at all well. This evidence is in line with that of Frenkel (1981) and others. We also found that PPP tends to hold better among the European countries.

DATA APPENDIX

The data for the period 1973(3) to 1982(4) were obtained from various issues of International Financial Statistics published by the IMF. Exchange rates are end of period (IFS code AE); income is nominal GDP (IFS code 99B); prices are CPI (IFS code 64) and WPI (IFS code 63); exports are under IFS code 70. A listing of all data used in the paper is available on request.

FOOTNOTES

1. This correlation coefficient is defined as

$$\rho_t^{es} = \frac{V_t^{es}}{\sqrt{V_t^{ee} V_t^{ss}}}$$

where

$$V_t^{es} = \sum_{i=1}^n \bar{w}_{it} (e_{it} - E_t) (Ds_{it} - DS_t)$$

and V_t^{ss} and V_t^{ee} are defined in equations (3.8) and (4.8), respectively.

2. This correlation coefficient is defined as

$$\rho_t^{ep'} = \frac{V_t^{ep'}}{\sqrt{V_t^{ee} V_t^{p'p'}}}$$

where $V_t^{ep'}$ and $V_t^{p'p'}$ are defined in equations (4.9) and (3.7), respectively.

3. These correlation coefficients are computed as:

$$\rho_t^{p's}(k) = \frac{V_t^{p's}(k)}{\sqrt{V_t^{p'p'}(k) V_t^{ss}(k)}} \quad k = 1, \dots, 37,$$

where

$$V_t^{p's}(k) = \sum_{i=1}^n \bar{w}_{it}(k) [Ds_{it}(k) - DS_t(k)] [Dp'_{it}(k) - DP'_t(k)];$$

$$V_t^{p'p'}(k) = \sum_{i=1}^n \bar{w}_{it}(k) [Dp'_{it}(k) - DP'_t(k)]^2;$$

$$V_t^{ss}(k) = \sum_{i=1}^n \bar{w}_{it}(k) [Ds_{it}(k) - DS_t(k)]^2;$$

$$Ds_{it}(k) = \log s_{it} - \log s_{i,t-k};$$

$$Dp'_{it}(k) = \log p'_{it} - \log p'_{i,t-k};$$

$$\bar{w}_{it}(k) = (w_{it} + w_{i,t-k}) / 2;$$

$$DS_t(k) = \sum_{i=1}^n \bar{w}_{it}(k) Ds_{it}(k); \text{ and}$$

$$DP'_t(k) = \sum_{i=1}^n \bar{w}_{it}(k) Dp'_{it}(k).$$

BIBLIOGRAPHY

- Balassa, B. (1964), "The Purchasing Power Parity: A Reappraisal".
Journal of Political Economy 72: 584-96.
- Bernholz, P. (1982), Flexible Exchange Rates in Historical Perspective, Princeton Studies in International Finance No.49, Princeton University Press.
- Bhagwati, J. (1984), "Why Services are Cheaper in Poorer Countries", Economic Journal 94: 279-286.
- Dornbusch, R. (1976), "Expectations and Exchange Rate Dynamics",
Journal of Political Economy 84:1161-76.
- (1985), "Purchasing Power Parity", New Palgrave Dictionary of Economics, (forthcoming).
- Flood, R.P. (1981), "Explanation of Exchange Rate Volatility and other Empirical Regularities in some Popular Models of Foreign Exchange Market", Carnegie-Rochester Conference Series on Public Policy 15: 219-250.
- Frenkel, J.A. (1978), "Purchasing Power Parity: Doctrinal Perspective and Evidence from the 1920s", Journal of International Economics 8:169-191.
- (1981), "The Collapse of Purchasing Power Parity during the 1970s", European Economic Review 16: 145-165.
- Genberg, H. (1978), "Purchasing Power Parity under Fixed and Flexible Exchange Rates", Journal of International Economics 8: 247-276.
- Hakkio, C.S. (1984), "A Re-examination of Purchasing Power Parity", Journal of International Economics 17:265-277.
- Isard, P. (1977), "How Far We Can Push the Law of One Price? ",
American Economic Review 67: 942-948.

- Junge, G. (1984), "Purchasing Power Parity in the 1920s and the 1970s", European Economic Review 26: 73-82.
- Kravis, I. and R. Lipsey (1978), "Price Behaviour in the Light of Balance of Payments Theories", Journal of International Economics 8: 193-246.
- (1983), "Toward an Explanation of National Price Levels", Princeton Studies in International Finance, No. 52, Princeton University Press.
- Krugman, P.R. (1978), "Purchasing Power Parity and Exchange Rates", Journal of International Economics 8: 397-407.
- Miller, S. (1984), "Purchasing Power Parity and Relative Price Variability", European Economic Review 16: 145-165.
- Mussa, M. (1982), "A Model of Exchange Rate Determination", Journal of Political Economy 90: 74-104.
- Officer, L.H. (1984), Purchasing Power Parity and Exchange Rates, Connecticut, JAI Press.
- Rush, M. and S. Husted (1985), "Purchasing Power Parity in the Long Run", Canadian Journal of Economics 1: 137-145.
- Theil, H. (1967), Economics and Information Theory, Amsterdam: North-Holland.