Testing for Long Run Purchasing Power Parity:
A Reexamination of Greek Drachma

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Absolute purchasing power parity between Greek Drachma and the currencies of 19 trading partners is tested using the effective exchange rate concept. Unlike the PPP based on bilateral exchange rates, the effective exchange rate based PPP receives empirical support using cointegration technique.

I. Introduction

The purchasing power parity theory (PPP) is one of the theories in international finance that perhaps has received the most attention. Specially, with the introduction of any new econometric technique, it is receiving even more attention. To be more precise, since the introduction of cointegration technique, many studies have tried to apply the cointegration analysis to test the PPP. Taylor (1988), McNown and Wallace (1989), Karfakis and Moschos (1989), and Kim (1990) are examples of studies that have used cointegration technique and have provided mixed conclusions. All these studies have used bilateral exchange rate in testing the PPP. Few recent studies, however, have advocated the use of effective exchange rate concept to test the PPP.

Genberg (1978), Officer (1980) are example of studies that have examined the deviation of effective exchange rates from their PPP levels using standard econometric techniques. Layton and Stark (1990), Bahmani-Oskooee and Rhee (1992), and Bahmani-Oskooee (1993a, 1993b) are example of studies that have used the effective exchange rate and cointegration technique to test the PPP. Layton and Stark used the

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effective rate of the U.S. dollar and rejected the PPP. Bahmani-Oskooee and Rhee used the effective rates of Korean won and again rejected the PPP. However, when black market exchange rate rather than the official exchange rate of Iranian rial was considered by Bahmani-Oskooee (1993a), the PPP received some support. Finally, Bahmani-Oskooee (1993b) examined the experience of 25 LDCs using effective exchange rate concept and cointegration analysis and rejected PPP for most countries.

Karfakis and Moschos (1989), one of the studies cited above used the bilateral exchange rates between Greek Drachma and currencies of six industrial countries and the cointegration analysis to show that the PPP is rejected for Drachma. However, a country like Greece has as its major trading partners more than six industrial countries. Thus, it is the purpose of this paper to show that when the PPP is based on effective exchange rate rather than bilateral exchange rates, we might obtain different results. To demonstrates our point, we consider the Greek Drachma for which the cointegration technique was applied by Karfakis and Moschos (1989) on a bilateral basis. We show that when most trading partners of Greece are taken into consideration, the PPP receives empirical support. Section II outlines the formulation of PPP using effective exchange rate concept. Section III very briefly explains the cointegration technique and reports our empirical results. Section IV concludes.

II. The PPP Formulation

In formulating the PPP, we follow Bahmani-Oskooee (1993a, 1993b). In its simplest form, the PPP theory could be outlined as $R = P_d/P_f$, where R is number of units of domestic currency per unit of foreign currency; P_d is the domestic price level; and P_f is the foreign price level. Alternatively, the above definition could be written as $P_d = R \cdot P_f$. This later definition implies that if PPP holds, the domestic price level should be equal to the foreign price level adjusted by the bilateral exchange rate. However, as noted in our introductory section, a more comprehensive test of PPP should be based on an effective exchange rate adjusted price index. The exercise usually amounts to taking a weighted average of bilateral exchange rate adjusted price levels of domestic country's trading partners. Thus, based on arithmetic average concept, the alternative definition outlined above becomes:

(1) $P_d = \Sigma_{i=1}^{n} \omega_i R_i \cdot P_i$

where ω_i is the weight given to trading partner i; R_i is the number of Drachma per unit of i's currency; P_i is the price level of trading partner i and $\Sigma\omega_i = 1$. However, if we follow geometric weighted averaging concept, the effective exchange rate based PPP could also be formulated as:

$$(2) \qquad P_d = \Pi[R_i \cdot P_i]^{\omega_i} \quad i = 2.....n$$

Taking natural logs of (1) and (2) and assigning an intercept and a slope coefficient we have

$$(3) \qquad \text{Log } P_d = a_0 + a_1 \text{ Log } P_{FA}$$

and

$$(4) \qquad \text{Log } P_d = b_0 + b_1 \text{ Log } P_{FG}$$

where P_{FA} denotes the exchange rate adjusted effective foreign price level based on arithmetic averaging concept and P_{FG} denotes the exchange rate adjusted effective foreign price level based on geometric averaging concept.[1] PPP theory implies that $a_1 = b_1 = 1$, reflecting the fact that in the long-run domestic inflation should be equal to foreign inflation rate adjusted for any movement in all trading partners' exchange rates.

Before we proceed with the empirical tests of equation (3) and (4) or their inverses, some comments are in order with regard to variables included in (3) and (4). First, due to lack of GNP deflator and Whole Sale Index for all trading partners of Greece, the Consumer Price Index (CPI) was used in constructing the variables. Second, on deciding a set of trading partners we followed Bahmani-Oskooee and Rhee (1992) and Bahmani-Oskooee (1993b) and selected 19 developed countries as Greece's trading partners. These trading partners were Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, U.K. and the U.S. Third, concerning the weights, following Bahmani-Oskooee (1991), we defined it as the share of Greece's imports from its trading partners in 1985. 1985 is the base year for the CPI series. Finally, the bilateral exchange rates between Greek

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1 More precisely the two effective foreign prices are generated in the following manners:
Log $P_{FA} = \text{Log}[w_1(R_1 \cdot P_1) + w_2(R_2 \cdot P_2) + ... + w_n(R_n \cdot P_n)]$,
Log $P_{FG} = w_1 \text{ Log}(R_1 \cdot P_1) + w_2(R_2 \cdot P_2) + ... + w_n \text{ Log}(R_n \cdot P_n)$.
These formulations are exactly the same as those of Bahmani-Oskooee and Rhee (1992) and Bahmani-Oskooee (1993a, 1993b).

Drachma and currencies of trading partners are not directly available. The International Monetary Fund in its International Financial Statistics only reports the exchange rates of all countries against the U.S. dollar. Therefore, following Officer (1980, p. 209), the bilateral rates were calculated from exchange rate data involving the U.S. dollar alone.[2]

III. The Methodology and Empirical Results

As indicated above the cointegration technique is used to test the PPP. The essence of cointegration approach between two variables, as outlined by Engle and Granger (1987) is first to determine that the two non-stationary variables are integrated of the same order, say, d.[3] The same two variables are said to be cointegrated if the residuals from the cointegration equation (when one variable is regressed on the other, such as those in equations 3 and 4) are integrated of any order less than d.

Therefore, our first step is to determine the degree of integration of each variable in equations (3) and (4). To this end, we rely upon Augmented Dickey-Fuller (ADF here after) test.[4]

Using quarterly data over 1973-1988 period, the ADF test was carried out for Log P_d, Log P_{FA} and Log P_{FG} variables. The results are reported in Table 1. Table 1 not only reports the results of the ADF test for the level of each variable but, for the first differenced variables as well.

Comparing our calculated ADF statistic to its critical value reported at the bottom of Table 1, we gather that all three variables have achieved stationarity after being differenced once. Thus, they are all said to be I(1).

The second step is to determine the degree of integration of residuals from the cointegration equations (3) and (4) and their inverses. After estimating cointegration equations by OLSQ, the ADF test was applied to their residuals for their stationarity. Table 2 reports the calculated

[2] Data on exchange rates and Consumer Price Indexes (1985 = 100) are from International Financial Statistics of IMF, different issues. Import shares are from Direction of Trade Statistics of IMF. All data are quarterly over 1973-1988 period.

[3] Thus, d is number of times that a variables needs to be differenced in order to achieve stationarity.

[4] For precise explanation of the ADF test see Bahmani-Oskooee (1993a, 1993b).

Table 1

THE CALCULATED ADF TEST STATISTICS FOR Log P_d, Log P_{FA}, Log P_{FG} AND THEIR FIRST DIFFERENCES

Variable	ADF Statistic	#of Lags in the ADF Test
Log P_d	1.08	4
Log P_{FA}	0.51	2
Log P_{FG}	0.75	2
$(1-L)$ Log P_d	-3.12	3
$(1-L)$ Log P_{FA}	-3.86	4
$(1-L)$ Log P_{FG}	-3.83	4

Notes: The critical value of the ADF statistics from the Fuller's (1976, p. 373) table are -2.93 and -2.89 for 50 and 100 observations respectively at the 5% level of significance.

Table 2

THE CALCULATED ADF TEST STATISTICS FOR THE RESIDUALS OF COINTEGRATION EQUATION

Cointegration Equation	ADF Statistics for the Level of Residuals	# of Lags in the ADF Test
Log $P_d=f[\log P_{FA}]$	-3.73	4
Log $P_{FA}=f[\log P_d]$	-3.75	4
Log $P_d=f[\log P_{FG}]$	-3.42	1
Log $P_{FG}=f(\log P_d]$	-3.38	1

Notes: The critical value of the ADF statistic from the Fuller's (1976, p. 373) table are -2.93 and -2.89 for 50 and 100 observations respectively at the 5% level of significance.

ADF statistic for the level of the residuals.

Table 2 reveals that since the calculated ADF statistics are less than their critical values, the residuals of all four cointegration equations are on a stationary process, i.e., they are all I(0). Since the degree of integration of the residuals in each equation is less than the degree of integration of the two variables involved in that equation, we conclude

that the two variables are cointegrated, i.e., there is a long-run equilibrium relation between domestic inflation and exchange-rate adjusted foreign inflation.

Now that we have provided evidence of cointegration, what remains to be seen is whether the estimates of slope coefficient in each cointegration equation is close to its theoretically expected value of one. For this purpose Table 3 reports the estimate of slope coefficient from all four cointegration equations. In Table 3 we also report other relevant statistics to be used in our discussion that follows.[5]

Table 3

ESTIMATE OF SLOPE COEFFICIENT FROM THE COINTEGRATION EQUATIONS AND OTHER STATISTICS

Cointegration Equation	Slope	St. Error	$\bar{R}^2$	CRDW
Log P_d = f[log P_{FA}]	0.947	0.006	0.997	0.9178
Log P_{FA} = f[log P_d]	1.053	0.006	0.997	0.9185
Log P_d = f[log P_{FG}]	0.940	0.007	0.996	0.6075
Log P_{FG} = f[log P_d]	1.059	0.008	0.996	0.6084

Note: The critical value of CRDW statistics for sample sizes in the vicinity of 50 observations at the usual 5% level is 0.78. This value is obtained from Engle and Yoo (1987, Table 4).

It is evident from Table 3 that no matter which equation we consider, the estimate of slope coefficient is very close to one. This along with the fact that two variables in each equation were found to be cointegrated, provides enough empirical evidence in support of PPP for Greek Drachma.

To enrich our findings further, we use an alternative approach to test for cointegration. One such approach is the use of Cointegration Regression Durbin Watson (DRDW) statistics. Although due to its high power, Engle and Granger (1987, p. 269) recommend the use of ADF procedure to test for the stationarity of the residuals, for a quick

[5] Note that according to Granger and Newbold (1974) estimated coefficient standard errors could be misleading in this context.

approximate results they argue that one could use the CRDW statistics to determine whether two variables are cointegrated. If the CRDW is too big, then residuals are I(0) and thus, two variables in the cointegration equation are said to cointegrated. However, if CRDW approaches zero, the two variables are not cointegrated. Table 3 also reports the estimated values of CRDW statistic for cointegration equations. Comparing those estimates with the critical value of CRDW statistic reported at the bottom of Table 3, we gather that at least when the foreign price level was based on the concept of arithmetic averaging, the CRDW statistic is higher than its critical value, enhancing our previous conclusion.

IV. Summary and Conclusion

The purchasing power parity theory (PPP) asserts that the long-run exchange rate between two national currencies is nothing but the ratio of their price levels. Most empirical studies have tested the PPP using bilateral exchange rates. However, recent studies have started advocating the use of effective exchange rates in testing the PPP.

In this paper we tested the PPP between Greek Drachma and 19 other currencies using the concept of effective exchange rate. Using two different concept of weighted averaging, we provided enough empirical evidence in support of the long-run PPP. This finding is in contrast to the finding of a previous study that tested the PPP between Drachma and six other currencies on a bilateral basis.

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