International Evidence on Purchasing Power Parity: A Study of High and Low Inflation Countries

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Absract

The purpose of this article is to select a sample of low inflation countries and high inflation countries and examine the long run validity of the relative Purchasing Power Parity doctrine. We explore the notion that countries with historically low inflation experience strong and stable currency and those with a continuous high inflation face weak and depreciating currencies. After a review of the literature, a theoretical model is developed for the relationship between inflation and exchange rate changes. This is followed by some graphical annual time series and empirical results for selected countries. We find our hypothesis is supported for high inflation countries. We then explore productivity differences and their impact on real exchange rates.

Keywords: purchasing power parity, exchange rate, inflation, depreciating currencies

1. Introduction

Purchasing power parity (PPP) is an old and controversial topic in economics literature. Many studies have used some version of PPP as a guide to systematic exchange rate movements, Foot and Rogoff (1991), Rogoff (1991). The original version of PPP is called the law of one price (Cassel 1922) where the domestic and foreign price level, expressed in the same currency, are equal. The law of one price is based on very restrictive assumptions that are difficult to be observed in reality. Those assumptions include a lack of transportation cost, no-trade barriers, and homogenous goods. It is hard to believe that these assumptions are valid in international trade between two countries. This seems particularly relevant now with health concerns disrupting international supply chains and the rise of protectionist sentiment. Even on a local level, one usually observes that the same good in different parts of a city are sold for different prices.

Most of the research in this area has rejected the strict validity of the law of one price. However, it is well known that in the long run, countries with a historically low inflation experience a strong and stable currency and those with a continuous high inflation face weak and depreciating currencies (Sachs and Larrian 1993). Countries like Switzerland, Germany, and Netherlands (before the introduction of the euro) historically had low and stable inflation. These countries also experienced strong currencies. The relationship between inflation and exchange rate fluctuation is a long run development and lends itself to a relative version of PPP. Several studies have provided support for the relative version of PPP (Cavallo 2018; Taylor 2002 & 2004).

The purpose of this study is to select a sample of low inflation countries and high inflation countries and examine the long run validity of the relative PPP hypothesis. A review of the literature is discussed in section 1. A theoretical model for the relationship between inflation and exchange rate changes is developed in section 2. Methodology issues are discussed in section 3. Some graphical annual time series and empirical results for selected countries are presented in section 4. Productivity differences are explored in section 45. Concluding remarks about productivity determinants are offered in section 6.

1.1 Review of Literature

One of the most comprehensive studies in this area is Froot, Kim and Rogoff (2001). The authors argue that "one of the most striking empirical regularities in international finance is the volatility and persistence of deviations from the law of one price across relatively homogeneous classes of goods." This study examines the law of one price over 700 years using annual data on commodity prices from England and Holland. The data set includes prices on seven commodities: barley, butter, cheese, oats, peas, silver, and wheat as well as pound/shilling nominal exchange rates. They find that the magnitude, volatility, and persistence of deviations from law of one price

have not declined by as much as it was expected. This finding is observed despite lower transport costs, reduced trade barriers, and less wars and conflicts in more recent periods. The authors argue that their conclusion is supportive of evidence that, even in modern era, goods-market arbitrage is far from being perfect.

Froot and Rogoff (1994) explain what, is known and what is unknown about the long-run determinants of purchasing power parity. The introduction of floating exchange rates made it clear that PPP is not a short-run relationship; price level changes do offset exchange rate fluctuations over longer time periods. The authors argue that there were neither sufficient data available on floating exchange rates, nor proper econometric techniques, for testing the validity of PPP in the long run. However, recently important results have emerged.

The authors argue that the most significant lesson has been stationarity of the real exchange rate over a longer period. The simple, univariate random walk model is rejected in favour of stationary alternatives. This research also examined the Balassa-Samuelson (1964 and 1964) hypothesis and the evidence supporting them. We explain and examine this later in this article. Balassa-Samuelson effects seem important, but more for countries with wide differences of income. Froot and Rogoff (1991) argue that during the past ten years, research on PPP has made significant progress. The main result is that there does seem to support PPP in the long run. Furthermore, the clear evidence on long-run convergence to PPP is based on data sets that employ some fixed exchange rates.

The empirical results from Monadjemi and Lodewijks (2021) based on eight countries are mixed, but mostly supportive of the relative PPP. Furthermore, this study showed that five out of seven cases there was co-integration of inflation differential and exchange rate, supporting the long-run stability of the real exchange rate.

2. Theoretical Discussion

The theoretical model of PPP is based on the law of one price,

$$E = P/P^* \quad \text{…………………………………………………..…..(1)}$$

where E, P and P* are exchange rate (price of foreign currency), domestic price level and foreign price level respectively. The law of one price has been rejected by most of the empirical studies on PPP. However, the relative version of PPP has been supported by data in the long run.

Following Froot and Rogoff (1994), the relative version can be derived from equation 1.

$$q_t = s_t + p^*_t - p_t \quad \text{…………………………………………………(2)}$$

Where all variables are in logarithm, where all of the variables starting from left are real exchange rate, nominal exchange rate, foreign price, and domestic price respectively. Equation 2 is similar to equation 1 if it is written in term of real exchange rate, $q = EP^*/P$ and taking logarithm of both side gives:

$$q = e_t + p^*_t - p_t \quad \text{…………………………………………………(3)}$$

where e_t is same as s_t.

Equation 3 is used to examine the stationarity of the real exchange rate for four high inflation and four low inflation countries.

3. Methodology

All the data on prices and exchange rates were collected from the OECD websites; details are given in the references. Prices are producer price index (PPI), and exchange rates are domestic currency per US dollar. High and low-inflation countries were selected based on average of inflation rates during last 4 years. The four low inflation countries are France, Greece, Ireland and Japan, and four high inflation countries are Columbia, South Africa, Mexico and Belgium.

Empirical results of this study are based on Augmented Dickey Fuller, to determine stationarity of relevant variables. Subsequently, cointegration of non-stationary variables is examined using Johansen and Juselius test.

Further empirical investigation is concerned with examination of Balassa-Samuelson (1964 and 1964) hypothesis using Granger Causality test for real exchange rate and per capita income.

4. Empirical Results

In Table 1 inflation rate over four years are presented. The inflation rates are based on 2019 PPI relative to 2015 = 100. For example, in case of Mexico, inflation is 26.6 percent over four years, roughly, 6.6 percent per year.

Table 1. High and Low Inflation Countries

High Inflation	Low Inflation
Mexico 126.5	Greece 95.0
Colombia 116.1	France 102.9
South Africa 123.8	Ireland 101.2
Belgium 109.1	Japan 100.9

All of the data for PPI were collected from the OECD website, web address given in references. The base year is 2015 = 100.

The first observation we can make is that even regarding a 6.6% inflation rate is "high" is unusual to those that have studied hyperinflationary episodes or even the stagflation of the 1970s. We have moved to a new 'normal' where the scourge of inflation appears to have been eradicated. Central Banks, often labelled as obsessive with regard to rising prices, may still warn of the dangers of ultra-low interest rates and historically unprecedented budget deficits in generating renewed inflationary pressure, but for many countries the inflation is well below their target rates. Why this has occurred is the subject of additional articles but it seems inextricably linked to low real wage growth, the entry of China and the former Soviet Union countries into the global trade system, and the Fourth Industrial Revolution related to improvements in information and digital technology.

Notwithstanding these observations, based on equation 3, real exchange rates are constructed for two selected categories of countries, high and low inflation. The foreign price is the PPI for OECD countries. To determine stationarity of real exchange rates, the Augmented Dicky- Fuller Statistic (ADFS) unit root test will be applied to each country.

Table 2. ADFS for Selected Counties

Country	ADFS	significant levels
France	-2.91*	1% = -3.57
Ireland	-0.55	5% = -2.94
Japan	-1.54	10% = -2.61
Greece	-2.12	
Mexico	-5.13**	
Colombia	-2.77*	
South Africa	-2.44	
Belgium	-2.21	

Dickey, Jensen and Thornton (1991) argued that a set of non-stationary time series are cointegrated if one or more linear combinations of these series have a finite variance. This implies that two or more series may wander around, but in the long run, there are economic forces that tend to push them toward an equilibrium. Hence, cointegrated series will not move far away from each other and are linked in the long run. Johansen and Juselius (1992) suggested a test for determining the number of cointegrating vectors in a multivariate system. Johansen's procedure uses likelihood ratio statistics and tests two hypotheses that the number of cointegrating vectors is, at most equal to r (Trace Test). The second tests the hypothesis that the number of cointegrating vectors is equal to r (Max Eigen value Test).

In Table 2, there are six non-stationary real exchange-rates. To determine, the number of cointegrating vectors, Johansen's test is applied to e_t, p^*_t and p_t . The result of cointegration will suggest the existence of long run equilibrium between three time series. Furthermore, the results would indicate validity of the relative PPP hypothesis. The cointegration test results are presented in Table 3.

Table 3. Cointegration Results

Country	Trace	λMax	5% Significant Level
Ireland	23.6	14.58	29.75 Trace
Japan	28.88	18.07	21.13 λMax

Greece	27.40	21.17*
Colombia	32.11*	21.16*
South Africa	30.55*	22.81*
Belgium	34.7*	25.30*

In Table 3, three of the high inflationary countries are cointegrated. This indicates that for these three countries there is a long run equilibrium between e_t, p^*_t and p_t. Otherwise, the PPP is supported for these high inflationary countries. The only exception is Greece, where a low inflationary county supports validity of the PPP in the long run. However, the Greece result is not strong because only the λMax statistic is significant. In other three cases both Trace and λMax are significant. We should mention that a panel cointegration model would have been an alternative estimation procedure.

We now move onto another related dimension, productivity differences.

5. Productivity Differences

Balassa and Samuelson (1964 and 1964) argue that technological progress has historically been faster in the traded goods sector than in the non-traded goods sector (perhaps because traded goods are weighted towards high-innovation agricultural or manufacturing goods) and, importantly, that this traded-goods productivity difference is more noticeable in high-income countries. As a result, CPI levels tend to be higher in high-income countries. The CPÍ is higher because a rise in productivity in the traded goods sector will force up wages in the whole economy; producers of nontraded goods will only be able to pay the higher wages if they raise their prices. For example, consider the fact that non-traded goods (services) are cheaper in India than in Switzerland, although Switzerland's absolute level of productivity is higher than that of India, the productivity in its nontraded-goods sector relative to its traded-goods sector is lower.

We now return to the impact on exchange rates. Balassa (1964) was the first to formally test the proposition that richer countries have higher real exchange rates and reported that there is a direct relationship between per-capita income and the inverse of the real exchange rate. This result is contrary to the proposal that the real exchange rate is higher in high-income countries. It is not clear why per-capita income was regressed against the inverse of real exchange rate and not its actual level. It could be argued that there is an inverse relationship if per-capita income is regressed against the actual level of real exchange rate, implying that low-income countries have lower prices.

Officer (1976) surveys a number of follow-up studies that, generally, all in all, yielded much more pessimistic results. Officer (1976) argued that Balassa's (1964) results are extremely sensitive to the period chosen, and to the countries included in the regression equations. A later study to construct absolute comparisons of PPP is conducted by Summers and Heston (1991), who developed absolute PPP data for a large number of countries. Generally, their results reveal significant differences in price levels between poor countries as a group and rich countries.

To resolve this controversial issue, this section attempts to follow Balassa Samuelson (1964 and 1964) proposal by examining behaviour of the real exchange rate over the last five decades for selected high incomes and low-income countries. Selections of countries were based on low inflation and high inflation countries as presented in Table 1. South Africa and Belgium were not included because of unavailability of sufficient data.

The Granger causality test (GC) is for determining whether one time series is useful in predicting another, was initially developed in 1969. Clive Granger argued that in economics, causality could be tested for by measuring the ability to predict the future values of a time series using past values of another time series. For example, a time series X is said to Granger-cause Y if it can be shown, that those X values provide statistically significant information about future values of Y. Below GC test is used to determine the relationship between real exchange rate and per capita income in a group of low and high inflation countries.

In Table 4, the results of pairwise GC for real exchange rate and per capita income are presented. The results are supportive of Balassa and Samuelson proposition. There is a strong and positive relationship between per capita income and real exchange rate in the first three high income countries. This relationship is much weaker for the last two low-income countries. Furthermore, the first three countries have low inflation, and the last two are among high inflation countries.

Table 4. Granger Causality Results: Per Capita Income and Real Exchange Rate

Country	RE doesn't cause PI	PI doesn't cause RE

France	F = 0.19	F = 2.78*
	Pr = 0.83	Pr – 0.08
Ireland	F = 0.71	F = 1.71*
	Pr = 0.50	Pr =0.196
Japan	F = 0.08	F = 2.19*
	Pr = 0.92	Pr = 0.13
Colombia	F = 1.65*	F = 0.23
	Pr = 0.23	Pr = 0.80
Mexico	F = 3.13**	F = 0.73
	Pr = 0.06	Pr = 0.49

RE and PI stand for real exchange rate and log of per capita income respectively. * and ** are significant at 5% and 1% levels.

6. Concluding Remarks about Productivity Determinants

We should caution that a number of other factors may be at play here. The first is that the process of structural transformation, and sectoral changes in employment and output, may impact on price level differences. Poorer countries moving out of agriculture into manufacturing may experience significant productivity improvements and with surplus labour the impact on wages may be delayed. In contrast, richer countries may be predominantly service economies where there is less scope for economies of scale and scope to lower costs. Working counter to that effect is the profit shifting strategies of global corporations in wealthy countries so that after tax profits are maximized permitting less pressure on price rises. Outsourcing and offshoring may also constrain domestic wage rates. It is no coincidence that moves are now afoot for a global minimum corporate tax rate. Almost half the top 100 multinationals initially targeted by the proposal are US companies. The rise of the digital economy, dominated by US companies, has caused a number of countries – France, Italy and the UK – to impose their own digital services taxes.

All the above factors will influence price levels, but perhaps one of the leading contributors is demographic change. Demographic forces — pushing toward more deaths than births — seem to be expanding and accelerating. Though some countries continue to see their populations grow, especially in Africa, fertility rates are falling nearly everywhere else. Demographers now predict that by the latter half of the century or possibly earlier, the global population will enter a sustained decline for the first time. It has been projected that 183 countries and territories — out of 195 — will have fertility rates below replacement level by 2100. Population growth impacts the need for resources (aggregate demand) while supplementing the labour supply (aggregate supply) and the balance affects price levels. The changing global demographic landscape, as well as the stark differences in developing regions, will also determine long run price levels.

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