



# Purchasing Power Parity and the European single currency: Some new evidence

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## ABSTRACT

The effect of the single currency on the Purchasing Power Parity (PPP) hypothesis is examined in this study for the 15 EU countries, vis a vis the US dollar, before and after the advent of the euro. Standard as well as nonlinear unit root tests are employed on the time series dimension. Unit root tests reject PPP and the highest half-lives are observed after the introduction of the single currency. Panel unit root (Pesaran, 2007) and stationarity tests (Hadri and Kurozumi, 2008) that take into account cross-sectional dependence are also estimated. The results remain inconclusive as panel stationarity tests fail to support PPP whereas panel unit root tests fail to reject PPP for the whole sample and for the period before the introduction of the single currency.

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## 1. Introduction

The Maastricht treaty in 1992 and the subsequent introduction of the euro in 1999 were the cornerstones for the creation of the European single market. Although the verdict for the effect of the introduction of the single currency is still open, we investigate its effects in one of the most examined parities in economics, the purchasing power parity (PPP). The latter suggests the existence of a proportional relationship between the nominal exchange rate ( $S_t$ ) and the relative price ratio ( $\frac{P_t}{P_t^*}$ ) which implies that the real exchange rate ( $Q_t$ ) is mean reverting over time. In logarithmic form (lower case), we have:

$$q_t \equiv s_t - p_t + p_t^*$$

where  $P_t$  denotes the aggregate price level in terms of the domestic currency at time  $t$ ,  $P_t^*$  is the aggregate price level in terms of the foreign currency at time  $t$  and  $S_t$  is the nominal exchange rate expressed as the domestic price of the foreign currency at time  $t$ .

The empirical evidence on PPP is extremely large since this parity has been widely tested in the literature. For a review of the vast literature see Sarno and Taylor (2002), Taylor (2002) and Sarno (2005).

However, the empirical evidence on PPP concerning the European Economic and Monetary Union (EMU) is still scant. The purpose of this paper is to fill this gap and test the validity of the PPP hypothesis between the European Union and the USA in the last four decades. In

particular, we examine whether the introduction of the new currency has affected the relationship, using recently developed nonlinear unit root tests, as well as panel unit root and stationarity tests that take into account cross-sectional dependence.

The organisation of the paper is as follows. Section 2 briefly develops some empirical evidence that has been shown in the literature. Section 3 describes the dataset and methodology used, while Section 4 discusses the results. Finally, Section 5 concludes.

## 2. Literature

The influence of the European economic integration process on price convergence and the stationarity of real exchange rates have fuelled the interest of several authors in the last years. Koedijk et al. (2004), using the Augmented Dickey-Fuller (ADF) unit root test in the context of Seemingly Unrelated Regression (SUR) methodology, test the PPP hypothesis within the Euro Area. For this purpose they collect a dataset of consumer price index (CPI) and nominal exchange rates against the US dollar for 10 Euro Area countries for the period 1973–2003 and construct the real exchange rates using the German mark as the numeraire currency. They provide evidence in favour of PPP, when a common mean reversion coefficient is assumed, while with different mean reversion coefficients they find evidence in support of PPP only for Belgium, Finland, France and Spain. They also test the PPP hypothesis between the Euro Area, as a separate economic entity, and other major economies, such as UK, Canada, Denmark, Japan, Norway, Switzerland, Sweden and US, using the “synthetic” euro<sup>1</sup> up to

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<sup>1</sup> The synthetic euro consists of the exchange rates of the euro legacy currencies, which are geometrically weighted using trade weights.

December 1998. Evidence of PPP is only detected between the Euro Area and Switzerland, when heterogeneous mean reversion is assumed, while the assumption of homogeneous mean reversion presents evidence in favour of PPP for the full panel. Finally, they assess the impact of the Maastricht treaty and the introduction of the euro on the convergence toward PPP. They confirm that especially the former event had an important impact on the stationarity of real exchange rates in the Euro Area, since strong evidence in favour of PPP is detected after 1992.

Gadea et al. (2004), using the ADF procedure, as well as unit root tests with structural breaks, study the evolution of the US dollar real exchange rate vis a vis the EU currencies during the recent floating regime, before and after the birth of the euro, over the period 1974–2001. They argue that the omission of some structural breaks which affect the behaviour of the real exchange rates may cause the unit root hypothesis to be accepted, resulting in the apparent lack of evidence in support of PPP and allow for three breaks; the first at the beginning of the 1980s, the second around 1985, while the third break appearing in 1996. They split the sample into two subperiods which reflect the pre and post-euro creation process, with 1997 marked as the beginning of the process of the monetary union. The economies considered are 14 EU Euro Area and non-Euro Area countries. They find no evidence in favour of the PPP hypothesis when the whole period is considered; nevertheless, strong evidence of PPP is provided, when allowing for two changes in the mean, for the period prior to the transition to the euro for those currencies closely related to the German mark; Austria, Belgium, Denmark, France and the Netherlands. Thus, they conclude that a weaker version or quasi long-run PPP holds.

Lopez and Papell (2007) claim that the choice of the numeraire currency plays an important role on the evidence of PPP. They use panel data on CPI and nominal exchange rates in US dollars for 23 countries from 1973 to 2001 and split the countries into 5 groups; the Eurozone, other Europe countries, negotiating countries, industrialized countries and Mediterranean countries. The methodology they use is a panel version of the ADF test with country-specific intercepts and serial correlation structures. They find strong evidence of convergence to PPP within the Eurozone, with the three largest members, France, Germany and Italy, as the numeraire countries, but they find no evidence of PPP before 1992; however, there is rapid convergence to PPP, starting in 1996. Moreover, they test the PPP hypothesis between the Eurozone and the other countries, but the evidence is weaker. When the US dollar is used as the numeraire currency, however, stronger evidence for the PPP is provided, with the process of convergence starting in 1993 and a rejection of the unit root hypothesis beginning in 1998.

Dwyer et al. (2007), on the other hand, find evidence not supportive of PPP within the Eurozone, using data of real exchange rates for eleven countries, from 1957 to 2005, with Germany being the numeraire country. Using univariate, as well as panel unit root tests, such as the standard ADF test and the SUR methodology employed by Koedijk et al. (2004), there is scant support for PPP in the Euro Area. The unit root hypothesis is inconsistent with the data for half of the countries during the whole period, while there is even less support when they split the sample into two subperiods, namely from 1973 to 2005 and from 1993 to 2005. In a Bayesian framework they test the probability of a unit root versus the probability of there not being a unit root and conclude that a unit root is less likely; in other words PPP receives support from these data.

Stronger support for PPP is provided by Zhou et al. (2008), using the nonlinear unit root test proposed by Kapetanios et al. (2003) to the bilateral real exchange rates of both European and other industrial countries, with the French franc and German mark (and the euro after 1998), as well as the US dollar as numeraire currencies. They suggest that convergence towards PPP between the EU countries, especially the Euro Area countries, tends to be nonlinear, because of factors such

as transportation costs and trade barriers, as well as official interventions in the foreign exchange market (see also Taylor et al., 2001). Using two sample periods, 1975–1998 and 1975–2006, they test whether the adoption of the euro has contributed to PPP to hold better. Their results show that, during the first period, there is evidence of PPP for most of the counties, by both the linear and the nonlinear tests. As far as the second period is concerned, the evidence of PPP is even stronger, with the nonlinear tests showing more evidence to reject the null of nonstationarity, when the real exchange rates are expressed with respect to the currencies of France and Germany; however, when they are expressed with respect to the US dollar, the linear tests show more evidence to reject the null. Overall, Zhou et al. (2008) suggest that PPP tends to hold well within the EU even before the adoption of the euro, while there is no evidence that the use of the euro has played an essential role for better performance of the PPP hypothesis within the Eurozone.

More recently, Gadea and Gracia (2009), testing for stationarity against a change in persistence to 14 European real exchange rates vis a vis the US dollar, for the period 1975–2003, find that the real exchange rates of Spain, Italy, Portugal, Greece and Finland experienced a change in their order of integration from  $I(1)$  to  $I(0)$  at sometime in the second half of the nineties. However, the other European real exchange rates do not show any change in the order of integration from  $I(1)$  to  $I(0)$ . This result leads to the conclusion that there is not a general structural break in EU countries as a result of the euro, even though the smaller countries have stabilised their prices and exchange rates.

### 3. Data and methodology

#### 3.1. Data

The dataset used comprises period-ending nominal exchange rates against the US dollar, as well as consumer price indices (CPI) for the fifteen countries of the EU-15. The countries under consideration are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. Additionally to the twelve member states of the Eurozone, Denmark, Sweden and the UK were also considered, in order to test the impact of the euro outside the Euro Area.

All series are monthly and seasonally adjusted and the sample period spans from 1/1973 to 4/2009<sup>2</sup>. Two breakpoints are also considered, the first in 12/1991 and the second in 12/1998, in order to test whether the treaty of Maastricht and the advent of the single currency have affected the relationship. CPI data are obtained from the OECD Economic Indicators, while nominal exchange rates data are obtained from the International Monetary Fund (IMF)'s International Financial Statistics. Summary statistics of the data are given in the Appendix (Table A1).

For 1999–2009, the dollar exchange rates of the Euro Area countries are calculated by  $s_i = s_{euro} + s_j$  where  $s_{euro}$  is the log of the euro price of a dollar and  $s_j$  is the log of a Eurozone country's currency conversion rate of a euro.

For each country  $i$ , the bilateral real exchange rate with US dollar is defined as follows:

$$q_i = s_i - p_i + p_{us} \quad (3.1)$$

where  $q_i$  is the real exchange rate,  $s_i$  is country  $i$ 's currency price of a dollar,  $p_i$  and  $p_{us}$  are the price indices of country  $i$  and the US, respectively, in logarithmic form.

<sup>2</sup> The CPI data for Ireland are available only after 11/1975.

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