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EMPIRICAL VERIFICATION OF THE VALIDITY OF THE PURCHASING POWER PARITY THEORY BETWEEN MOROCCO AND THE EUROPEAN UNION

VERIFICATION EMPIRIQUE DE LA VALIDITE DE LA THEORIE DE LA PARITE DU POUVOIR D'ACHAT ENTRE LE MAROC ET L'UNION EUROPEENNE

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ABSTRACT

This article attempts to test the existence of purchasing power parity between Morocco and the European Union. To do this, we have used two types of tests to confirm this hypothesis. The methodology used is based on a set of empirical studies, including Johansen cointegration tests and unit root tests.

The results of our study show that the unit root test rejects the hypothesis of the existence of purchasing power parity between Morocco and the European Union. However, for the cointegration test, the criteria for selecting the number of lags influenced the results. If the choice of the number of delays is based on the AIC and BIC information criteria, the validity of the purchasing power parity is rejected. On the other hand, if the choice of the number of delays is based on the HQ criterion, purchasing power parity is validated, which contradicts the conclusion of the first approach.

Key Words: Exchange rate, purchasing power, purchasing power parity, consumer price index, unit root tests, Johansen cointegration tests

RESUMÉ

Le présent article tente de tester l'existence d'une parité de pouvoir d'achat entre le Maroc et l'Union européenne. Pour ce faire, nous avons utilisé deux types de tests pour confirmer cette hypothèse. La méthodologie utilisée est basée sur un ensemble d'études empiriques, notamment les tests de cointégration de Johansen et les tests de racine unitaire.

Les résultats de notre étude montrent que le test de racine unitaire rejette l'hypothèse de l'existence de la parité de pouvoir d'achat entre le Maroc et l'Union européenne. Par contre, pour le test de cointégration, le critère de sélection du nombre de retards a influencé les résultats. Si le choix du nombre de retards est basé sur les critères d'information AIC et BIC, la validité de la parité de pouvoir d'achat est rejetée. En revanche, si le choix du nombre de retards est basé sur le critère HQ, la parité de pouvoir d'achat est validée, ce qui contredit la conclusion de la première approche.

Mot clefs*: *Taux de change, pouvoir d'achat, parité de pouvoir d'achat, indice des prix à la consommation, tests de racine unitaire, tests de cointégration de Johansen

1. INTRODUCTION

The European Union is Morocco's main trading partner. The implementation of trade agreements has led to the definitive abolition of customs duties on trade in industrial products, as well as many agricultural and fisheries products, which has boosted trade between the two shores of the Mediterranean. In 2016, trade between Morocco and the European Union totalled €13.809 million in exports, compared with €20.791 million in imports.

In an economic context where exchange rate fluctuations have an impact on all economic sectors, these fluctuations in particular have repercussions on exports and imports of goods and services insofar as, if the exchange rate falls, this change influences prices and thus stimulates exports, which become relatively cheaper in other currencies, and curbs imports, which become more expensive.

On the other hand, variations in the exchange rate also affect purchasing power. This has been demonstrated by the theory of purchasing power parity used in economics to establish comparisons of living standards between countries.

In order to crystallize the relationship between purchasing power parity and the exchange rate, it is essential to study the link between the exchange rate and purchasing power through consumer prices. The aim of this article is to answer the following central question: **does purchasing power parity exist between Morocco and the European Union?**

To do this, we will examine whether purchasing power parity is true between Morocco and the European Union, and whether this hypothesis plays a significant role in the development of the countries' economic exchanges, or vice versa. In order to have a satisfactory idea of the equilibrium mechanism of the exchange rate, and to respond to this problem, it is necessary to put forward a theoretical content that covers the most important concepts, in order to demonstrate the place of PPP within the framework of these theories. We will present all the works that have included Morocco in their study. This will be followed by a presentation of works that have not included Morocco. Finally, we will present works that have adopted other approaches.

2. THEORETICAL FRAMEWORK

2.1 DEFINITIONS OF KEY CONCEPTS

The theory of purchasing power parity (PPP) postulates that the exchange rate between two currencies is determined by the relationship between their respective purchasing powers. "The exchange rate must ensure equality of purchasing power between countries". This theory has its roots in the writings of the Spaniard M. de Azpilcueta Navarro (Salamanca school) in the 16th century, and D. Hume and D. Ricardo in the 18th century, but it was G. Cassel who set it out clearly in 1916 and then in a book written by G. Cassel and published in 1923.

According to Bartolini (1995), the law of one price seems to hold universally and at all times for homogeneous commodities traded on major exchanges, taking into account contractual differences and

delivery times. However, it is important to note that the validity of the law of one price does not seem to hold for differentiated products such as manufactured goods and services.

Because technological progress varies from one country to another, it is widely accepted that the production of differentiated goods is not perfectly or instantaneously substitutable. Furthermore, it should be noted that imperfect competition on the goods market renders the law of one price inoperative. Going back to the sixteenth century with Navarro (of the Salamanca school) and De Malynes (1601), via D. Hume and D. Ricardo more than a century and a half later, the theory of purchasing power parity is the oldest and most criticised in exchange rate theory. However, it is Gustaf Cassel, a Swedish economist in 1922, who is considered to be the father of the PPP doctrine in its modern form, as he was the first to provide a systematic exposition of the relationship between purchasing power and the exchange rate.

There are two versions of the theory of purchasing power parity: absolute and relative[1] . These two forms lead to purchasing power parity when the principle of the law of one price is applied to all traded goods, assuming that the consumption structure of economic agents is identical in the different countries (Simon, Y, p. 116).

The real effective exchange rate (REER) is a global indicator that summarises a country's competitive position in relation to its main trading partners. The REER is defined as the nominal effective exchange rate, relative to the relative prices of the national economy and the main partner countries, which simultaneously promotes non-inflationary growth (internal balance) and a sustainable balance of payments current account over the long term (external balance). Maintaining the stability of this rate is of paramount importance in promoting the competitiveness of exports. When a country trades with several countries, it is necessary to calculate the real effective exchange rate in order to correctly estimate the evolution of its competitiveness vis-à-vis the rest of the world, rather than calculating bilateral real exchange rates for each partner country.

3. LITERATURE REVIEW

The equilibrium exchange rate is the one that ensures that the price of goods and services is the same throughout the world and that current account balances are balanced. The two main traditional theories for determining the exchange rate are purchasing power parity, on which the problematic of our article is based, and the balance of payments approach to the exchange rate. Normally, these two theories converge, since both are based on a real approach to the exchange rate, in which the market for goods and services plays an essential role.

However, with the rise of currency trading on the financial market, international trade in goods and services has lost its importance in the exchange rate equilibrium mechanism. This phenomenon is at the root of new exchange rate theories that take into account the financial aspect of international transactions leading to equilibrium, such as the portfolio approach to exchange rates and the balance of payments financial accounts.

3.1 EMPIRICAL STUDIES INCLUDING MOROCCO

Much of the empirical work on the validity of purchasing power parity has been carried out on African countries and has focused on Morocco. We will present a summary of work based on *stationarity tests* and work based on *cointegration tests*.

With regard to work based on *stationarity tests*: Holmes (2001b) tested relative PPP on a sample of thirty developing countries using a new econometric test that investigates the stationarity of the principal component as a function of deviations from the United States. This test has advantages over existing studies which have used Engle and Granger and Johansen tests which can suffer from low power due to limited data,

[1] Giorgia Ginovannetti (1993): "Théorie de la parité des pouvoirs d'achat : les difficultés d'une vérification empirique" Problèmes économiques N° 2314 du 24 Fév.

leading to rejection of exchange rate stationarity or cointegration between the nominal exchange rate and the domestic/foreign price ratio.

For Holmes (2002), there is evidence of purchasing power parity for the vast majority of less developed countries using ADF unit root tests. However, the author found that the real exchange rates of eight countries are fractional, meaning that mean reversion is a rare phenomenon. There is mixed evidence that purchasing power parity is limited to high inflation and less developed countries. Camarero et al (2006) apply a group of basic and statistical tests to investigate the hypothesis of purchasing power parity in ten Mediterranean countries. The real effective exchange rate vis-à-vis the European Union is found to be stationary for five of the countries analysed once the presence of structural changes and non-linearities is taken into account. Lopez and Papell (2007) examine convergence towards purchasing power parity within the eurozone and between the eurozone and its main partners using panel models. They find strong rejections of the unit root hypothesis and hence evidence of PPP in the eurozone for different currencies, as well as for the United States with the dollar as the reference currency between 1996 and 1999.

Arize (2011) uses real effective exchange rate data from 66 developing countries and a monthly dataset from January 1980 to October 2009. This study examines whether the real effective exchange rate is stationary using two approaches: *the KPSS test and the KSS test*. Yilanci and Eris (2013) examine the validity of the purchasing power parity hypothesis for 33 African countries using Fourier unit root tests to explain the existence of multiple breaks in real exchange rates.

As for the validity of PPP, the results show strong evidence of PPP in the 1980s using quarterly data. PPP validity is also found using annual data between 1974 and 1998. These results are generally consistent with the findings of Odedokun (2000), who studied the conditions of PPP in Africa. They could largely be influenced by the extent of nominal exchange rate flexibility. The results provide stronger evidence and faster adjustment towards PPP if periods of fixed exchange rate regimes are excluded from the analysis.

Doganlar and Ozmen (2000) use the ADF and Phillips-Perron unit root tests to test the stationarity of real exchange rate series defined in terms of US consumer prices and the consumer prices of industrialised countries. This study is conducted for the period January 1986 to April 1997 for 18 developing countries: Bolivia, Chile, Mexico, Ecuador, Uruguay, Costa Rica, Dominican Republic, Jamaica, Morocco, Ghana, Nigeria, India, Indonesia, South Korea, Pakistan, Philippines, Sri Lanka and Turkey.

The results of the unit root test indicate that none of the real exchange rate series is stationary for these countries. Consequently, it can be argued that PPP is not valid for these countries when defined in terms of the real exchange rate. Holmes (2001a) tests relative PPP on a sample of thirty less developed countries. A new test advocated by Im, Pesaran and Shin is used, which allows unit roots to be tested in heterogeneous panel data sets.

Stationarity of a real exchange rate is identified when the average ADF statistic based on real exchange rate data is significantly different from zero. Using quarterly data covering the period 1973-1999, the author provides evidence against the validity of PPP for most less developed countries. This conclusion is also drawn from panels based on region and inflationary experience, as well as from the application of a panel approach based on seemingly independent regression analysis (SUR).

Cerrato and Sarantis (2007) examine the purchasing power parity hypothesis using a unique panel of monthly parallel market exchange rate data for 34 emerging economies. The authors apply a large number of unit root and cointegration tests on the heterogeneous panels. The unit root tests reject the mean reversion of real parallel market exchange rates for most (but not all) emerging market economies.

On the other hand, all panel cointegration tests provide strong evidence of cointegration between the parallel market nominal exchange rate and domestic and foreign prices for individual countries and for the full panel.

Since they believe that the results of the unit root tests may be affected by the imposition of joint symmetry and the proportionality restriction due to trade restrictions and measurement errors, they test for such a restriction using likelihood ratio tests and find that it is strongly rejected.

Pesaran et al (2009) perform a variety of unit root tests on all real rates and estimate the proportion of stationary pairs. This proportion can be systematically estimated even in the presence of cross-sectional dependence. They estimate this proportion using quarterly real exchange rate data for 50 countries for the period 1957-2001.

The main conclusion drawn is that, in order to reject the null hypothesis of PPP adjustment, sufficiently large imbalances are required to displace the real rate from the band of inaction set by trade costs. In such cases, the null hypothesis of PPP adjustment can be rejected up to 90% of the time compared with around 40% in the sample as a whole using a linear alternative and around 60% using a non-linear alternative. Bahmani-Oskooee (1998) use the KPSS and ADF tests to determine whether real effective exchange rates in Middle Eastern countries follow a random walk process or are stationary. In most cases, the KPSS test confirmed the stationarity of the real effective exchange rates and therefore the PPP, whereas the ADF test did not, probably because of its low statistical power.

Alba and Park (2003) examine PPP using panel unit root tests for the real US dollar exchange rates of developing countries during the floating exchange rate period. Since evidence of PPP can vary from period to period, Albo and Park examine data for 10-year periods from 1976 to 1985 through to 1990-1999. They classify the panels on the basis of country characteristics likely to influence the validity of PPP.

These characteristics include the degree of openness, the inflation rate and the level and growth rate of GDP per capita. Although they found stronger evidence in favour of PPPs after 1980, their examination of panel data over 15 10-year periods provides only limited support for PPPs.

Alba and Papell (2007) use panel models to test for unit roots in the real exchange rate of 84 countries vis-à-vis the US dollar. They find stronger evidence for PPP in countries that are more open to trade, closer to the US, with lower inflation and moderate nominal exchange rate volatility, and with economic growth rates similar to the US.

They also show that PPP is verified for panels of European and Latin American countries, but not for African and Asian countries. Their results show that country characteristics can help explain both adherence and deviations from PPP in the long term.

Bahmani-Oskooee et al. (2014) apply a panel stationarity test with allowance for abrupt and smooth changes to test the validity of long-term purchasing power parity for 20 African countries using quarterly data over the period 1971 to 2012. The empirical results of these tests indicate that PPP is valid for 10 of the 20 African countries studied, namely Burkina Faso, Cameroon, Ghana, Kenya, Niger, Senegal, Seychelles, South Africa, Tanzania and Togo.

Table -1: Studies based on stationarity tests including Morocco

Reference	Countries studied	Partner countries	Period	APP test	Test results
Bahmani-Oskooee (1998)	11 countries in the Middle East	20 OECD countries 6 South East Asian countries	1971T1 - 1994T4	ADF and KPSS (non)-stationarity tests	Mixed results
Doganlar and Ozmen (2000)	18 developing countries	United States of America Industrial countries	1986M1 - 1997M4	ADF and PP unit root tests	PPA rejected
Holmes (2001a)	30 developing countries	United States of America	1973T2 - 1999T1	ADF panel bar unit root tests	PPA rejected
Holmes (2001b)	30 developing countries	United States of America	1973T2 - 1997T3	Principal component ADF unit root tests	PPA accepted
Holmes (2002)	30 developing countries	United States of America	1973T2 - 2001T1	Long memory test	PPA accepted
Alba and Park (2003)	65 PVD 15 developed countries	United States of America	1976M1 - 1999M12	Unit root test on panel data	Mixed results
Camarero et al (2006)	10 Mediterranean countries	European Union	1979T1 - 2002T4	(Non)-stationarity tests on TAR models	PPA accepted
Alba and Papell (2007)	84 countries (Europe, Latin America, Africa and Asia)	United States of America	1976M1 - 2002M12	Unit root test on panel data	Mixed results
Cerrato and Sarantis (2007)	34 emerging countries	United States of America	1973M1 - 1998M12	Unit root and cointegration tests on panel data	PPP rejected by unit root tests and accepted by cointegration tests
Lopez and Papell (2007)	Eurozone, Mediterranean countries, industrial countries...	United States of America	1973T1 - 2001T4	Unit root tests on panel data	PPA accepted
Pesaran et al (2009)	22 developed countries 27 developing countries	United States of America	1957T1 - 2001T4	ADF and KPSS (non)-stationarity tests	PPA rejected
Arize (2011)	66 developing countries	TCER Multiple partners	1980M1 - 2009M10	KPSS and KSS tests	PPA accepted
Yilanci and Eris (2013)	33 African countries	United States of America	1980M1 - 2011M7	Fourier unit root tests	PPA accepted for 20 countries
Chiu (2002)	45 countries	United States of America	1980 - 1999	Unit root tests on panel data	PPA accepted
Hassanain (2004)	24 African countries	France	1969/74 - 1998 1974T2/1981T4 - 1999T1	Unit root tests on panel data	PPA accepted
Bahmani-Oskooee et al (2014)	20 African countries	TCER Multiple partners	1971Q1 - 2012Q4	Unit root tests on panel data	Mixed results

Source: prepared by authors

Work based on cointegration tests:

After presenting some empirical work that has tested the validity of PPP based on stationarity tests for the real exchange rate, we will now present some work that has used cointegration tests.

Kargbo (2003) used Johansen's cointegration test and an error correction model on annual data for parallel market exchange rates and the consumer price index in 30 countries over the period 1960 to 1997. The author found a strong case for PPP as a useful guide to exchange rate policy reform in Africa. Kargbo (2004) applied Johansen's cointegration tests to annual bilateral exchange rate and consumer price index data for 35

countries covering the period 1958-2002. His research supports the validity of long-term PPP in African countries. Similar empirical evidence has been provided by Aggarwal and Simmons (2002), Salehizadeh and Taylor (1999) and Lui (1992) for various other developing countries. Since PPP theory considers relative prices as the fundamental determinants of appropriate exchange rates when a long-run relationship exists, their empirical results imply that PPP is a reliable guide for exchange rate determination and exchange rate reform in various African countries. Holmes and Wang (2005) study the possibility that the adjustment to relative purchasing power parity in its relative long-run version depends on the nature of the deviations from the tested PPP. Although existing studies involving developed and less developed countries often find that PPP has used linear non-stationarity or non-cointegration tests, the authors have used a new cointegration test, advocated by Enders and Siklos, Enders and Dibooglu for asymmetric adjustment towards parity in relation to positive and negative deviations of the real exchange rate from its equilibrium value. Using a sample of ten African economies with data from the post-BrettonWoods floating exchange rate era, long-run PPP is found in eight of these cases if an explicit distinction is made between positive and negative deviations. In the sample, the authors find a variation of the asymmetric type displayed by the price and nominal exchange rate adjustment. Kargbo (2006) conducted a detailed empirical analysis to determine whether there is empirical evidence in favour of long-run PPP in African countries. Because of the significant parallel market premium, the author applied Johansen's cointegration test to annual data on official and parallel market exchange rates and GDP deflators for 40 countries covering the period 1958-2003. The author finds arguments in favour of long-term PPP in Africa. PPP is therefore a reliable guide for exchange rate determination and exchange rate reform in African countries. Cerrato and Sarantis (2007) examine the PPP hypothesis using a unique panel of monthly parallel market exchange rate data for 34 emerging economies. They apply a large number of unit root and cointegration tests in heterogeneous panels. The unit root tests reject the mean reversion of real parallel market exchange rates for most emerging economies. On the other hand, all the cointegration tests provide strong evidence of cointegration between the nominal parallel market exchange rate and domestic and foreign prices for individual countries and for the full panel. Since they believe that the results of unit root tests may be affected by the imposition of joint symmetry and the proportionality restriction due to trade restrictions and measurement errors, Cerrato and Sarantis test for such a restriction using likelihood ratio tests and find that it is strongly rejected.

Arize et al (2010) test the validity of PPP in Africa in the context of a multivariate error correction model. Monthly data for fourteen African countries are used. The period examined runs from April 1973 to July 2007. The results of the long-run cointegration analysis, the short-run error correction models, the perpetuity profile analysis and the variance decomposition confirm the validity of PPP in these countries with moderate to high inflation, in which the estimates of PPP deviations lie outside the range of values proposed by Rogoff (1996). Salehizadeh and Taylor (1999) use data covering the period 1975-1997, and carry out cointegration tests between price indices and exchange rates for 27 countries against the US dollar. The results provide relatively strong evidence (for 14 countries) in favour of the long-term validity of the PPP. Further tests on real exchange rates indicate that the symmetry and proportionality conditions implied by PPP are rejected in all but one case. These latter tests also show that deviations from long-run values of the real exchange rate and a priori restrictions imposed on the cointegrating vector can lead to a false rejection of the PPP hypothesis. Drine and Rault (2008) apply the panel cointegration tests developed by Pedroni and generalised by Banerjee and Carrion-i-Silvestre (2006) to examine the validity of the PPP theory for a sample of 80 developed and developing countries. The authors find that PPP is strongly verified for OECD countries. On the other hand, they find that PPP is poorly accepted for countries in the Middle East and North Africa. However, in the countries of Africa, Asia, Latin America and Central and Eastern Europe, PPP does not seem relevant for characterising the long-term behaviour of the real exchange rate. Other analyses indicate that the nature of the exchange rate regime does not condition the validity of PPP, which is more readily accepted in countries with low inflation. Selmi (2014) examines the long-run relationship between exchange rates and relative prices. He uses long memory tests that allow for the persistence of the impact of shocks on the real exchange rate to examine the existence of purchasing power parity between Tunisia and five of its partner

countries, namely: Germany, the United States, France, Italy, the United Kingdom, Morocco and Libya. The empirical results obtained allow the PPP to be considered as a long-run event if significant short-run deviations from the PPP cannot exist. Consequently, the fractional cointegration analysis treats deviations from equilibrium as a slightly integrated process and therefore captures a wider group of parities.

Table 2-: Work based on cointegration tests including Morocco

Reference	Countries studied	Partner countries	Period	APP test	Test results
Salehizadeh and Taylor (1999)	27 countries (developing and emerging)	United States of America	1975M1 - 1997M9	Cointegration tests	Mixed results
Kargbo (2003)	30 African countries	France United States of America	1960 - 1997	Cointegration tests	PPA accepted
Kargbo (2004)	35 African countries	France United States of America	1958 - 2002	Co-integration tests	PPA accepted
Holmes and Wang (2005)	10 African countries	United States of America	1973Q2 - 2002Q2	Cointegration tests	PPA accepted
Kargbo (2006)	40 African countries	France United States of America	1958 - 2003	Cointegration test	PPA accepted
Cerrato and Sarantis (2007)	34 emerging countries	United States of America	1973M1 - 1998M12	Cointegration test on panel data	PPA accepted
Drine and Rault (2008)	80 developed and developing countries	TCER Multiple partners	1964 - 1998	Cointegration test on panel data	Mixed results
Arize et al (2010)	14 African countries	United States of America	1973M4 - 2007M7	Cointegration test	PPA accepted
Selmi (2014)	Tunisia	Germany, United States of America, France, Italy, United Kingdom, Morocco and Libya.	1990M1 - 2006M12	Fractional cointegration test	Mixed results

Source: made by the auteurs

4. METHODOLOGY ADOPTED

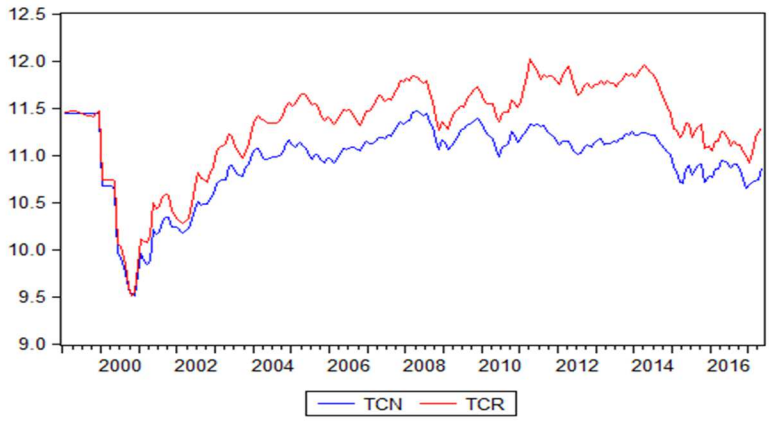
The approach followed here is exclusively quantitative and concerns the period from January 1999 to May 2017, i.e. 221 observations. Estimation was carried out using "Eviews" software. We will empirically analyse the validity of purchasing power parity between Morocco and the European Union in two ways: firstly, we will apply stationarity tests to the real exchange rate series between the dirham and the euro, and secondly, we will apply Johansen's cointegration test to check whether there is a long-term relationship between the nominal EUR/MAD exchange rate, the Moroccan consumer price index and the European Union consumer price index.

The empirical analysis of the purchasing power parity (PPP) hypothesis in its absolute version between Morocco and the European Union uses macroeconomic and financial variables. These include the nominal exchange rate (TCN) and the real exchange rate (TCR) between the dirham and the euro, quoted in uncertain terms, i.e. the number of units of the dirham needed to acquire a single unit of the euro. These are also the Moroccan consumer price index (IPCMA) and the European Union consumer price index (IPCUE). The data are observed monthly and are taken from IMF databases. They cover the period from January 1999 to May 2017, i.e. 221 observations.

Figure 1 shows the simultaneous evolution of the nominal and real exchange rates of the Moroccan dirham against the euro. The figure shows that the two rates behaved similarly throughout the period under consideration. In particular, they fell together from January 1999, coinciding with the introduction of the euro in intangible form. This fall lasted until around the end of 2000. Thereafter, the nominal and real

exchange rates maintained steady growth, disrupted by a number of crises, the most serious of which was the subprime crisis in 2007.

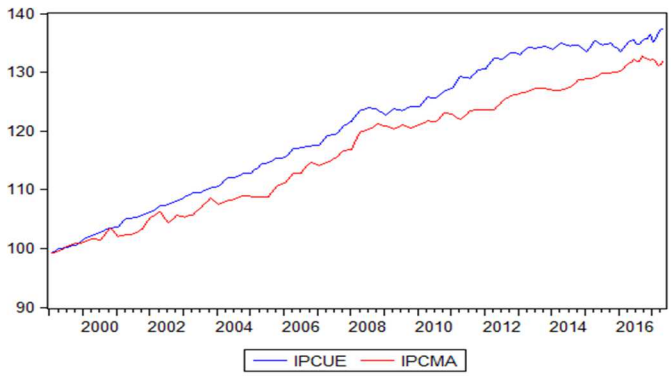
Figure-1: Nominal and real EUR/MAD exchange rates



Source : made by the auteurs

Figure 2 shows the joint trend in consumer price indices in Morocco and the European Union, which followed virtually the same upward trend throughout the period under review.

Figure-2: Trends in consumer price indices in Morocco and the European Union



Source: made by the auteurs

5.2 DESCRIPTIVE STATISTICS

Table-5: Descriptive statistics for the four series studied

	Variables			
	IPCUE	IPCMA	TCN	TCR
Average	120.40	116.44	10.95	11.32
Median	122.74	118.87	11.068	11.44
Standard deviation	11.77	10.24	0.40	0.50
Skewness	-0.20	-0.11	-1.49	-1.41
Kurtosis	1.68	1.63	5.15	4.85
Prob. Jarque-Bera	0	0	0	0

Source: made by the auteurs

This table shows that the EU consumer price index is - on average - slightly higher than the Moroccan consumer price index (averages: 120.40>116.44).

It is also relatively more volatile (standard deviations: 11.77>10.24). The distributions of all the series are skewed to the left (Skewness: -0.20, -0.11, -1.49 and -1.41), flatter than normal in the case of consumer price

indices (Kurtosis: 1.68 and 1.63) and less flat than normal in the case of exchange rates (Kurtosis: 5.15 and 4.85). As a result, the data in our sample are not distributed according to a Gaussian distribution, as indicated by the p-values of the Jarque and Bera test, which are all below 5%.

6 RESULTS AND DISCUSSION

All the theoretical and empirical work cited in the previous sections has tested the validity of PPP by opting for one or other of the following two approaches.

6.1 STATIONARITY TEST FOR THE REAL EXCHANGE RATE

Most statistical studies of time series are based on stationarity assumptions, which stipulate that the probabilistic properties of the financial series studied remain stable over time.

Within the framework of the PPP between Morocco and the European Union, the null hypothesis of non-stationarity of the real exchange rate series of the dirham against the euro (EUR/MAD) is tested using the unit root tests ADF of Dickey and Fuller (1979) and PP of Philips and Perron (1988) and the null hypothesis of stationarity of the real exchange rate series is tested using the KPSS stationarity test of Kwiatkowski et al (1992). The results are summarised in the table below:

Table-6: Stationarity and non-stationarity tests for the real exchange rate

	ADF test			***PP test***			***Test KPSS***	
	Statistics	Critical value	p-value	Statistics	Critical value	p-value	Statistics	Critical value
Model 1	-2.307	-4.001	0.428	-2.310	-4.000	0.427	0.233	0.216
Model 2	-1.906	-3.460	0.329	-1.928	-3.460	0.319	0.775	0.739
Model 3	-0.163	-2.576	0.626	-0.167	-2.576	0.625		

Source: made by the auteurs

Model 1 is the Dickey and Fuller regression containing a constant and a linear trend, model 2 is the same regression without a linear trend and model 3 contains neither a constant term nor a linear trend. All three models are augmented by lags of the dependent variable, the number of which is set automatically on the basis of an information criterion, the BIC in this case.

The ADF and PP tests do not reject the hypothesis of non-stationarity of the real exchange rate at the 5% risk threshold. This conclusion is confirmed by the KPSS test of the stationarity hypothesis, since the value of the test statistic is greater than the critical value (the software does not provide p-values for this test). The three tests are therefore unanimous on the non-stationarity of the real EUR/MAD exchange rate.

6.2 COINTEGRATION TEST BETWEEN THE NOMINAL EXCHANGE RATE AND RELATIVE PRICES

The second approach is to test for cointegration between the nominal exchange rate and relative prices. Note that this second approach is equivalent to the first, simply by recalling the relationship between the real exchange rate (RER) and the nominal exchange rate (CER).

This relationship can be written as follows:

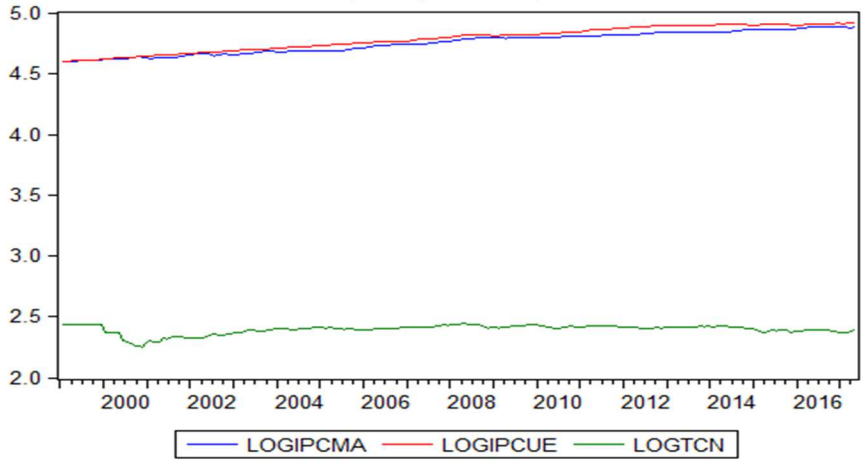
$$TCR = TCN * \frac{IPCUE}{IPCMA}$$

Where IPCMA and IPCUE are the consumer price indices for Morocco and the European Union respectively. The logarithmic transformation of this relationship gives the following formula:

$$log\ log(TCR) = log\ log(TCN) + log\ log(IPCUE) - log(IPCMA)$$

The stationarity of the real exchange rate implies that of its logarithm, so the right-hand side of the previous equation is stationary. In the particular case where the variables log log(TCN), log log(IPCUE) and log(IPCMA) are integrated of order 1, i.e. I(1)their combination, which is equal to log log(TCR)is stationary, which means that the variables log log(TCN), log log(IPCUE) and log(IPCMA) are cointegrated and there is a long-term relationship between them.The figure above shows the simultaneous evolution of the logarithms of the nominal exchange rate and the consumer price indices for Morocco and the European Union.

Figure-3: Simultaneous movements in the nominal exchange rate and consumer price indices (in logarithms)



Source: made by the auteurs

The consumer price indices (in logarithm) are clearly non-stationary, but it is difficult to judge the stationarity of the nominal exchange rate. The stationarity of these three series therefore needs to be tested econometrically.

6.3 STATIONARITY TESTS FOR THE NOMINAL EUR/MAD EXCHANGE RATE

The table below gives the results of the ADF, PP and KPSS stationarity tests for the logarithm of the nominal EUR/MAD exchange rate:

Table-7: Stationarity tests for the logarithm of the nominal EUR/MAD exchange rate

	Level							
	ADF			***PP***			***KPSS***	
	Statistics	Val. Review	P-value	Statistics	Val. Review	P-value	Statistics	Val. Review
Model 1	-3,35242	-4,00152	0,0608	-2,63379	-4,00032	0,2658	0,196414	0,146
Model 2	-2,78186	-3,46088	0,0626	-3,46004	-2,34101	0,1601	0,474313	0,463
Model 3	-0,32288	-2,57581	0,5682	-0,41601	-2,57552	0,5325		
	1ere difference							
Model 1	-5,0013	-4,00152	0,0003	-12,9292	-4,00051	0	0,092313	0,216
Model 2	-4,99446	-3,46088	0	-12,9459	-3,46017	0	0,093691	0,739
Model 3	-5,00256	-2,57581	0	-12,9682	-2,57556	0		

Source: made by the auteurs

The stationarity tests show that at the 5% risk threshold the log variable (TCN) is not stationary in level in model 1 (with constant term and linear trend), in model 2 (with constant term and without linear trend) and in model 3 (without constant term and without linear trend). However, stationarity tests show that the series of variations is stationary for all three models. We conclude that the log variable (TCN) is integrated of order 1, i.e. I (1).

6.4 STATIONARITY TESTS FOR THE CONSUMER PRICE INDEX IN MOROCCO :

The table below gives the results of the ADF, PP and KPSS tests of the Moroccan consumer price index series expressed in logarithm:

Table-8: Stationarity tests for the logarithm of Morocco's consumer price index

	Level							
	ADF			***PP***			***KPSS***	
	Statistics	Val. Review	P-value	Statistics	Val. Review	P-value	Statistics	Val. Review
Model 1	-2,467524	-4,001108	0,344	-2,152691	-4,000316	0,5131	0,226382	0,216
Model 2	-0,609903	-3,460596	0,8645	0,757841	-3,460035	0,8284	1,937757	0,739
Model 3	4,131319	-2,575712	1	5,611358	-2,575516	1		
	1ere difference							
	ADF			PP			KPSS	
	Statistics	Val. Review	P-value	Statistics	Val. Review	P-value	Statistics	Val. Review
Model 1	-6,61648	-4,00111	0	-7,02319	-4,00051	0	0,048782	0,216
Model 2	-6,62266	-3,4606	0	-7,06697	-3,46017	0	0,075653	0,739
Model 3	-4,9025	-2,57571	0	-7,01544	-2,57556	0		

Source: made by the auteurs

The stationarity tests show that at the 5% risk threshold the log(IPCMA) variable is not stationary in level in model 1 (with constant term and linear trend), in model 2 (with constant term and no linear trend) and in model 3 (without constant term and no linear trend). However, stationarity tests show that the first-difference series is stationary for all three models. We conclude that the log(IPCMA) variable is I(1).

6.5 STATIONARITY TESTS FOR THE EUROPEAN UNION CONSUMER PRICE INDEX :

The following table shows the results of the ADF, PP and KPSS tests on the European Union consumer price index series expressed in logarithm:

Table-9: Stationarity tests for the logarithm of the EU consumer price index

	LEVEL							
	ADF			***PP***			***KPSS***	
	Statistics	Val. Review	P-value	Statistics	Val. Review	P-value	Statistics	Val. Review
Model 1	-2,05695	-4,00301	0,5662	-0,89605	-4,00032	0,9535	0,295759	0,216
Model 2	-1,28924	-3,46194	0,6347	-1,6935	-3,46004	0,4332	1,934061	0,739
Model 3	2,127503	-2,57618	0,9922	7,29389	-2,57552	1		
	1st difference							
	ADF			PP			KPSS	
	Statistics	Val. Review	P-value	Statistics	Val. Review	P-value	Statistics	Val. Review
Model 1	-2,8556	-4,00301	0,1794	-9,7526	-4,00051	0	0,076143	0,216
Model 2	-2,66578	-3,46194	0,0818	-10,074	-3,46017	0	0,284231	0,739
Model 3	-1,19705	-2,57618	0,2114	-8,75156	-2,57556	0		

Source: made by the auteurs

The stationarity tests show that at the 5% risk threshold the log variable (IPCUE) is not stationary in level in model 1 (with constant term and linear trend), in model 2 (with constant term and without linear trend) and in model 3 (without constant term and without linear trend). On the other hand, the stationarity tests show that, at the 10% risk threshold, the series of first differences is stationary for model 2. Consequently, the log variable (IPCUE) is I (1).

6.6 COINTEGRATION TESTS BETWEEN THE NOMINAL EXCHANGE RATE AND PRICE INDICES

The three variables in question are integrated of order 1, and it remains to be seen whether or not they are cointegrated. If this is the case, then the real exchange rate (expressed as a logarithm) which is their combination will be stationary and we can therefore conclude that the PPP between Morocco and its main trading partner is valid.

Before testing the cointegration of the three variables using the Johansen test, we first need to find the optimal number of lags to include in the test. This number is selected using information criteria such as the AIC, BIC and HQ criteria, with the optimal number of lags being the one that minimises the information criteria.

The table below shows the result of the selection:

Table-10: Criteria for selecting the optimum number of delays

LAG	***AIC***	***SC***	***HQ***
0	-12.38558	-12.3376	-12.36618
1	-25.05616	-24.86426	-24.97858
2	-25.46745	-25.13162*	-25.33168
3	-25.47293	-24.99317	-25.27896
4	-25.62134	-24.99765	-25.36918
5	-25.66773	-24.90011	-25.35738
6	-25.79182	-24.88028	-25.42328
7	-25.91571	-24.86024	-25.48898
8	-26.24325	-25.04385	-25.75833*
9	-26.23618	-24.89285	-25.69306
10	-26.19219	-24.70494	-25.59089
11	-26.31055	-24.67936	-25.65105
12	-26.35296*	-24.57784	-25.63527

Source: made by the auteurs

The three information criteria do not provide the same number of lags: the AIC criterion recommends 12 lags, the BIC criterion suggests 2 lags and the HQ criterion suggests 8 lags. Unfortunately, the choice may

strongly influence the conclusion of the Johansen test as to the cointegration of the variables. We will therefore consider the three possibilities and try three Johansen tests, each corresponding to the number of lags (Lag) 2, 8 and 12. The results of the trace and maximum eigenvalue tests are summarised in the table below, where "r" denotes the number of long-term relationships retained.

Table-11: Cointegration test results

		Trace test				Maximum eigenvalue test			
		Statistics	Critical value	p-value	r	Statistics	Critical value	p-value	r
Lag = 2	No	27.50962	29.79707	0.0898	0	12.36868	21.13162	0.5117	0
	No more than 1	15.14094	15.49471	0.0565		11.04982	14.26460	0.1517	
	No more than 2	4.091122	3.841466	0.0431		4.091122	3.841466	0.0431	
Lag = 8	No	33.86281	29.79707	0.0161	1	23.21665	21.13162	0.0251	1
	No more than 1	10.64617	15.49471	0.2342		6.901721	14.26460	0.5008	
	No more than 2	3.744446	3.841466	0.0530		3.744446	3.841466	0.0530	
Lag = 12	No	17.34538	29.79707	0.6145	0	12.09439	21.13162	0.5384	0
	No more than 1	5.250991	15.49471	0.7816		5.026543	14.26460	0.7385	
	No more than 2	0.224448	3.841466	0.6357		0.224448	3.841466	0.6357	

Source: made by the auteurs

The trace and maximum eigenvalue tests find no long-run relationship between the nominal exchange rate and the consumer price indices if the optimal number of lags is set at 2 or 12. On the other hand, if this number is equal to 8, the two previous tests find a single long-term relationship between the three variables under consideration.

6.7 ECONOMIC INTERPRETATION OF RESULTS

Econometrically, purchasing power parity is verified by two main methods: the first is based on stationarity tests for the real exchange rate and the second is based on the cointegration test between the nominal exchange rate and relative prices.

According to the first method, the existence of a unit root indicates the non-stationarity of the real exchange rate and therefore the rejection of PPP. On the other hand, confirmation of the stationarity of the real exchange rate leads us to accept the validity of PPP.

The results obtained in this article show that the real exchange rate is not stationary at the 5% risk threshold, whatever the test used, thus confirming the rejection of the PPP in its absolute version between Morocco and the European Union for the period considered. This coincides with the work of Doganlar and Ozmen (2000), Holmes (2001a), Cerrato and Sarantis (2007) and Pesaran et al. (2009) who applied unit root tests to panel models. Doganlar and Ozmen (2000) tested the PPP hypothesis between 18 developing countries and the United States of America using monthly data observed between January 1986 and April 1997. They found that none of the real exchange rate series is stationary for these countries. Similarly, Holmes (2001) tested PPP between 30 developing countries and the United States using quarterly data from 1973 to 1999. Here again, the tests generally rejected PPP for these countries and for the period under consideration. Cerrato and Sarantis (2007) tested PPP between 34 emerging market economies and the United States of America using monthly data from January 1973 to December 1998. The tests rejected the averaging of real parallel market exchange rates for most (but not all) emerging market economies and therefore concluded that PPP was invalid for these countries. Finally, Pesaran et al (2009) tested PPP between 22 developed countries and 27 developing countries vis-à-vis the United States using quarterly data between 1957 and 2001. PPP was generally rejected for these countries.In order to verify the robustness of this result, the second method, based on the cointegration test itself based on stationarity tests, consists of testing the existence of long-term

relationships between the variables studied. In the case of PPP, we are looking for long-term relationships between the nominal EUR/MAD exchange rate, the Moroccan consumer price index and the European Union consumer price index expressed in logarithm. Depending on the information criterion chosen to determine the optimal number of lags to include in the Johansen cointegration test, the decision may change. If we choose the BIC and AIC criteria, we include 2 and 12 lags respectively in the trace and maximum eigenvalue tests, and we find no long-run relationship between the nominal exchange rate and the consumer price indices (transformed into logarithms). The absolute PPP between Morocco and the European Union is therefore rejected by the cointegration test and we find the same conclusion as that provided by the stationarity tests. On the other hand, if we opt for the HQ information criterion, we retain 8 lags in the trace and maximum eigenvalue tests and find a single long-run relationship between the nominal exchange rate and the consumer price indices (transformed into logarithms). The absolute PPP between Morocco and the European Union is therefore validated by the cointegration test, unlike the stationarity tests which validated it. Overall, our results are mixed, as it is difficult to find a compromise between the results of the stationarity tests and the cointegration tests. This ambiguity essentially stems from the number of delays to be included in the Johansen test retained by each of the information criteria. Mixed results have also been found by Cheung and Lai (1993), Salehizadeh and Taylor (1999), Drine and Rault (2008) and Selmi (2014). Indeed, Cheung and Lai (1993) studied the validity of PPP between Canada, France, Italy, Japan and the United Kingdom over the period from 1914 to 1989 using a cointegration approach and found mixed results. Salehizadeh and Taylor (1999), tested the PPP hypothesis between 27 countries (developing and emerging) and the United States of America by applying a panel cointegration test on monthly data from January 1975 to September 1997 and found mixed results. Drine and Rault (2008) analysed PPP for 80 countries (developed and developing) using annual real effective exchange rate data between 1964 and 1998 and applying a panel cointegration test and found mixed results. Finally, Selmi (2014) found mixed results, studying the PPP between Tunisia and its main trading partners such as Germany, the United States of America, France, Italy, the United Kingdom, Morocco and Libya using a fractional cointegration test on monthly data from January 1990 to December 2006.

CONCLUSION

By way of conclusion, we have attempted to test the validity of purchasing power parity between Morocco and the European Union. The first approach, based on stationarity tests of the real EUR/MAD exchange rate, rejected the validity of PPP for the period in question. On the other hand, the second approach based on Johansen's cointegration test led to two conclusions: if the choice of the number of delays is set using the AIC and BIC information criteria, we reject the validity of PPP and return to the conclusion of the first approach. On the other hand, if the choice of the number of delays is set using the HQ criterion, the APP is valid, but this contradicts the conclusion of the first approach. The results obtained are therefore mixed, as has been the case in certain empirical studies. The PPP hypotheses are not economically verifiable, because competition between markets is not perfect (due to customs barriers, for example) and transport costs are not zero. Econometrically, the unit root and cointegration tests used to test PPP suffer from a number of limitations that can lead to erroneous conclusions in some cases. Some of these limitations have been resolved, but others remain to be resolved, in particular the sensitivity of the Johansen test to the information criterion chosen to set the optimal number of delays to be included in the test.

REFERENCES

Alba and Papell (2007), Purchasing power parity and country characteristics: Evidence from panel data tests. Journal of Development Economics, volume 83, number 1, pp: 240 - 251.

Alba and Park (2003), Purchasing power parity in developing countries: Multi- period evidence under the current float, World Development 31, issue 12, pp: 2049-2060.

Ali M Kutan and Su Zhou, PPP may hold better than you think: Smooth breaks and non-linear mean reversion in real effective exchange rates, Economic Systems 39 (2015), no. 2, 358-366.

Arize, Malindretos and Nam (2010), Cointegration, dynamic structure, and the validity of purchasing power parity in African countries. International Review of Economics & Finance, volume 19, number 4, pp: 755 - 768.

Bahmani-Oskooee, Chang and Lee (2016), Purchasing power parity in emerging markets: A panel stationary test with both sharp and smooth breaks. Economic Systems, volume 40, number 3, pp: 453 - 460.

Bahmani-Oskooee, Chang and Wu (2014), Revisiting purchasing power parity in African countries: panel stationary test with sharp and smooth breaks. Applied Financial Economics,

Baizhu Chen, Long-run purchasing power parity: evidence from some european monetary system countries, Applied Economics 27 (1995), no. 4, 377{383.

Balassa (1964), The purchasing power parity doctrine: A reappraisal. Journal of Political Economy, volume 72, number 6, pp: 584-596.

Camarero, Cuestas and Ordonez (2006), Purchasing power parity versus the European union in the Mediterranean countries. Applied Financial Economics, volume 16, number 1-2, pp: 157- 167.

Cerrato and Sarantis (2007), Does purchasing power parity hold in emerging markets? Evidence from a panel of black market exchange rates. International Journal of Finance & Economics, volume 12, number 4, pp: 427 - 444.

Cheung and Lai (1993), A fractional cointegration analysis of purchasing power parity, Journal of Business & Economic Statistics, volume 11, number 1, pp: 103-112.

Chiu (2002), Testing the purchasing power parity in panel data. International Review of Economics & Finance, volume 11, no. 4, pp: 349 - 362.

Chun Jiang, Na Jian, Tie-Ying Liu, and Chi-Wei Su, Purchasing power parity and real exchange rate in central eastern european countries, International Review of Economics & Finance 44 (2016), 349{358.

Divino, Teles and Pinto (2009), On the purchasing power parity for Latin American countries. Journal of Applied Economics, volume 12, number 1, pp: 33.

Doganlar and Ozmen (2000), Purchasing power parity and real exchange rates in case of developing countries. Istanbul Stock Exchange Review, volume 4, number 16, pp: 91-102.

Drine and Rault (2008), Purchasing power parity for developing and developed countries: what can we learn from non-stationary panel data models? Journal of Economic Surveys, volume 22, number 4, pp: 752-773.

François Pétry, Guide pratique d'introduction à la régression en sciences sociales, Presses Université Laval, 2003.

Hassanain (2004), Purchasing power parity and cross-sectional dependency, South African Journal of Economics, volume 72, number 2, pp: 238-257.

Holmes (2001), New evidence on real exchange rate stationarity and purchasing power parity in less developed countries. Journal of Macroeconomics, volume 23, number 4, pp: 601 - 614.

Holmes (2001), Principal components, stationary, and new evidence of purchasing power parity in developing countries. The Developing Economies, volume 39, number 2, pp: 189 - 198.

Holmes (2002), Purchasing power parity and the fractional integration of the real exchange rate: new evidence for less developed countries. Journal of economic development, volume 27 number 1, pp: 125- 135.

Holmes and Wang (2005), Do African countries move asymmetrically towards purchasing power parity? South African Journal of Economics, volume 73, number 2, pp: 292-301.

Jacob A Frenkel, Purchasing power parity: doctrinal perspective and evidence from the 1920s, Journal of International Economics 8 (1978), no. 2, 169{191.

Jiang, Jian, Liu and Su (2016), Purchasing power parity and real exchange rate in central eastern European countries. International Review of Economics & Finance, volume 44, pp: 349 - 358.

John Y Campbell and Robert J Shiller, Interpreting cointegrated models, Journal of Economic Dynamics and Control 12 (1988), no. 2-3, 505{522.

Jose Angelo Divino, Vladimir Kuhl Teles, and Joaquim Pinto De Andrade, On the purchasing power parity for Latin American countries, Journal of Applied Economics 12 (2009), no. 1, 33{54.

Juan Carlos Cuestas and Paulo Jos'e Regis, Purchasing power parity in oecd countries: Nonlinear unit root tests revisited, Economic Modelling 32 (2013), 343{346.

Kadir Karagöz and T Bahadır Sara¸c, Testing the validity of ppp theory for turkey: Nonlinear unit root testing, Procedia Economics and Finance 38 (2016), 458{467.

Kargbo (2003), Cointegration tests of purchasing power parity in Africa. World Develop- ment, volume 31, number 10, pp: 1673 - 1685.

Kargbo (2004), Purchasing power parity and exchange rate policy reforms in Africa reforms. South African Journal of Economics volume 72, number 2, pp: 258 - 281.

Kargbo (2006), Purchasing power parity and real exchange rate behavior in Africa. Applied Financial Economics, volume 16, number 1-2, pp: 169-183.

Keith Cuthbertson and Dirk Nitzsche, Quantitative financial economics: stocks, bonds and foreign exchange, John Wiley & Sons, 2005.

Kenneth A Froot and Kenneth Rogoff, Perspectives on ppp and long-run real exchange rates, Handbook of international economics 3 (1995), 1647{1688.

Kutan and Zhou (2015), PPP may hold better than you think: Smooth breaks and non-linear mean reversion in real effective exchange rates. Economic Systems, volume 39, number 2, pp: 358 -366.

Giorgia Ginovannetti (1993): "Théorie de la parité des pouvoirs d'achat : les difficultés d'une vérification empirique" Problèmes économiques N° 2314 du 24 Fév.

Lopez and Papell (2007), Convergence to purchasing power parity at the pommencement of the euro. Review of International Economics, volume 15, number 1, pp: 116.

Lothian (2016), Purchasing power parity and the behavior of prices and nominal exchange rates across exchange rate regimes. Journal of international money and finance, volume 69, pp: 5-21.

Magda Kandil and Ida Mirzaie, The effects of exchange rate fluctuations on output and prices: evidence from developing countries, The Journal of Developing Areas (2005), 189{219.

Melvin and Bernstein (1984), Trade concentration, openness, and deviations from purchasing power parity. Journal of International Money & Finance, volume 3, number 3, pp: 369 - 376.

Mohamed Adel Barhoumi, Traitement des données manquantes dans les données de panel: cas des variables dichotomiques, Ph.D. thesis, Universit'e Laval, 2006.

Mohsen Bahmani-Oskooee, Tsangyao Chang, and Kuei-Chiu Lee, Purchasing power parity in emerging markets: A panel stationary test with both sharp and smooth breaks, Economic Systems 40 (2016), no. 3, 453{460.

Narayan and Prasad (2005), The validity of purchasing power parity hypothesis for eleven middle eastern countries. Review of Middle East Economics and Finance, volume 3, number 2, pp: 135-149.

Pesaran, Smith, Yamagata and Hvozdyk (2009), Pairwise tests of purchasing power parity. Econometric Reviews, volume 28, number 6, pp: 495 - 521.

Rogoff (1996), The purchasing power parity puzzle. Journal of Economic Literature, volume 34, pp: 647-668.

Salehizadeh and Taylor (1999), A test of purchasing power parity for emerging economies. Journal of International Financial Markets, Institutions and Money, volume 9, number 2, pp: 183 - 193.

Selmi (2014), A fractional cointegration analysis of purchasing power parity: Evidence of ELW. International Journal of Management and Sustainability, volume 3, issue 11, pp: 664-672.

Tsangyao Chang, Chia-Hao Lee, and Wen-Chi Liu, Nonlinear adjustment to purchasing power parity for asean countries, Japan and the World Economy 24 (2012), no. 4, 325{331.

Wu, Cheng and Hou (2011), Further evidence on purchasing power parity and country characteristics. International Review of Economics and Finance, volume 20, number 2, pp: 257-266.

Yilanci and Eris (2013), Purchasing power parity in African countries: Further evidence from Fourier unit root tests based on linear and non-linear models. South African Journal of Economics, volume 81, number 1, pp: 20-34.

Yildirim (2017), Empirical investigation of purchasing power parity for Turkey: Evidence from recent nonlinear unit root tests, Central Bank Review, volume 17, issue 2, pp: 39 - 45.

Yin-Wong Cheung and Kon S Lai, A fractional cointegration analysis of purchasing power parity, Journal of Business & Economic Statistics 11 (1993), no. 1, 103{112.

Zhou and Kutan (2011), Is the evidence for ppp reliable? A sustainability examination of the stationarity of real exchange rates. Journal of Banking & Finance, volume 35, number 9, pp: 2479-2490.