



TESTING THE PPP USING UNIT ROOT TESTS WITH STRUCTURAL BREAKS: EVIDENCE FROM POLITICALLY UNSTABLE ARAB COUNTRIES

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ABSTRACT

This study examines the validity of the Purchasing Power Parity (PPP) in four Arab countries that recently experienced political instability, those being Syria, Egypt, Tunisia, and Bahrain. Using monthly data of the real effective exchange rates (REER) of the countries in question from 1995 to 2014, the study utilizes the ADF test along with unit root tests that account for endogenous structural breaks in the data, this includes the Zivot and Andrews one structural break test and the Lumsdaine and Papell one, two and three structural breaks tests. The findings were in favor of the PPP in Syria, Egypt and Tunisia when the Lumsdaine and Papell three structural breaks test was applied. The findings also confirm the importance of capturing the right number of the breaks in the data as tests that failed to account for structural breaks in the data were more against the PPP. Interestingly, the findings reveal that the political instability did not cause a structural break for Syria and Egypt, which validates the criticism to the Perron test that exogenously defining structural breaks might not be appropriate.

Keywords: Purchasing power parity (PPP), Unit root tests, Structural breaks, Lumsdaine and Papell test, Zivot and Andrews test, Political instability, Arab countries.

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Contribution/ Originality

This study contributes to the PPP literature as it is the first, up to our knowledge, that examines the validity of the PPP in the presence of a structural break triggered by political instability as the one experienced recently by many Arab countries.

1. INTRODUCTION

Despite being broadly examined in the literature since its development by Gustaf Cassel in 1918, the theory of Purchasing Power Parity (PPP) is still widely used to model the behavior of exchange rates as it has important implications for academicians and policy makers. More specifically, it could be used in determining the degree of misalignment of the nominal exchange rate and the appropriate policy response, the setting of exchange rate parities, and the international comparison of national income levels (Sarno and Taylor, 2002). In addition to this, the PPP is still on the center of attention due to the inconclusive evidence regarding its validity. In other words, there are still too many questions that need to be explored regarding whether the PPP does or does not hold.

In its absolute version that is built on the law of one price, and based on the assumptions that all goods are identical and transportation costs and trade barriers are very low in both countries, the PPP postulates that the

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same basket of goods and services should cost the same when expressed in terms of the same currency (Isard, 1995). The relative version of the PPP however takes into account the possibility of market imperfections such as the presence of tariffs, non tariff barriers¹ and transportation costs. It postulates that the exchange rate changes for two countries will be proportional to the relative inflation of each country (Sarno and Taylor, 2002).

For the PPP to hold, the real exchange rate has to be constant. If there are movements in the real exchange rate on the other hand, this means that there are deviations from the PPP (Sarno and Taylor, 2002). It is generally accepted though that the PPP does not explain the short run exchange rate dynamics (Frenkel, 1978; Frenkel, 1981) instead it is more like a long run theory of the behavior of exchange rates in the developed and developing countries (Rogoff, 1996). In other words, as argued by Frenkel, due to temporary shocks and prices stickiness that might happen in the goods market, the PPP will be violated on the short term. However, the impact of shocks should be temporary and if there are no other disturbances, the real exchange rate should revert to its mean value on the long term (Astogra, 2010).²

Tests conducted to validate the PPP developed over time. Early tests of the PPP involved regressing the nominal exchange rate on the price levels of the two countries, this was criticized later on as such tests do not take into account the stationarity condition of the data which could result in a spurious regression. Thus, later tests focused on the stationarity of the exchange rate and they mainly were revolving around unit root tests and mean reversion. Tests that followed were based on the Engle and Granger cointegration approach. That is to say, they were based on the idea that although the exchange rate and the relative price level might not be stationary, they could still be cointegrated over the long term (Sarno and Taylor, 2002).

Early studies on the validity of the PPP used data from the pre-1914 gold standard to the managed float of the 1970s. The findings were mostly in favor of the PPP (Officer, 1982; McCloskey and Zecher, 1984). Interestingly, the same conclusion could not be reached by early studies that examined the post Bretton Woods era (Roll, 1979; Adler and Lehmann, 1983; Darby, 1983). These studies revealed that the PPP does not hold as exchange rates do not exhibit mean reversion, instead they follow the random walk model. Froot and Rogoff (1995) commented on this by referring that what was a “dull topic a decade ago”. i.e. testing the PPP due to the conclusive evidence in favor of it, became a subject of a growing body of literature due to the new evidence against its validity.

The failure to support the PPP in the post Bretton Woods era (1970s-mid 1990s) was later on attributed by many researchers to the use of short span data³ and the low power of the tests applied. In other words, the unit root tests could have a low power in small samples (Wu, 1996; Caner and Kilian, 2001). Applying a longer period however, could also bias the results. This is because longer periods are more likely to include data from different exchange rate regimes, and thus being affected by structural breaks; accordingly, interpreting the results would not be easy (Taylor and Taylor, 2004). Following the criticism on the use of time series data in testing the PPP, a new trend of studies (Breitung and Meyer, 1994; Pedroni, 2001; Levin *et al.*, 2002; Im *et al.*, 2003) started applying panel data to test for the validity of the PPP. Despite the fact that the use of panel data overcomes the flaws inherited in using tests based on time series data, the use of the panel data also provided inconclusive evidence. In addition, Taylor and Sarno (1998) warned against the interpretation of the findings when panel data is used. This stems from the fact that the null hypothesis under the panel data test is that none of the exchange rates of interest is mean

¹ Such as the strict inspection requirements imposed by the government on the foreign goods Rogoff (1996).

² The degree to which mean reversion takes place is often measured by the half-life, a measure of the persistence of shocks, that indicates how long it takes for the impact of a unit shock to dissipate by half Kula, Aslan and Feridun (2011).

³ Frankel (1986;1990). highlighted that if the speed of convergence to PPP is slow, examining the PPP over a short time span will lead to biased results towards its rejection.

reverting. If the null is rejected however, this means that at least one of them is mean reverting. Nevertheless, researchers are over interpreting the results as all the examined exchange rates are mean reverting.⁴

Other trend of studies testing the PPP applied time series models with long period spans but after controlling for structural breaks. Structural breaks could be resulted from any significant economic, financial, or political events. That is to say, it could take any of the following: changes in exchange rate regimes such as switching from a fixed to a managed or a free float system, financial and currency crises, financial liberalization, and external forces such as economic sanctions and wars (Yahya *et al.*, 2011). Perron (1989) was amongst the first who highlighted the importance of controlling for structural breaks in the data. He revealed that controlling for the structural break led to a different conclusion regarding the unit root null hypothesis, as his evidence were more in favor of rejecting the unit root hypothesis. The Perron test however, was based on specifying the break exogenously based on a previous knowledge or examination of the data. This was criticized later on by Christiano (1992) who pointed that such a determination of the break allows for 'data mining'. In addition, it might lead, as suggested by Zivot and Andrews (1992) to an over rejection of the unit root hypothesis. Trying to overcome the criticism to the Perron test, Zivot and Andrews have developed their model which allows for the break to be endogenously determined. In line with their argument, Zivot and Andrews reached different conclusions about the rejection of the unit root hypothesis in several of the macro economic variables that were tested by Perron. Nevertheless, the Zivot and Andrews test only accounts for the most significant break in the data whereas there might be multiple breaks in the data that are not accounted for. Lumsdaine and Papell (1997) extended the one endogenous break of the Zivot and Andrews test to take into account two endogenous breaks. Their findings were in favor of more rejection of the unit root hypothesis than that reported by the Zivot and Andrews test. Recently, the Lumsdaine and Papell test was extended further to account for a higher number of structural breaks in the data.

Worth noting that studies that tested the PPP using unit root tests with structural breaks were mainly concerned with the structural breaks caused by financial crisis. Nusair (2003) and Allsopp and Zurbruegg (2003) for example were interested on the impact of the Asian financial crisis on the PPP. Voiena (2013); Biqing and Xiaowe (2012) and Rashid and Saedan (2013) on the other hand examined the impact of the 2008 financial crisis on the PPP. In addition to other studies that only conducted structural break tests without a pre specified interest on the driver of the break (For example, Kula *et al.* (2011)). Little attention has been paid though to test the PPP under structural breaks caused by political instability. In fact, the crisis faced by several Arab counties since 2011 raises the question of the impact of such political instability on the validity of the PPP in these countries.

Interestingly, studies that examined the PPP in the MENA countries did not provide conclusive evidence on its validity. Bahmani-Oskooee (1998) tested the PPP in a sample of 11 Middle Eastern countries (9 Arab countries, Iran and Turkey). He tested the stationarity of the real effective exchange rates using the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) and the Augmented Dickey-Fuller (ADF) univariate unit root tests. His results revealed that in most cases the results of the KPSS supported the PPP whereas those of the ADF test did not. Salehizadeh and Taylor (1999) tested the PPP for 27 developing countries including 4 Arab countries those being Algeria, Bahrain, Egypt and Morocco. They used monthly data for the post-Bretton Woods period of 1975-1997. Applying cointegration tests of price indices and exchange rates, they found evidence of long run PPP as the variables of interest were cointegrated in 14 countries including Bahrain, Egypt and Morocco. Hassanain (2004) examined the PPP in 10 Arab countries including Egypt, Bahrain, Syria and Tunisia. Using panel unit root tests from 1980 to 1999, the author found evidence in favor of the PPP. El-Ramly (2005) applied a panel unit root test to examine the

⁴ Even if the results are not over interpreted as all exchange rates are mean reverting, a rejection of the null does not provide us with a clear understanding on which countries have exchange rates that are mean reverting. That is to say, all we know is that the hypothesis that all exchange rates are not mean reverting is rejected.

PPP in 12 Arab countries including Syria, Tunisia, Egypt, and Bahrain for the period 1969-2002. She applied four unit root tests to examine mean reversion in the real exchange rate of the countries in question. Her findings revealed that evidence supporting the PPP is generally weak. [Cashin and Mcdermott \(2006\)](#) tested for the PPP using real effective exchange rates for 20 developed and 70 developing countries including Syria and Egypt from 1973-2002. The authors utilized the median-unbiased estimation techniques that remove the downward bias of least squares. They reported evidence in favor of the PPP in the majority of countries as the deviations from the PPP were found finite. They noted that the speed of reversion is higher for developed countries and for countries with flexible exchange rates. [Drine and Rault \(2008\)](#) applied panel unit root and cointegration techniques proposed by [Pedroni \(1999;2004\)](#) to examine the validity of PPP. They utilized a sample of 80 developed and developing countries including Middle Eastern countries from 1970-1997. They reported weak PPP for MENA countries. [Kula et al. \(2011\)](#) used a sample of 13 MENA countries, including Syria, Egypt and Tunisia from 1970 to 1998 to examine the validity of the PPP. Utilizing Lagrange Multiplier unit root test that endogenously determines structural breaks, they reported that the PPP holds in all countries when the Lagrange Multiplier test with two structural breaks was applied. [Al-Gasaymeh and Kasem \(2015\)](#) applied four panel unit root tests to examine the PPP in different geographical regions including the Middle East. They used quarterly data from 2004 to 2014. The authors failed to find evidence in favor of the PPP in the Middle Eastern countries that were examined.

The lack of consensus on the empirical validity of PPP in general and in the Arab countries in particular, along with the scarcity of research that focused on the Arab countries that are currently facing political instability, motivated further testing of the PPP in these countries.

The aim of the study is three folds: First, to examine the validity of PPP in Arab countries that are facing political instability, those being: Syria, Egypt, Tunisia, and Bahrain. More precisely, it aims to explore whether the political instability that erupted in 2011 caused a structural break in the data that should be taken into account before judging the PPP in the above mentioned countries. Second, it aims to reinvestigate the ability of the exogenously defined breaks to accurately specify the real timing of the breaks with the focus is mainly being on the political instability that erupted in 2011. Third, it aims to reinvestigate the impact of failing to account for structural breaks in the data on the validity of PPP.

The findings of the study should provide new evidence on the behavior of exchange rates and therefore should be of interest not only to investors but also to policy makers. More specifically, investors, including corporate managers, may use the implied deviation from PPP to assess the risk of a future currency crisis. Similarly, knowing whether the PPP holds is important for policy makers, as if it holds, then the effects of a shock to the real exchange rates would only be transitory. Meaning that, real exchange shocks would have no adverse impact on trade flows on the long run ([Aslan, 2010](#)).

The remainder of this study proceeds as follows: section two describes the data and explains the methodology, section three displays the results and discussion, and section four concludes the study.

2. DATA AND METHODOLOGY

2.1. Data

This study focuses on the following four Arab countries Syria, Egypt, Tunisia, and Bahrain as these countries are facing political instability since 2011. To test the validity of PPP in these countries, monthly real effective exchange rate data for the period 1995-2014 was used.⁵The exchange rate was measured by the natural logarithm

⁵ The reason for not extending the data beyond 1995 is the data availability for the countries in question.

of the real effective exchange rates of the countries in question. Data for real effective exchange rates were collected from Bruegel Association.

The importance of using the effective exchange rate emerges from the fact that the use of bilateral exchange rate in testing the PPP is criticized as it ignores the large correlation that might exist between exchange rate movements which could lead to imprecise estimates (Hakkio, 1984). In addition, the PPP might hold between a country and its major trading partners rather than between isolated countries (Officer, 1980). One way to address this issue is to assess whether the PPP holds by using a single rate, such as the effective exchange rate, which is a weighted average of a country's bilateral exchange rates with its major trading partners (Bahmani-Oskooee *et al.*, 2008).⁶ Worth noting that the effective exchange rate has been used in a number of previous studies (Schotman, 1989; Abuaf and Jorion, 1990; Bahmani-Oskooee, 1998; Cashin and McDermott, 2006).

2.2. Methodology

The real effective exchange rate (REER) is calculated as:

$$REER_t = \frac{NEER_t \cdot CPI_t}{CPI_t^{foreign}} (1)$$

Where $REER_t$ is the real effective exchange rate of the country of interest, $NEER_t$ is the nominal effective exchange rate of the country of interest against a basket of currencies of its trading partners. The NEER is calculated as the geometrically weighted average of the nominal bilateral exchange rate of the country of interest and its trading partners. The NEER is expressed in terms of the indirect method. That is to say the foreign currency price of a unit of domestic currency. CPI_t is the consumer price index in the country of interest and $CPI_t^{foreign}$ is the geometrically weighted average of the CPI_t indices of the trading partners of the country of interest.

Equation (1) indicates that an increase in the REAR could result either from an increase in the NEER which means an appreciation of the domestic currency, an increase in the domestic CPI or a decrease in the foreign CPI.

Unit root tests are widely used in the literature to examine whether a time series data is stationary (mean reverting) or random. If the series has a unit root, then it is following the random walk model without reverting to its mean and as a result, the PPP is rejected. Alternatively, if the series is stationary, no unit root is detected, then it has a long-run mean reversion and therefore, the PPP holds on the long run (Froot and Rogoff, 1995; Rogoff, 1996).

To test for the presence of a unit root in the exchange rate series, the ADF test is first applied. However, this test, as referred earlier, does not take into account the presence of structural breaks in the data. In order to capture the structural breaks in the data, we employ the Zivot and Andrews (1992) test which endogenously captures one structural break in the REER. Capturing only one break however, might not be sufficient and could lead to a loss of information particularly when in reality there are multiple breaks (Lumsdaine and Papell, 1997; Valadkhani *et al.*, 2005). To address this issue, the Lumsdaine and Papell test with two and three structural breaks are used. Below is a brief explanation of the tests applied.

2.2.1. The ADF Test

The ADF test developed by Said and Dickey (1984) is one of the most widely used unit root tests, the test is applied as follows

⁶ Despite being broadly used in the literature, the weights used in the calculation of the REER are mainly criticized for being time invariant. In other words, while the importance of trading partners might change from year to year, the weights do not change but remain constant as when constructed. Although this limitation is acknowledged by Bruegel Association, the association argues that using time variant weights might also be problematic Darvas (2012).

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^k \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (2)$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^k \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (3)$$

$$\Delta Y_t = \beta_1 + \beta_2 T + \delta Y_{t-1} + \sum_{i=1}^k \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (4)$$

Where T is the time series being tested (REER), ΔY_t is the first difference of the variable, β_1 is the constant, β_2 is the estimated coefficient for the deterministic trend T , ρ and δ are coefficients to be estimated, K is the lag length, and ε_t is a pure white noise.

The unit root test tests the hypothesis that $\delta = 0$ against the alternative hypothesis that $\delta < 0$. Failing to reject the null hypothesis implies the presence of a unit root and thus the series is not stationary.

Worth noting that in equation (2), if the null is rejected then the series is stationary with zero mean, in equation (3) and (4) however, a rejection of the null hypothesis indicates that the series is mean stationary and trend stationary respectively.

2.2.2. The Zivot and Andrews (1992) Test

As highlighted earlier, Perron amongst others stressed on the importance of accounting for structural breaks when conducting unit root tests. The Zivot and Andrews (1992) test is preferred to the Perron test however as it endogenously estimates the structural break in the data instead of exogenously specifying it based on a pre knowledge of the data which could allow for data mining.

To estimate the Zivot and Andrews test, the following equations are estimated following Zivot and Andrews (1992):

$$\Delta Y_t = \beta_1 + \beta_2 T + \theta DU_t + \delta Y_{t-1} + \sum_{i=1}^k \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (5)$$

$$\Delta Y_t = \beta_1 + \beta_2 T + \gamma DT_t + \delta Y_{t-1} + \sum_{i=1}^k \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (6)$$

$$\Delta Y_t = \beta_1 + \beta_2 T + \theta DU_t + \gamma DT_t + \delta Y_{t-1} + \sum_{i=1}^k \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (7)$$

Where the dummy variable DU captures structural change in the intercept at time TB ; $DU_t = 1$ if $t > TB$ and zero otherwise; the dummy variable DT_t represents a change in the slope of the trend function (captures shift in the trend variable at time TB); $DT_t = t - TB$ if $t > TB$ and zero otherwise; TB denotes the time of break (Glynn *et al.*, 2007).

As can be seen, while model (5)⁷ allows for a one-time structural break in the intercept, model (6) allows for a one-time structural break in the slope whereas model (7) allows for a one-time structural break in both the intercept and the slope (Narayan and Smyth, 2004).

The null hypothesis under the three models is that the series has a unit root with a drift that excludes any structural breaks whereas the alternative hypothesis is that the series is a trend-stationary process with a one-time break occurring at an unknown point in time (Waheed *et al.*, 2006).

The test considers each point in time as a potential break date (TB) and runs a regression for every possible break date. Then the break date is chosen as the one which minimizes the one-sided t-statistic for the ADF unit root (δ). Worth noting that as the selection of the break time is the outcome of an estimation procedure rather than an exogenous determination, the critical values of the Zivot and Andrews test is different than that of the Perron (1989).

According to Perron (1989) one can adequately model most economic time series data using model 5 or model 7. Therefore, model 5 and 7 became widely used in the literature. Later on however, Sen (2003) documented that

⁷According to Perron (1989), and Zivot and Andrews (1992), models (5), (6), and (7) are named as model (A), (B), and (C) respectively and this naming is widely used by researchers.

using model 5 when in fact the break occurs according to model 7, will lead to a substantial loss in power. Alternatively, if the break is characterized according to model 5, however model 7 is applied, then the loss in power is minor. This led him to suggest that model 7 is superior to model 5.

Because of the superiority of model 7 over model 5, we employ model 7 of the Zivot and Andrews test which allows for one-time structural break in the intercept and in the slope.

2.2.3. The Lumsdaine and Papell (1997) Test

Since the Zivot and Andrews (1992) test captures only the most significant structural break in the data, the Lumsdaine and Papell (1997) unit root test is also applied. This model extends the Zivot and Andrews model C to allow for two breaks in the intercept and slope of the trend function and is named CC by Lumsdaine and Papell (1997).

The model CC is expressed as follows:

$$\Delta Y_t = \beta_1 + \beta_2 T + \theta DU1_t + \gamma DT1_t + \omega DU2_t + \psi DT2_t + \delta Y_{t-1} + \sum_{i=1}^k \rho_i \Delta Y_{t-i} + \varepsilon_t(8)$$

Where the two dummy variables (i.e. $DU1_t$ and $DU2_t$) are indicators for structural breaks in the intercept at time TB1 and TB2, respectively; the other two dummy variables (i.e. $DT1_t$ and $DT2_t$) capture structural breaks in the trend at time TB1 and TB2, respectively. $DU1_t=1$ if $t>TB1$ and zero otherwise; $DU2_t=1$ if $t>TB2$ and zero otherwise; $DT1_t= t-TB1$ if $t>TB1$ and zero otherwise; and finally $DT2_t=t-TB2$ if $t>TB2$ and zero otherwise (Valadkhani et al., 2005).

Worth noting that the null hypothesis under the Lumsdaine and Papell test is the same as the one under the Zivot and Andrews test. That is to say, the series has a unit root that excludes any structural breaks.

In addition to applying the Lumsdaine and Papell test with two structural breaks, the test was extended further to allow for three structural breaks in both the intercept and the trend. The test is conducted under the same null hypothesis as the one with two breaks.

3. RESULTS AND DISCUSSION

The results of the ADF test with intercept and trend are reported in table 1. As can be seen from the table, the calculated t-statistics are lower than the critical values. Hence, one can not reject the unit root null hypothesis for all the examined exchange rate series. Accordingly, based on the results of the ADF test, one can say that none of the series under investigation is stationary at the level, and thus no evidence in favour of the PPP is reported.

Table-1. The results of ADF unit root test

Countries	T-statistic
Syria	-2.123 (2)
Egypt	-0.68 (1)
Tunisia	-2.744 (1)
Bahrain	-1.775 (1)

Notes: Critical values at the 1%, 5%, and 10% are -3.997, -3.429 and -3.138 respectively. The lag length of the ADF test is reported in brackets. The optimal lag length of the ADF test was selected based on the Schwartz Info Criterion (SIC)

As suggested earlier, the failure to find stationarity in exchange rate series may be due to the fact that univariate unit root tests have low power when structural breaks are ignored (Perron, 1989). To address this

problem, we investigated the validity of the PPP by applying the Zivot and Andrews test and the Lumsdaine and Papell test that allow for one, the most significant, structural break.

The results of the Zivot and Andrews test and Lumsdaine and Papell one structural break test are presented in table 2. As revealed in the table, the endogenously captured breaks were year 2008 for Syria, year 2002 for Egypt, year 2004 for Tunisia and year 2002 for Bahrain.

In line with the results of the ADF test, the t-statistics for all the exchange rates in question are less than the critical values; and thus, the null hypothesis of unit root could not be rejected. Accordingly, based on these tests one can draw the conclusion that no evidence is found in support of the PPP in any of the examined countries.

Table-2. The results of unit root test with one structural break

Countries	Zivot and Andrews test			Lumsdaine and Papell test		
	Lag	Break date	coefficient (t-statistics)	Lag	Break date	coefficient (t-statistics)
Syria	4	2008:08	-0.128 (-4.710)	4	2008:07	-0.1278 (-4.2427)
Egypt	3	2002:11	-0.060 (-4.245)	3	2002:10	-0.0600 (-4.245)
Tunisia	4	2004:09	-0.087 (-3.324)	4	2004:08	-0.0876 (-3.3228)
Bahrain	8	2002:11	-0.067 (-2.865)	7	2002:10	-0.0644 (-2.7797)

Notes: Critical values at the 1% (***), 5% (**), and 10% (*) level are -5.570, -5.080 and -4.82 respectively. The optimal lag length is determined by AIC method and following Lumsdaine and Papell (1997) and Ben-David *et al.* (2003) for annual data Kmax is assumed to be equal to eight.

The failure of the Zivot and Andrews test and Lumsdaine and Papell test to find evidence in favour of stationarity despite the fact that these unit root tests allow for a structural break could be due to the failure of these tests to allow for more than one structural break (Aslan, 2010) since, as referred earlier, they only capture the most significant break. Hence, it is interesting to see whether the series remain random if we allow for the existence of more than one structural break in the data and not only the most significant one. For this purpose, we apply the Lumsdaine and Papell (1997) unit root test with two and three structural breaks. The results of these tests are reported in table 3.

Table-3. The results of Lumsdaine and Papell test with two and three structural breaks

Countries	with two breaks			with three breaks		
	Lag	Break date	co-efficient (t-statistics)	Lag	Break date	co-efficient (t-statistics)
Syria	4	1999:11 2008:07	-0.192 (-5.829)	4	1999:11 2008:07 2012:02	-0.219 (-6.588)*
Egypt	3	1999:10 2002:12	-0.126 (-6.588)*	3	2000:03 2003:01 2008:07	-0.263 (-9.317)***
Tunisia	4	1998:07 2004:08	-0.225 (-5.947)	4	1998:07 2004:08 2010:12	-0.271 (-6.579)*
Bahrain	7	2002:10 2011:02	-0.133 (-4.546)	7	2002:10 2008:07 2012:02	-0.215 (-5.941)

Notes: Critical value at the 1% (***), 5% (**), and 10% (*) are -7.1900, -6.7500, -6.4800 respectively. The optimal lag length is determined by the general to specific method suggested by Ng and Perron (1995) and following Lumsdaine and Papell (1997) and Ben-David *et al.* (2003) for annual data Kmax is assumed to be equal to eight.

As can be seen from the table 3, the Lumsdaine and Papell tests with two and three structural breaks capture additional breaks to the ones captured by the Zivot and Andres test and Lumsdaine and Papell one break test. The table reveals that in addition to the 2008 break identified earlier for Syria, the two breaks test captures another break in 1999, and the three- breaks test captures an additional break in 2012. Similarly, in addition to the 2002 break that was captured by the Zivot and Andrews test for Egypt, the Lumsdaine and Papell test with two and three structural breaks capture another break in 1999/2000 and in 2008 respectively. As for Tunisia, the Lumsdaine and Papell test with three structural breaks captures the break in 2004 that was captured by the Zivot and Andrews test along with the break in 1998 that was captured by the Lumsdaine and Papell test with two structural breaks and an additional break in 2012. Similarly, the Lumsdaine and Papell test with three breaks for Bahrain captures a break in 2008 in addition to the 2002 break that was captured by the Zivot and Andrews test, and the 2011/2012 that was captured by the Lumsdaine and Papell two breaks test.

The results of the Lumsdaine and Papell two structural breaks test reveal that the t-statistics of the test are less than the critical values for all the countries examined except Egypt; and thus, we fail to reject the null hypothesis of a unit root for all the countries in question at the 5% level of significance. In the case of Egypt, however, there was a weak evidence in favour of the PPP as the unit root null hypothesis was rejected at the 10% level.

When the Lumsdaine and Papell three structural breaks test was applied, the results were more in favour of mean reversion, and thus of the PPP, relative to the earlier results obtained from unit root tests with no breaks or with lower number of breaks. Table 3 reveals that except for Bahrain where the unit root null hypothesis could not be rejected, the Lumsdaine and Papell three breaks test indicates the rejection of the unit root null hypothesis for Egypt at the 1% level of significance, and for Syria and Tunisia though only at the 10% level of significance.

Overall the results confirm the early concerns about the importance of accounting for the right number of breaks as ignoring a break could lead to the erroneous conclusion of rejecting the PPP against the unit root hypothesis.

Coming back to the breaks that were noticed in the data, it is worth noting that the majority of the breaks captured were in most of the cases linked to: a) changes in exchange rate regimes, b) economic events and political announcements, c) financial crises, and d) political instability and wars.

In fact, the break in 1999-2000 reported in Egypt, coincides with a switch in the IMF De facto exchange rate regime from a conventional fixed peg to a managed floating with no determined path for the exchange rate; the 2003 break in Egypt, could also be linked to the announcement of adopting a floating regime in January 2003; and the 2004 break reported in Tunisia is most probably related to the inability of Tunisia to keep the crawling peg system that it was adopting as later on in 2005, Tunisia had to drop the crawling peg and move into a managed float regime with no-predetermined path for the exchange rate.

The financial crises could also explain the 2008 break captured in Syria, Egypt and Bahrain.⁸ Examining the graphs in Figure (1) indicates that the REER increased (appreciated) in 2008 for these three countries. The appreciation could be attributed to the effect of the 2008 financial crisis on the trade partners as the crisis resulted in a depreciation in the currencies of the trade partners and a decrease in the level of inflation at the international level.⁹ It is worth noting that the 2008 break in Bahrain could also be linked to the record oil prices reported in

⁸ Interestingly, the impact of the 2008 financial crisis was not captured as a break in the REER in Tunisia.

⁹ With the large fall in the Dow Jones Industrial Average (it fell below 11,000 for the first time in two years), it was becoming clear that the crisis is not easy to handle. In July 2008, the financial authorities in the US stepped in to assist America's two largest lenders, Fannie Mae and Freddie Mac, owners or guarantors of 5 trillion worth of home loans [The Telegraph \(n.d\)](#).

July 2008 at \$145.29.¹⁰ That is to say, it is a combination of a depreciation in the currencies of the trade partners and an appreciation in the currency of Bahrain as a result of the record oil prices reported that month.

The economic events and political announcements could explain the break in 1998 in Tunisia, which might be associated with the implementation of the bilateral Association Agreement with the EU,¹¹ and the break in 1999 in Egypt. As on the 5th of October 1999, Dr. Atif Muhammed Obeid was appointed as the new Prime Minister after the re-election of President Mubarak in the National referendum, held on 26 September 1999. Dr. Obeid was viewed in business circles as being pro-liberalisation and pro-privatization, hence, his appointment was widely interpreted as an indication that economic reform would be accelerated.

Our main concern though is, as referred earlier, the break that might have been caused by the political instability in the countries in question. The structural break dates obtained appear to indicate that the impact of the instability in the examined countries is asymmetric. Starting with Syria, the break is reported in 2012. Had this break taken place in 2011, we would have said that it is the structural break that we are expecting to find. i.e. the one resulted from the political instability. However, the fact that the break appeared in 2012 is actually more linked to the issuance of law No. 1131, which stated the movement towards a free exchange rate regime, with the right of the Central Bank of Syria to intervene in the exchange market to correct the exchange rate trends in the market. Interestingly, despite the depreciation in the NEER as a result of the economic crisis that followed the political one, the severe increase in the level of inflation in Syria was exceeding the depreciation level of the NEER which resulted in the upward break in 2012.¹² Overall, the results for Syria reveal that the political instability did not cause a structural break in the same month of its onset, instead, the changes were several months after the onset of the crisis which again validates the criticism to the exogenous determination of the structural breaks.¹³

Surprisingly, the political instability that started in Egypt in January 2011 was not captured by any of the models as a structural break. Again this highlights the importance of not exogenously determining the break as this may not be supported by the data. Unlike the case for Syria and Egypt, apparently, the political instability caused a structural break in Tunisia. In fact, the break captured in December 2010 in Tunisia is associated with the political instability that took place on 18 December 2010, the day after the self-immolation of Mohammed Bouazizi in Sidi Bouzid, which led later on to the ousting of President Zine El Abidine Ben Ali in January 2011.

The February 2011 break reported in Bahrain is most probably linked to the political instability that was transferred from Tunisia to Bahrain, as violent uprising took place between 14 February 2011 and 18 March 2011 in Bahrain. Worth noting that no change of the exchange rate regime or classification was reported in the case of Bahrain; and thus, one can say that this break is more likely a result of the political instability.

¹⁰ The production of petroleum is Bahrain's most exported product. It accounts for 60% of export receipts, 70% of government revenues, and 11% of GDP [CIA World Fact Book Bahrain \(n.d\)](#).

¹¹ The Agreement was signed in July 1995 but not implemented until 1 March 1998.

¹² According to the inflation report issued by the Central Bank of Syria for September 2012: the inflation rate reached 32.38% in the first nine months of 2012 in comparison to 4.07% of same months in 2011. The annual inflation for September 2012 reached 48.10% in comparison to 3.38% in September 2011 [Central Bank of Syria Inflation Report 2011-2012 \(2012\)](#).

The report also indicates that from August 2011 until February 2012 (the month of the break), the annual core inflation rate continued to record higher rates than the general inflation rate. And from March 2012 onward the core inflation rate decreased relative to the general one.

¹³ We are more inclined to believe that the break is not a result of the political instability itself but the deterioration of the economic conditions in Syria that resulted from the political instability later on.

4. CONCLUSION

The political instability faced by several Arab countries since 2011 motivated us to examine the PPP in four Arab countries that were affected by the instability, those being Syria, Egypt, Tunisia, and Bahrain. And hence, unlike previous research that was mainly interested in examining the PPP under the presence of structural breaks caused by financial crisis, this study is interested in examining the PPP under the potential presence of a structural break caused by political instability. In addition, it aimed at providing new evidence on the inability of exogenously specified breaks to capture the right timing of the breaks; and at exploring the impact of failing to account for structural breaks in the data on the conclusion drawn regarding the validity of the PPP.

The study applies monthly time series data of the real effective exchange rates for the countries of interest from January 1995 to December 2014. Data of the real effective exchange rate for the countries of interest were collected from Brugel association. Testing the PPP was conducted through unit root tests, as if the PPP holds over the long run, the exchange rates should be mean reverting. In addition to the ADF test which does not account for structural breaks in the data, the Zivot and Andrews test with one break and the Lumsdaine and Papell test with one, two and three endogenously determined structural breaks were applied.

The findings were in favour of the PPP in Syria and Tunisia at the 10% level of significance and in Egypt at the 5% level of significance when the Lumsdaine and Papell three structural breaks test is applied.¹⁴ The results also indicate that the political crisis did not cause a structural break in Egypt and Syria. This gives credit to the argument that exogenously defining the break, as is the case in Perron test, might be misleading as the exact timing of the break might not be accurately defined. The findings also reassure the importance of allowing for structural breaks while testing the mean reversion as the results of the unit root test were so sensitive to the recognition of breaks in the data. The more breaks the model was able to capture, the more the results were in favour of mean reversion, and thus, ignoring the presence of structural breaks while examining the PPP is more likely to lead to erroneous conclusion regarding its validity.

¹⁴ Worth noting that the results appear to be insensitive to the number of trading partners (138 or 41) used therefore, and for brevity reasons, we only displayed the results using the real effective exchange rates with 138 trading partners.

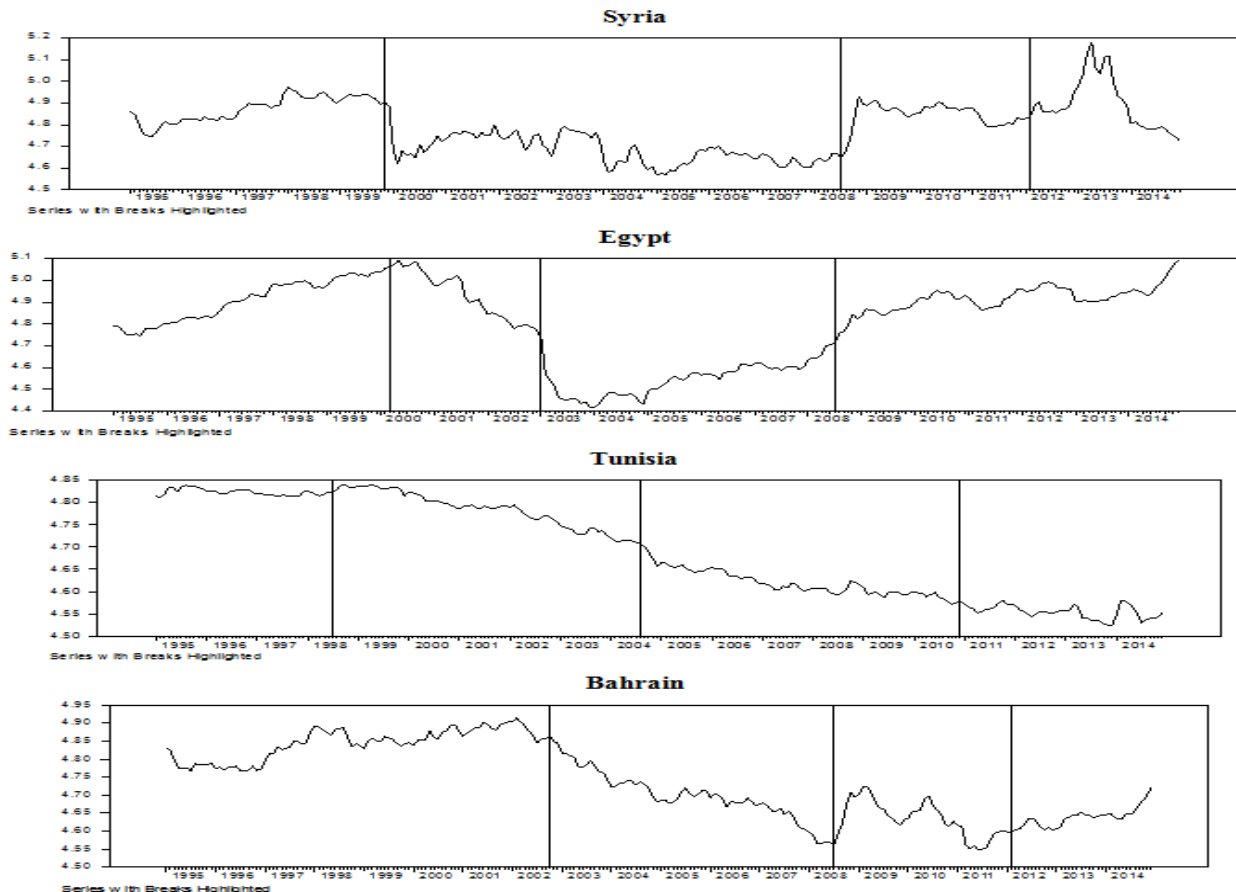


Figure-1. The LP test with three breaks (both intercept and trend)

Source: Eviews output

The fact that ignoring the structural breaks might lead to the erroneous rejection of the PPP raises the question on whether the PPP does not explain the behaviour of the exchange rate in the countries where it was rejected or whether the rejection of the PPP was mainly due to the failure to account for structural breaks in the data. And thus, future research should take on the issue of structural breaks more seriously when examining the unit root null hypothesis. In addition, it is so important that future research uses time variant weights in the calculation of the REER as this might help in reflecting the real weights of trading with the trade partners. We also encourage further research that uses the Lee and Strazicich test as its unit root test is unaffected by breaks under the null.¹⁵

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¹⁵ The relatively short span of the data did not enable us to use the Lee and Strazicich test as their critical values might not be applicable to our data set. However, we are aware that both the Zivot and Andrews test and the Lumsdaine and Papell test were criticized as they assume no break under the unit root null hypothesis which may bias the results toward trend stationarity while in fact it is non stationary with breaks Lee and Strazicich (2003); Narayan and Smyth (2004); Glynn, Perera and Verma (2007). addressed this issue by developing a two-break LM unit root test that is unaffected by breaks under the null.

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