Testing for the purchasing power parity (PPP) hypothesis between South Africa and its main trading partners: application of the quantile approach

Hendriks, Johannes Jurgens and Bonga-Bonga, Lumengo

University of Johannesburg

1 May 2022

Testing for the purchasing power parity (PPP) hypothesis between South Africa and its main trading partners: application of the quantile approach

Abstract

This paper tests whether the PPP theory holds between trading partners, depending on the volume of trade and the existence of trade friction, such as exchange control. The test is applied between South Africa, a country that applies exchange control policy, and its trading partners. The paper makes use of the quantile unit root test and quantile cointegration regression approach to test for the strong and weak-form PPP hypothesis. Strong evidence of the weak-form PPP hypothesis is found for high export countries over all quantiles. Specifically, the existence of weak-form PPP is found for China, the United States, Japan and for the United Kingdom, whereas evidence of PPP in general was found to be lacking. The paper finds evidence that PPP is more likely to exist between countries that share greater trade volumes.

Keywords: Purchasing Power Parity, Quantile unit root test, Quantile cointegration regression, trade volumes

1. Introduction

A number of studies have attempted to test the PPP hypothesis, be it for bilateral or multilateral exchange rates (See Alba et Papell, 2007)). The PPP hypothesis stipulates that the exchange rate between two countries reflect their price differential or the difference in their consumer price index. It is assumed that when the purchasing power parity (PPP) hypothesis holds between two countries, a given basket of goods will be the same price in both countries after controlling for the exchange rate. The validity of the PPP hypothesis can act as a catalyst to assess the degree of bilateral or multilateral financial and economic integration between countries (see Tagushi, 2010).

Controversial results have arised from testing the PPP hypothesis with some supporting the hypothesis and other refuting it. The controversy in the results of the PPP test is often attributed to the use of inadequate statistical and econometric techniques. For example, Taylor aand Taylor (2004) pointed that theoretical work on the PPP hypothesis might be elegant but the empirical studies using traditional unit root and cointegration tests have failed to bring relaible results. There is an agreement among scholars that the test of the PPP hypothesis is conducted by using two general types of tests, one involving the stationarity of the real exchange rate, and another using the cointegration relationship of the nominal exchange rate and prices difference (Chang et al.,2011). However, disagreement reside on the apprioate type of ststionary or cointegration technique to be used. Traditional stationarity and cointegration techniques developed by Granger (1984), Engle and Granger (1987) and Johansen and Juselius (1990) are usually associated with these tests. However, studies are challenged the use of these techniques arguing that the mean reverting process related to the PP theory is nonlinear, rather than linear (see Chang, 2002; Lyon and Olmo, 2017).

On the theoretical basis, the validity of the PP is often attributed to free flow of goods and services between trading partners. It is in that context that studies have shown that the hypothesis holds between trading partners or countries that belong in a regional grouping or integration (see Yildirim, 2017). However, Tiwari and Shahbaz (2014) show that PPP hypothesis does not exist for

all major trading partners in case of India. The authors attribute this failure to the fact that that intermediate goods face high barriers to trade between India and its trading partners. This finding may reveal that friction to trade may hamper the validity of the PPP theory. However, friction to trade may come up in different forms. it may occur in the form of quota or exchange rate control. For example, Wei and Zhang (2007) show that exchange controls have negative effects on trade as they increase the cost of conducting trade due to the intensification of inspections at the borders and other related control to avoid possible evasion.

While friction to trade in the form of exchange control may be an impediment for the PPP theory in bilateral trade, however, no study has ever tested the PPP hypothesis in the case a bilateral trade with countries that apply exchange control. To fill this gap, this paper will test the PPP hypothesis between South Africa and its main trading partners. The paper assesses whether PPP hypothesis holds between South Africa and its trading partners, depending on their trade volume. The South African's five top trading partners chosen for this paper are China, the United States of America, Botswana, Japan and the United Kingdom. The low trade volume countries are Indonesia, Egypt, Czech Republic, Sri Lanka and Morocco (see Global Edge, 2016). To this end, the paper uses the quantile unit root test derived by (Koenker & Xiao, 2004) and the quantile cointegration regression method by (Xiao, 2009) . Following Pedroni (2001) and Robertson, et al.(2014), the weak-from PPP hypothesis is tested based on the stationarity of the real exchange rate using quantile unit root approach. The strong form of PPP, which considers the relationship between exchange rates and relative prices to be one-to-one, is tested using the quatile cointegration approach.

The paper is structured as follows. Section 2 discusses previous studies on PPP and relevant statistical methods. Section 3 considers the definition of PPP and the methodology developed by (Koenker & Xiao, 2004) and (Xiao, 2009) that is used in the paper. Section 4 discusses the data that is used for this study and Section 5 the empirical results. Section 6 summarises the main findings and concludes the paper.

2. Literature Review

The testing of the PPP hypothesis has been done for many currencies over time. Some early examples include (Kovoes & Seifert, 1985) where the PPP is tested for black-market currencies using the efficient market version of PPP developed by (Roll, 1979), and (Darby & Lothian, 1983) that tested the PPP hypothesis over the short and long run.

After the introduction of the unit root and cointegration tests by the likes of (Said & Dickey, 1984), (Granger, 1984), (Engle & Granger, 1987) and (Phillips & Perron, 1988), and the multivariate cointegration methodology proposed by (Johansen, 1988), the studies of PPP grew extensively with a leading example being (Corbae & Ouliaris, 1988) which failed to find evidence for the PPP by testing the stationarity of the real exchange rate and cointegration of the nominal exchange rate and price differences between the United States of America and Canada. This was accompanied by numerous studies on the same data that also failed to find evidence of PPP, for example (Mark, 1987) and (Taylor, 1988). Interestingly enough, studies emerged that did find evidence of PPP, for example (Johnson, 1990), when a considerable amount of data is used.

This spurred the development of additional empirical tests of how one can better assess the existence of PPP, specifically with the consideration of nonlinear models. For example, (Pippenger & Goering, 1993) showed the low power of traditional unit root tests if the underlying processes are threshold processes and (Sercu, et al., 1995) studied the effect of transaction costs in international arbitrage on PPP by considering nonlinear models. Whilst (Lopez, et al., 2005) disproved the findings of (Taylor, 2002) by using superior lag selection models, (Kim & Moh, 2010) finds evidence for the findings of (Taylor, 2002) by utilizing the nonlinear models exponential smooth transition autoregression (ESTAR), band logistic smooth transition autoregression (BLSTAR), and band threshold autoregression (BTAR).

Further development in nonlinear models introduced the concepts of quantile unit root tests introduced by (Koenker & Xiao, 2004) and quantile cointegration regression by (Xiao, 2009) which utilizes the fact that a time series can act differently over varying quantiles. Using these techniques, (Ma, et al., 2017) studied PPP for East Asian countries. One of their findings is that PPP held for Japan and the United States of America only when the Japanese yen is either strongly appreciating or strongly depreciating with respect to the US dollar. (Bahmani-Oskooee, et al., 2016) used the quantile unit root test to consider PPP in 20 African countries and found evidence that it holds between South Africa and the United States. They also found that shocks to the real exchange rate adjust faster when the South African Rand is appreciating with regards to the US Dollar. (Peng & Chang, 2017) specifically utilized the quantile unit root tests on the BRICS nations and found that the PPP holds for all of the BRICS nations.

could group literature in terms of theoretical and practical contributions..

12/20

3. Methodology

The PPP hypothesis states that the nominal exchange rate between two countries should be equal to their relative prices. This implies

$$\mathrm{S_t} = \mathrm{A}\frac{\mathrm{P_t}}{\mathrm{P_t^*}} \tag{1}$$

with $\mathrm{S_t}$ being the nominal exchange rate (the domestic price of foreign currency), A a constant number, $\mathrm{P_t}$ the domestic price level and $\mathrm{P_t^*}$ the foreign price level. When the natural logarithm is taken, St= $\mathrm{A}\frac{\mathrm{P_t}}{\mathrm{P_t^*}}$ (1) is transformed into

$$s_t = \alpha + p_t - p_t^* \tag{2}$$

with s_t, α, p_t and p_t^* being the natural logarithms of $\mathrm{S_t}$, A, $\mathrm{P_t}$ and $\mathrm{P_t^*}$, respectively. This can be rewritten to

$$r_t = s_t - (p_t - p_t^*) \tag{3}$$

where r_t is referred to as the real exchange rate. To test for the strong and weak form of PPP, o n e

c

$$t = s_t - (p_t - p_t^*) \quad (3)$$

in the form of

$$r_t = s_t - \beta(p_t - p_t^*) \quad (4)$$

where β is the coefficient to be estimated. The strong-form PPP states that there is a one-to-one relationship between the exchange rate and the price difference, implying that the real exchange rate should be stationary if $\beta = 1$, as in equation (3). The weak-form PPP states that the nominal exchange rate and price difference are cointegrated, implying that there exists a linear relationship between the two variables such that r_t is stationary and $\beta \neq 0$.

To test the PPP hypothesis in different economic conditions, quantile approaches are considered. Considering the manner in which the nominal exchange rate and real exchange rate is defined

To test for the strong-form of PPP within the quantile methodology, the quantile unit root test of (Koenker & Xiao, 2004) is considered. The conditional quantile autoregression model is given by

$$Q_{r_t}(\tau|r_{t-1}, \dots, r_{t-q-1}) = \alpha_0(\tau) + \alpha_1(\tau)r_{t-1} + \sum_{j=1}^{q} \alpha_{j+1}\Delta r_{t-j} + \varepsilon_t \quad (5)$$

with $Q_{r_t}(\tau|r_{t-1}, \dots, r_{t-q-1})$ being the conditional quantile of r_t for the defined quantile level $\tau \in (0,1)$ and ε_t the error term. The solution for $\hat{\alpha}_0, \hat{\alpha}_1, \dots, \hat{\alpha}_q$ is obtained using quantile regression. The null hypothesis conditional on the quantile level τ is then given by

$$H_0: \alpha_1(\tau) = 1 \; vs \; H_1: \alpha_1(\tau) \leq 1$$

with a t-ratio statistic defined by

$$t_n(\tau) = \frac{f\left(F^{-1}(\tau)\right)}{(\tau(1-\tau))^{\frac{1}{2}}} (\boldsymbol{R}`_{-1}\boldsymbol{P_X}\boldsymbol{R}_{-1})^{\frac{1}{2}}(\alpha_1(\tau) - 1) \quad (6)$$

where $f(u)$ and $F(u)$ are the probability and cumulative density functions of ε_t, $\boldsymbol{R_{-1}}$ is the vector of lagged real exchange rates used and $\boldsymbol{P_X}$ is the projection matrix onto the space orthogonal to $(1, \Delta r_{t-1}, \Delta r_{t-2}, \dots, \Delta r_{t-q})$. The t-ratio statistic is estimated and its critical values are found using a bootstrap approach outlined in (Koenker & Xiao, 2004). A Kolmogorov-Smirnov type test for stationarity over an interval of quantiles $[\tau_0, 1 - \tau_0]$ is also suggested and has the form

$$QKS = \max_{\tau \in [\tau_0, 1-\tau_0]} |t_n(\tau)| \quad (7)$$

where critical values are also estimated with a bootstrap approach given in (Koenker & Xiao, 2004).

To test for the weak-form of PPP within the quantile methodology, the quantile cointegration regression framework of (Xiao, 2009) is considered. The model takes the form

$$Q_{s_t}(\tau|\mathrm{F_t}) = \beta_0(\tau) + \beta_1(\tau)(p_t - p_t^*) + \sum_{j=-\mathrm{q}}^{q} \beta_{j+1}\Delta(p_{t-j} - p_{t-j}^*) + \varepsilon_t \quad (8)$$

where $(p_t - p_t^*)$ is the price difference and $\mathrm{F_t}$ refers to information that is known prior to time t. The parameters are solved using quantile regression and the null hypothesis conditional on the quantile level τ is of the form

$$H_0: \beta_1(\tau) = 0 \; vs \; H_1: \beta_1(\tau) \neq 1$$

with test statistic

$$Y_T(\tau) = \max_{k=1,\dots,T} \frac{1}{\hat{\omega}_\psi^* \sqrt{T}} \left| \sum_{j=1}^{K} \psi_\tau(\varepsilon_{j\tau}) \right| \quad (9)$$

where $\psi_\tau(u) = \tau - \boldsymbol{I}(u < 0)$, $\varepsilon_{j\tau} = s_t - Q_{s_t}(\tau|F_t)$, and $\hat{\omega}_\psi^*$ is the long-run variance of $\psi_\tau(\varepsilon_{j\tau})$. The critical values are obtained through a bootstrap method. These results will, however, be displayed visually with confidence intervals for $\beta_1(\tau)$. In this manner, one can test for strong and weak form PPP. If the confidence interval of $\beta_1(\tau)$ does not contain 0, one rejects the conditional null hypothesis and weak-form PPP holds for the quantile level τ. If the confidence interval contains 1 as well, one cannot reject the hypothesis that $\beta_1(\tau) = 1$ and the strong-form PPP holds for the quantile level τ.

4. Data

The data considered for this study was collected from the International Monetary fund (International Monetary Fund, 2018) and consists of varying date lengths depending on the availability of both monthly Consumer Price Index (CPI) values and monthly exchange rates. South Africa is considered the domestic country.

The countries that are considered as high volume and low volume trade partners are given in Table 1: Countries with high export volume and Table 2: Countries with low export volume respectively, with the corresponding dollar amount in exports and percentage exports that was observed in the 2016 period.

Partner	Export ($)	Export (%)
China	$6,812,080,879	9.19%
United States	$5,473,767,809	7.39%
Botswana	$3,712,233,382	5.01%
Japan	$3,450,199,522	4.66%
United Kingdom	$3,158,231,907	4.26%

Table 1: Countries with high export volume

Partner	Export ($)	Export (%)
Indonesia	$255,953,470	0.35%
Egypt	$207,917,882	0.28%
Madagascar	$155,485,797	0.21%
Czech Republic	$150,303,634	0.20%
Sri Lanka	$146,825,111	0.20%
Morocco	$144,594,916	0.20%

Table 2: Countries with low export volume

By considering the latter tables, one should note that the aggregate percentage exported of the high export countries tally up to 31.5% of South Africa's exports, whereas the low export countries only account for 1.43% of total exports.

Figure 1: Exchange rates and CPI of considered countries provides the exchange rate and CPI time series plots of the considered countries with high export countries being on the left column and low export countries on the right.

For all high export countries except Botswana, one should note that a depreciating local currency is observed. Since the Botswana Pula is a weighted average of the South African Rand and other international currencies, one would expect the Pula to be similar to the Rand to some extent. Also, Japan is the only country that observed considerable drops in CPI over the considered period.

One should note the sudden devaluation of the Egyptian Pound that gained extreme momentum in 2016. This occurred at the backdrop of the IMF's demand that Egypt devaluate their currency as a prerequisite of an estimated $12bn loan that was provided over three years. After that period, one observes a steeper gradient for the CPI of Egypt, matching up to what one would consider in the PPP context.

Whilst the CPI figure for South Africa is omitted here, for completeness it is stated that one observes a constant increase in the CPI figures for South Africa.

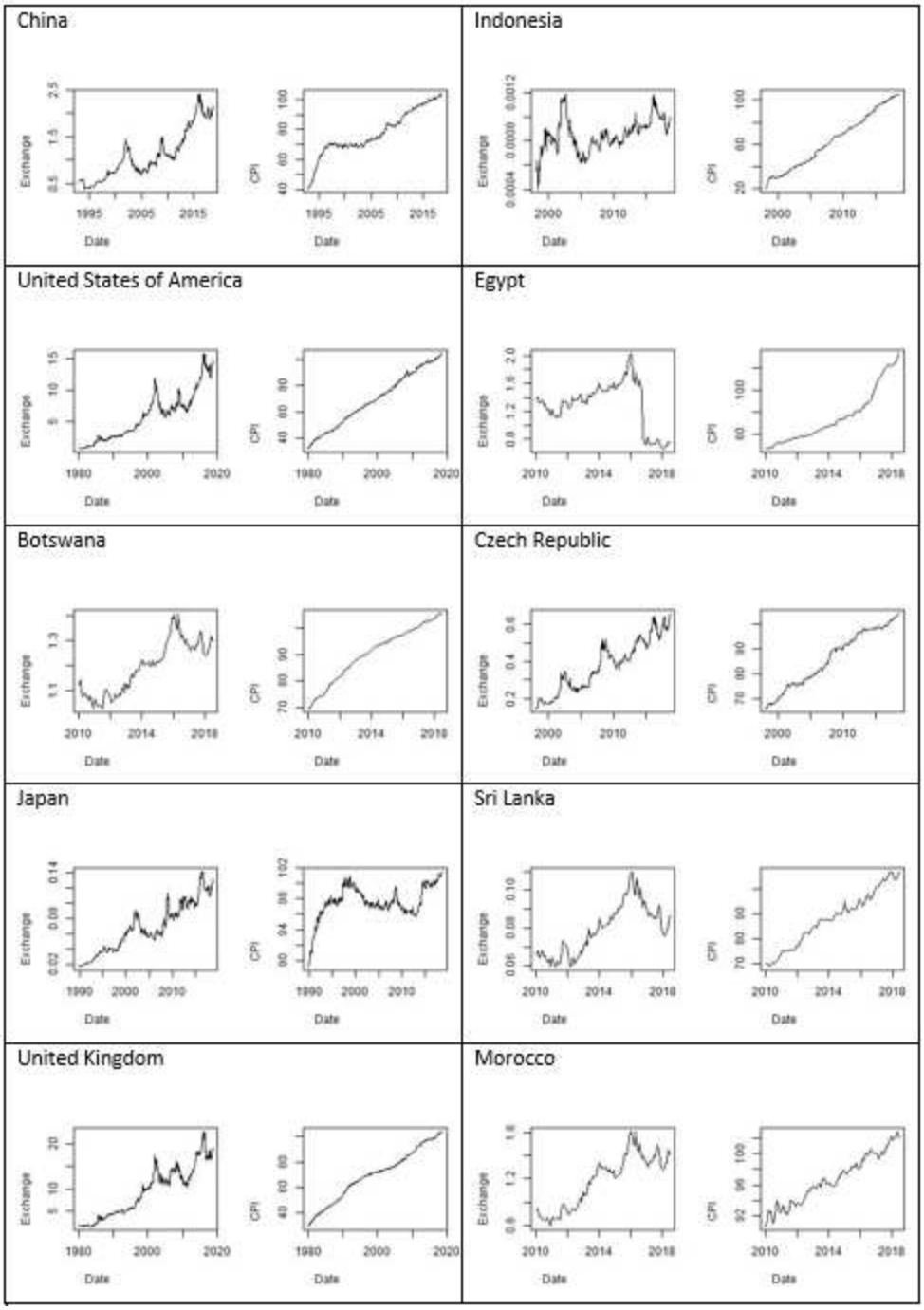

Figure 1: Exchange rates and CPI of considered countries

5. Empirical Results

For the strong-form PPP hypothesis, quantile unit root tests are performed over the quantiles $\tau \in (0.1, 0.2, \ldots, 0.9)$. Table 3: Quantile unit root test for high export volume countries represents the results for high export volume countries.

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
BOTSWANA									
t-statistic	-0.1346	-0.052	-0.145	-0.0448	0.0275	0.0418	0.1309	0.2521	0.1918
(p-value)	(0.06)	(0.33)	(0.03)	(0.28)	(0.67)	(0.62)	(0.93)	(1)	(0.93)
QKS	0.2521								
(QKS p-value)	0.94								
CHINA									
t-statistic	0.6839	-0.242	-0.4596	-0.2904	-0.458	-0.3705	-0.3994	-0.3027	-0.1901
(p-value)	(0.99)	(0.25)	(0.05)	(0.14)	(0.03)	(0.07)	(0.06)	(0.13)	(0.15)
QKS	0.6839								
(QKS p-value)	0.86								
JAPAN									
t-statistic	-0.1112	-0.0126	-0.0489	-0.0491	0.1705	0.0994	0.3619	0.2334	-0.1998
(p-value)	(0.34)	(0.46)	(0.4)	(0.34)	(0.66)	(0.52)	(0.83)	(0.52)	(0.1)
QKS	0.3619								
(QKS p-value)	0.45								
UNITEDKINGDOM									
t-statistic	-0.0759	-0.0877	-0.0306	-0.033	0.3871	0.4767	0.313	0.5767	0.7886
(p-value)	(0.43)	(0.35)	(0.49)	(0.44)	(0.8)	(0.92)	(0.71)	(0.89)	(0.95)
QKS	0.7886								
(QKS p-value)	0.85								
UNITEDSTATES									
t-statistic	-0.588	0.2134	0.2528	0.219	0.2681	0.3804	0.8036	0.3993	0.2412
(p-value)	(0.15)	(0.73)	(0.72)	(0.79)	(0.76)	(0.82)	(0.91)	(0.79)	(0.52)
QKS	0.8036								
(QKS p-value)	0.79								

Table 3: Quantile unit root test for high export volume countries

The prevalence of strong-form PPP is not as clear when the QKS statistics are considered. In none of the cases could we find evidence that the strong-form PPP holds over all quantiles. The first case where it is observed is with Botswana at the 10^{th} quantile at a 10% level of significance. This implies that when the real exchange rate appreciates with regards to the Botswana Pula, the existence of strong-form PPP is present. We also observe the existence of strong-form PPP with China at the 30^{th}, 50^{th} and 60^{th} quantile of the real exchange rate, implying that in stable conditions the strong-form PPP holds between China and South Africa. Lastly, one observes that at the 90^{th} quantile, the strong-form PPP holds for Japan, indicating that the strong-form PPP holds when the rand is depreciating in real terms.

Next, the results of the low export volumes are considered in Table 4.

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
CZECHREPUBLIC									
t-statistic	-0.3269	-0.3959	-0.1759	-0.0996	-0.1774	-0.1917	-0.064	-0.0129	0.0475
(p-value)	(0.16)	(0.08)	(0.25)	(0.38)	(0.19)	(0.15)	(0.28)	(0.37)	(0.46)
QKS	0.0475								
(QKS p-value)	0.1								
EGYPT									
t-statistic	-0.1669	-0.2808	-0.1428	0.1857	0.3043	0.3014	0.2394	0.236	0.5975
(p-value)	(0.23)	(0.16)	(0.33)	(0.8)	(0.82)	(0.79)	(0.67)	(0.66)	(0.82)
QKS	0.5975								
(QKS p-value)	0.74								
INDONESIA									
t-statistic	-1.6191	-1.7769	-1.2521	-0.9211	-0.4376	-0.2717	-0.6121	-0.3581	0.2689
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.11)	(0.19)	(0.04)	(0.09)	(0.61)
QKS	0.2689								
(QKS p-value)	0.27								
MOROCCO									
t-statistic	-0.1941	-0.1179	-0.0133	0.0553	0.0287	0.1727	0.2054	0.1801	0.4127
(p-value)	(0.15)	(0.28)	(0.54)	(0.75)	(0.52)	(0.84)	(0.89)	(0.82)	(0.94)
QKS	0.4127								
(QKS p-value)	0.92								
SRILANKA									
t-statistic	-0.2164	-0.1993	-0.0795	-0.0433	0.1153	0.1372	0.1505	0.3169	0.2164
(p-value)	(0.14)	(0.1)	(0.36)	(0.35)	(0.69)	(0.71)	(0.77)	(0.91)	(0.74)
QKS	0.3169								
(QKS p-value)	0.79								

Table 4: Quantile unit root test for high export volume countries

If one considers the QKS test, one can observe that, at an aggregate level, there seems to be some evidence of strong-form PPP for the Czech Republic. Also, for Indonesia we observe the existence of strong-form PPP in all quantiles except the 60^{th} and 90^{th} quantiles. The reason for this might be that although South Africa does not export a considerable amount of goods to Indonesia per say, South Africa is one of Indonesia's largest trade partners, and its largest trade partner in Africa.

Figure 2 considers the results of the quantile cointegration regression methodology. Countries with high export volume are again considered on the left-hand side of the figure whereas countries with low export volume are considered on the right-hand side of the figure.

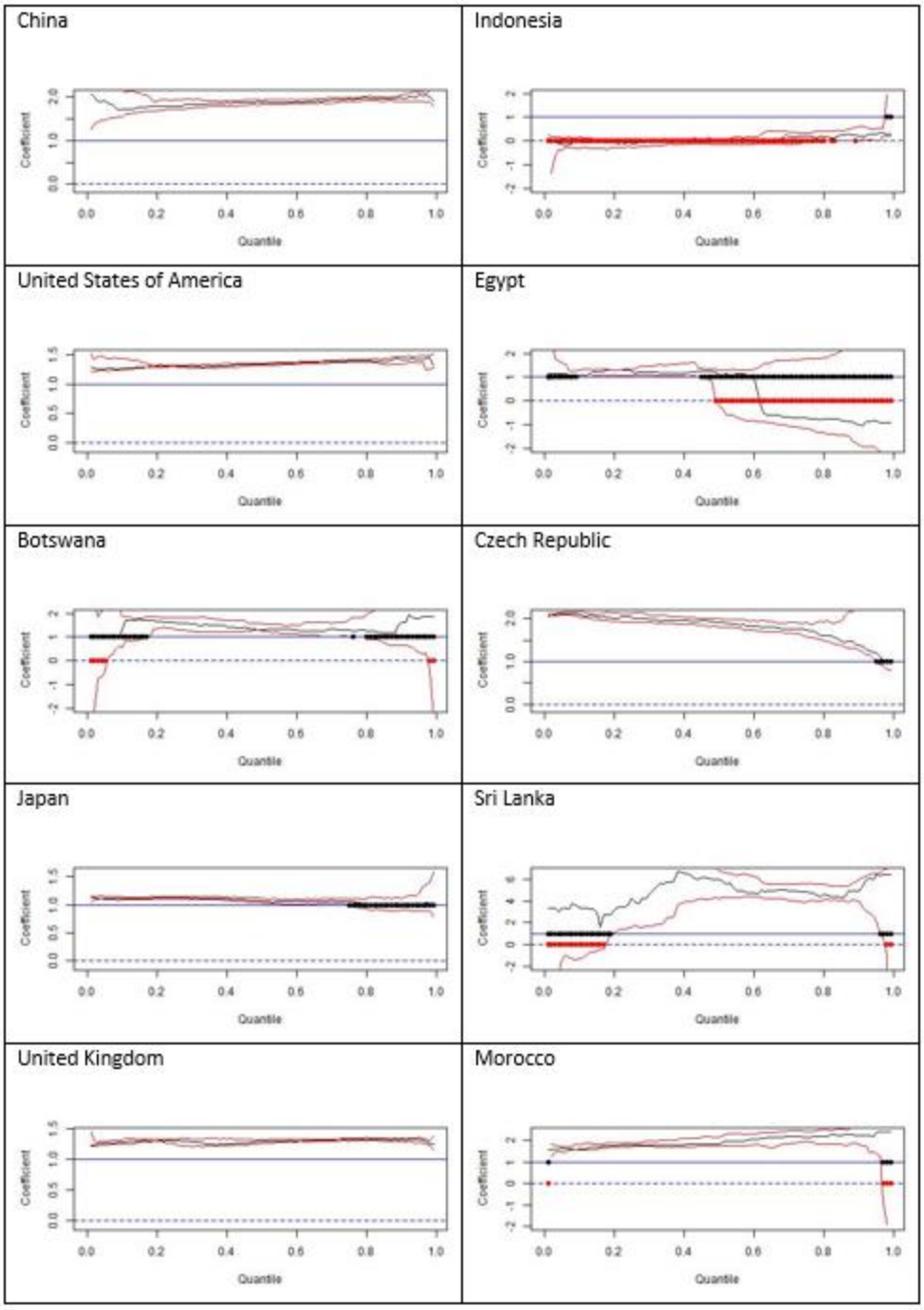

Figure 2: Quantile Cointegration Regression

The black line

Using the latter argument, one should note that the weak-form PPP holds over all quantiles for China, the United States, Japan and the United Kingdom. Similar results are obtained for the weak-form PPP of the United States by (Bonga-Bonga, 2011) who used a VAR-X approach. Botswana violates the weak-form PPP when the nominal interest rate is either appreciating or depreciating and Japan may have strong-form PPP when the nominal exchange rate is depreciating.

We do however observe violations for all countries over all low export countries, the worst of which is observed for Indonesia and Egypt.

Conclusion

This paper attempted to study whether countries with higher export volumes with the domestic country have additional evidence of PPP when compared with countries with lower export volume. The paper made use of the quantile unit root test and quantile cointegration regression approach to test the strong and weak-form PPP over different quantiles of the exchange rate. Whilst not a considerable amount of evidence of the strong-form PPP hypothesis was found, the weak-form PPP hypothesis was proven over all quantiles for China, the United States, Japan and for the United Kingdom. Japan also shows the existence of strong-form PPP when the nominal exchange rate is depreciating. Although this cannot be deemed an exhaustive study, the paper does find strong evidence that countries with greater financial integration with respect to their import and export relations tend to have greater evidence for the existence of PPP.

References

Alba, J., and Papell, D. (2007). Purchasing power parity and country characteristics: Evidence from panel data tests. *Journal of Development Economics, 83, 240–251*

Bahmani-Oskooee, M., Chang, T., Chen, T.-H. & Tzeng, H.-W., 2016. Quantile unit root test and the PPP in Africa. *Applied Economics, 49(19), pp. 1913-1921.*

Bonga-Bonga, L., 2011. Testing for the purchasing power parity hypothesis in a small open economy: A VAR-X Approach. *International Business & Economics Research Journal, 10(12), pp. 97-106.*

Chang, Y., 2002. Nonlinear IV unit root tests in panels with cross-sectional dependency. *Journal of Econometrics, 110(2), pp. 261-292.*

Corbae, D. & Ouliaris, S., 1988. Cointegration and tests of purchasing power parity. *Review of Economics & Statistics, 70(3), p. 508.*

Darby, M. R. & Lothian, J. R., 1983. Movements in Purchasing Power Parity: The Short and Long Runs. In: A. E. Gandolfi, A. J. Schwartz & A. C. Stockman, eds. The International Transmission of Inflation. Chicago: University of Chicago Press, pp. 462-477.

Engle, R. F. & Granger, 1987. Co-integration and error correction: representation, estimation, and testing. *Econometrica, 55(2), pp. 251-276.*

Fuller, D. A. D. a. W. A., 1979. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74(366, part 1), pp. 427-431.*

Global Edge, 2016. Global Edge. [Online] Available at: https://globaledge.msu.edu/countries/south-africa/tradestats. [Accessed 23 10 2018].

Granger, C. W. J., 1984. Some properties of time series data and their use in econometric model specification. Handbook of Econometrics, Volume 2, p. 1023–1100.

Gyamfi, E., 2017. Testing the Validity of Purchasing Power Parity in the BRICS: Further Evidence. EuroEconomica, Volume 36, pp. 117-122.

International Monetary Fund, 2018. IMF. [Online]. Available at: www.imf.org. [Accessed 20 10 2018].

Johansen, S., 1988. Statustucal Analysis of Cointegration Vectors. Journal of Economic Dynamics and Control, Volume 12, pp. 231-254.

Johansen, S., Juselius, K., (March, 1990), "Maximum Likelihood Estimation and Inference on Cointegration – With Applications To the Demand For Money", *Oxford Bulletin of Economics and Statistics, 52 (2), 169-210.*

Johnson, D. R., 1990. Co-Integration, Error and Purchasing Power Parity between Canada and the United States. *The Canadian Journal of Economics, 23(4), pp. 839-855*.

Kim, H. & Moh, Y.-K., 2010. A century of purchasing power parity confirmedL The role of nonlinearity. *Journal of International Money and Finance, Volume 29, pp. 1398-1405.*

Koenker, R. & Xiao, Z., 2004. Unit root quantile augoregression inference. *Journal of the American Statistical Association, Volume 99, pp. 775-787.*

Kovoes, P. & Seifert, B., 1985. Purchasing Power Parity and Black Markets. *Financial Management, 14(3), pp. 40-46.*

Lopez, C., Murray, C. J. & Papell, D. H., 2005. State of the Art Unit Root Tests and Purchasing Power Parity. *Journal of Money, Credit and Banking, 37(2), pp. 361-369.*

Lyon, M. & Olmo, J., 2017. Does the PPP condition hold for oil-exporting countries? A quantile cointegration regression approach. *International Journal of Finance and Economics, 23(2), pp. 79-93.*

Mark, N. C., 1987. Real and nominal exchange rates in the long run: an empirical investigation. Mimeo, Ohio State University.

Ma, W., Li, H. & Park, S. Y., 2017. Empirical conditional quantile test for purchasing power parity: Evidence from East Asian countries. *International Review of Economics and Finance, Volume 49, pp. 122-222.*

Pedroni, P., 2001. Purchasing power parity tests in cointegrated panels. *Review of Economics and Statistics, Volume 83, pp. 727-731.*

Peng, H. & Chang, T., 2017. Revisiting purchasing power parity in BRICS countries using more powerfull quantile unit-root tests with stationary covariates. *Communications in Statistics: Theory & Methods, 46(20), pp. 10051-10057.*

Peng, H., Liu, Z. & Chang, T., 2017. Revisiting purchasing power parity in BRICS countries using more powerful quantile unit-root tests with stationary covariates. *Communications in Statistics - Theory and Methods, 46(20), pp. 10051-10057.*

Phillips, P. C. & Perron, P., 1988. Testing for a Unit Root in Time Series Regression. *Biometrica, 75(2), pp. 335-346.*

Phillips, P. & Pherron, P., 1988. Testing for a unit root in time series regression. *Biometrica, Volume 75, pp. 335-346.*

Pippenger, M. & Goering, G., 1993. A note on the empirical power of unit root tests under threshold processes. *Oxford Bulletin of Economics and Statistics, Volume 55, pp. 473-481.*

Robertson, R., Kumar, A. & Dutkowsky, D., 2014. Weak-form and strong-form purchasing power parity between the US and Mexico: A panel cointegration investigation. *Journal of Macroconomics, Volume 42, pp. 241-262.*

Roll, R., 1979. Violations of Purchasing Power Parity and their Implications for Efficient International Commodity Markets. *International Finance and Trade, Volume 1, pp. 133-176.*

Said, E. & Dickey, D. A., 1984. Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order. *Biometrica, Volume 71, pp. 599-607.*

Sercu, P., Uppal, R. & Hulle, C., 1995. The exchange rate in the presence of transaction costs: implications for tests of purchasing power parity. *Econometrica, Volume 69, pp. 473-498.*

Su, C.-W., Chang, H.-L., Chang, T. & Lee, C.-H., 2012. Purchasing power parity for BRICS: linear and nonlinear unit root tests with stationary covariates. *Applied Economics Letters, Volume 19, pp. 1587-1591.*

Taylor, 2002. A century of purchasing power parity. *The Review of Economics and Statistics , Volume 84, pp. 139-150.*

Taylor, A. M. & Taylor, M. P., 2004. The Purchasing Power Parity Debate. *Journal of Economic Perspectives, 18(4), pp. 135-158.*

Taylor, M. P., 1988. An empirical examination of long-run purchasing power parity using cointegration techniques. *Applied Economics, Volume 20, pp. 1369-1381.*

Taguchi,H. 2010. "Feasibility of Currency Unions in Asia - An Assessment Using Generalized Purchasing Power Parity -," *Public Policy Review, , vol. 6(5), pages 859-872.*

Xiao, Z., 2009. Quantile cointegration regression. *Journal of Econometrics, Volume 150, pp. 248-260.*