BRICS Export Performance:
An ARDL Bounds Testing Empirical Investigation

Flávio Vilela Vieira
Institute of Economics, Federal University of Uberlândia (UFU), Brazil
& CNPQ Associate Researcher
E-mail: flaviovieira@ufu.br
The author thanks CNPQ and FAPEMIG for financial support

Cleomar Gomes da Silva
Institute of Economics, Federal University of Uberlândia (UFU), Brazil
& CNPQ Associate Researcher
E-mail: cleomargomes@ufu.br
The author thanks CNPQ and FAPEMIG for financial support

Abstract

This article aims to investigate the export performance of the BRICS countries: Brazil, Russia, India, China and South Africa. By making use of the bounds testing (ARDL) approach to cointegration for the period from January 2000 to December 2014, the results suggest the existence of asymmetries when considering which variables are relevant in the long run. Export performance relies mainly on: i) foreign demand and commodity prices, in the case of Brazil; ii) real effective exchange rate, foreign demand and commodity prices (Russia); iii) real effective exchange rate and commodity prices (India); iv) real effective exchange rate and foreign demand (China); v) foreign demand (South Africa). The estimated coefficients for the error correction mechanism show higher speed of adjustment for Brazil and China, intermediate speed for India, and lower for Russia and South Africa.

Key Words: Exports, International Trade, Foreign Exchange, ARDL, Cointegration
JEL Classification: C22, F14, F17

Introduction

The BRICS countries account for a group of emerging market economies (Brazil, Russia, India, China and South Africa) which have had a considerable expansion of their export sectors in the past few years, with similarities, but also differences, in their pattern of export diversification. And there is no doubt that a country's export performance is crucial for a sound current account and, consequently, a sound balance of payments, contributing to short run and long run economic growth and economic development.

Export performance of the BRICS countries is an important issue not only in relation to the impact caused on each domestic economy, but also in relation to the increasing participation of the BRICS in world trade and global economic performance. Despite the recent crisis, the BRICS can become a group capable of boosting world economic growth, trade flows and financial resources. Along with a high consumption growth potential, due to the emergence of a new middle class and to the size of their populations, such export performance is helping BRICS countries catch up to industrialized nations much faster, although they have not yet reached the level of development of advanced economies.

The aim of this article is to investigate the export performance for Brazil, Russia, India, China and South Africa (BRICS) by applying the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration. For the period ranging from January 2000 to December 2014, the variables used are exports, real effective exchange rate (level and volatility), world imports (proxy for foreign demand) and commodity prices. We are able to reject the null of no long run relationship for each country, indicating the existence of cointegration among the variables used in our empirical analysis. The empirical results also suggest that in the long run, export performance relies mainly on real effective exchange rate (level and volatility) and foreign demand, in the case of China and Russia, foreign demand and commodity prices (Brazil), real effective exchange rate and commodity prices (India) and on foreign demand in the case of South Africa.

Besides this introduction, this paper reviews the literature in Section 2. Section 3 shows the data used in the analysis as well as the econometric methodology and Section 4 reports the results. The final section concludes the article.

2. Literature Review

The literature on exchange rate volatility and trade flows is quite extensive and the purpose of this section is to summarize the general empirical findings and in a second moment to focus on the empirical studies and lessons for the BRICS. In general, it is difficult to draw an unambiguous conclusion of the effect of exchange rate volatility on trade flows, regardless of the econometric method used, with the coefficient on volatility suggesting a positive, negative or no impact.[1]

Previous studies, such as Ethier (1973) and Hooper and Kohlhagen (1978), showed that a higher exchange rate volatility is associated with higher costs, for risk averse traders, and ultimately associated with lower foreign trade. The main argument is that if changes in exchange rates become unpredictable, they raise profit uncertainty and reduce the benefits of international trade.

Assery and Peel (1991) investigated the effects of exchange rate volatility on exports using an error correction model. Their results support the significant impact of real exchange rate volatility on exports. De Grauwe (1988) and Clark (1973) are examples of empirical studies casting doubt on the negative effect of higher exchange rate volatility on trade flows. Their argument is that if income effect dominates substitution effect, the outcome can be a positive relationship between exchange rate volatility and trade flows.

McKenzie (1999) and Bahmani-Oskooee and Hegerty (2007) are good examples of articles which evaluate the impact of exchange rate volatility and the lessons learnt. For instance, the main empirical finding from Bahmani-Oskooee and Hegerty (2007) indicates that there is no consensus on the effects of exchange rate volatility on export and import flows, especially when analyzing the floating period (post 1973), when most countries faced an increase in exchange rate volatility.

Arize et al. (2000) investigated the impact on export flows for a set of 13 developing economies, for the period 1973-1996, using cointegration analysis. Their results suggest that an increase in exchange rate volatility is associated with a negative impact on export demand both in the short and long run.

Huchet-Bourdon and Korinek (2011) analyzed the impact of both level and volatility of exchange rates of exchange rates on trade flows for two sectors (agriculture and manufacturing/mining) in China, the Euro area and the United States. By making use of ARDL cointegration analysis, the empirical results highlight the existence of a significant impact of the level of exchange rate on trade flows, but only a minor effect of exchange rate volatility. There is also evidence of: i) a far greater long-run effect of the real exchange rate on exports than on imports; ii) a greater relevance of the income effect on trade flows, when compared to price effect.

Vieira and MacDonald (2016) studied the relationship between real effective exchange rate volatility and exports for a sample of 106 countries, by applying a System GMM panel data analysis over the period ranging from 2000 to 2011. The results corroborated the view that real effective exchange rate volatility plays a significant role in export performance. However, the results were robust only when: i) oil export countries are part of the sample; ii) an increase (decrease) in exchange rate volatility reduces (increases) export volume; iii) there is evidence that export volume is price and income inelastic.

As far as BRICS countries are concerned, Gouvea et al. (2013) investigated their export performance and diversification strategies. Their results showed that China has a more diversified export profile than the other member countries. Bojnec et al. (2014) examined the relationship between BRICS countries' agricultural exports and the quality of institutions. The authors applied a gravity trade model and a panel data analysis for the period 1998-2009 and found an increase in food exports from Brazil and China, whilst Russia has faced a stagnation pattern and high volatility. The authors also found that food exports were positively associated with institutional quality and GDP, and negatively associated with market distance.

Ying et al. (2014) analyzed how competitive high technology exports from BRICS countries to the U.S. were, and found that there are some comparative advantages. Investments in R&D and patents have a positive relation high tech exports to the U.S. market, while foreign direct investment does not directly promote export competitiveness.

Kocourek (2015) studied whether exports could be seen as a relevant factor of structural changes for the BRICS. The author found that there was a shift from primary manufacturing, and from the production of merchandise with low added value, to more sophisticated goods. In most sectors the driving force of the structural change is associated to domestic customers. Also, foreign demand plays a crucial role in industry output of other sectors, such as mining and manufacturing. There was no significant impact of exports on the following sectors: construction, financial intermediation, real estate and other business activities.

Naudé and Rossouw (2011) also focused on the economic performance and export diversification of the BRICS, except Russia, for the period 1962-2000. They found evidence of a U-shape relationship between per capita income and export specialization, for China and South Africa, and partial evidence that export diversification Granger causes GDP per capita in the case of Brazil, China and South Africa, but not for India, where the causation is the other way around. Also, only South African export diversification had a positive impact on economic development, while the remaining countries presented a positive impact on economic activity coming from export specialization.

Regarding studies related to individual country members, Todani and Munyama (2005) examined the role of exchange rate volatility on export flows for South Africa, by using the ARDL bounds testing approach with quarterly data for the period 1984 to 2004. Depending on the measure of volatility used, the results showed that there was no influence of exchange rate volatility on export flows, or when such influence did exist it was positive.[2]

Ekanayake et al. (2012) also studied the South African case, especially the effect of exchange rate volatility on South Africa´s trade (exports and imports) with the EU for the period of 1980 to 2009 using the bounds testing approach to cointegration and error-correction model. The results for exports indicated that exports positively affected by foreign income and negatively by relative prices and exchange rate volatility.

As for China´s case, Chit (2008) examined the role of exchange rate volatility for bilateral export performance for the ASEAN-China free trade area. The author made use of a generalized gravity model for a panel data of 20 bilateral observations using quarterly data from 1982:Q1 to 2005:Q1. The panel unit root tests corroborated the existence of a long run relationship between exchange rate volatility and exports. The fixed and random effect estimated models suggested that bilateral real exchange rate volatility had a negative effect on ASEAN-China bilateral exports, but with small magnitude.

The specific case of India has been studied by Srinivasan and Kalaivani (2013), who examined the role of exchange rate volatility on India´s export growth. For the period 1970-2011, the authors also made use of ARDL bounds testing approach and found cointegration amongst exchange rate volatility, real exchange rate, domestic and foreign GDP. Exchange rate volatility had a negative impact on real exports in the short and long run, while the level of real exchange rate had a negative (positive) impact in the short (long) run. Domestic GDP had a positive long run impact on real exports but no role in the short run, whilst foreign demand had negative (positive) impact in the short (long) run.

As for the Brazilian case, Cavalcanti and Ribeiro (1998) found that relative prices (exchange rates) were relevant in the explanation of the country´s exports. Markwald and Puga (2002) argued in favor of a positive (negative) effect of exchange rate depreciation (appreciation) on exports, but the effect was higher in the depreciation process, supporting the hysteresis hypothesis.

Aguirre et al. (2007) investigated the impact of exchange rate volatility on Brazilian manufactured-good exports, for the period ranging from 1985 to 2002. The authors applied the ARDL cointegration analysis and found evidence of a long-run relation (cointegration) amongst the volume of Brazilian manufactured exports, real effective exchange rate, real exchange rate volatility, output gap (manufacturing sector), and the level of world imports (proxy for foreign income).

Vieira et al. (2014) considered the role of the trade-weighted real exchange rate and foreign income on the export performance of Brazilian states. The methodology used was a panel data estimation based on System GMM, for the period 1996-2009. The empirical results suggested that state exports are price (exchange rate) and income (foreign) inelastic. There was also evidence that the real exchange rate effect for non-Mercosur partners plays a significant role on state export performance. The estimation for the Mercosur export partners revealed that lagged exports and commodity prices were significant, but there was no robust evidence on the role of trade-weighted GDP and lagged trade-weighted real exchange rate.

Based on the previous review of empirical studies, there is some important difference in the role of exchange rate volatility, price (exchange rate level) and foreign income on export performance. This behavior is expected to some extent, since each of the BRICS countries has its own historical, economic, political and social idiosyncrasy. The role of each of these variables can also vary when different periods of time are taken into account. Nevertheless, it is fair to say that the growth strategies of these emerging economies can be, at least partially, explained by their export performance.

3. Data and Econometric Approach

In order to investigate the BRICS countries' export performance, the following equation is estimated for the period ranging from January 2000 to December 2014:

$$LEXP_t = \beta_0 + \beta_1 VOLAT_t + \beta_2 LREER_t + \beta_3 LWIMP_t + \beta_4 LPCOM_t + \varepsilon_t \tag{1}$$

where: i) LEXP: Log of Exports (US$ Million; Source: DOTS); LREER: Log of Real Effective Exchange Rate (2005 = 100; Source: BIS); VOLAT: Real Effective Exchange Rate Volatility (Source: BIS); LWIMP: Log of World Imports (US$ Million; Source: DOTS); LPCOM: Log of Commodity Price Index – Emerging Market Economies (2010 = 100; Source: The World Bank).[3]

The empirical analysis developed in this work is based on Autoregressive Distributed Lag (ARDL) models applied to cointegration, as proposed in Pesaran and Shin (1999) and Pesaran et al. (2001). These models were chosen due to their advantage over the cointegration tests in non-stationary variables, such the ones developed by Engle and Granger (1987), Phillips and Hansen (1990) and Johansen (1991), as well as over the traditional VAR methodology. ARDL models applied to cointegration also tend to be more efficient to capture the long-term relationship data in small samples, and they perform well irrespective of whether variables are stationary I(0), non-stationary I(1), or even mutually cointegrated (Pesaran and Shin, 1999).

A traditional ARDL model with two variables can be defined as:

$$y_t = \alpha_0 + \delta_1 y_{t-1} + \ldots + \delta_s y_{t-s} + \beta_1 x_{t-1} + \ \ldots \ + \beta_s x_{t-s} + \varepsilon_t \tag{2}$$

Prior to the estimation of an ARDL model applied to cointegration, it is important to make sure that no variable in the empirical model is I(2).[4] Having had this confirmation, a typical Error Correction Model (ARDL-ECM) can estimated by the following specification:

$$\Delta y_t = \alpha_0 + \delta_1 y_{t-1} + \delta_2 x_{t-1} + \sum_{i=0}^{n} \phi_1 \Delta y_{t-i} + \sum_{i=0}^{n} \phi_2 \Delta x_{t-i} + \varepsilon_t \tag{3}$$

Before going any further with estimations related to short and long run dynamics, it is important to check the performance of the ARDL estimates through some diagnostic tests for autocorrelation and stability. The former is a typical autocorrelation LM test, while the latter refers to the cumulative sum (CUSUM) and the cumulative sum of squared (CUSUMSQ) recursive residuals tests, as in Brown, Durbin and Evans (1975). Parameter instability is found if the cumulative sum falls outside the area between the two 5% critical lines. This is crucial in ARDL estimations once the CUSUM and CUSUMSQ are also able to diagnose the influence of structural breaks in the estimations.

Once the researcher has made sure that the model estimated has no serial correlation problem and that it is dynamically stable, the ARDL-Bounds testing methodology can be applied to confirm cointegration (long run relationship) of the variables. Pesaran's bounds testing is a Wald test (F-test) to check the joint significance of the model's long-term parameters. However, under the null hypothesis of no cointegration (H_0: δ_1 = δ_2 = 0), the critical values of the Wald test have no standard asymptotic distribution for any order of integration of the regressors. To circumvent this problem, Pesaran et al. (2001) provide bounds on the critical values for the F statistics, where the lower (upper) bound is calculated on the assumption that all variables of the model are ARDL stationary (non stationary), showing no cointegration (cointegration). Finally, an F-statistic falling between the bounds means that the test is inconclusive.

Once such relationship is confirmed, the long-run equilibrium coefficients can be estimated, as well as the ECM itself, which provides the long-term balance adjustment speed. In fact, the ARDL model can keep information on both short and long run properties of the estimated model, and disequilibrium is seen as a process of adjustment to the long run.

4. Results

As already mentioned, if the cointegration test statistics falls between the critical values calculated by Pesaran et al. (2001), it is necessary to know the order of integration of variables to reject the null hypothesis. Thus, we ran the following unit root tests: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) and the Modified Dickey-Fuller Test (DF-GLS). As Table 1 makes clear, the results related to some variables are inconclusive, especially those associated to exports and real exchange rate volatility. Therefore, this makes ARDL modelling and bounds testing applicable.

Table 1

Unit Root Tests (Jan/2000 – Dec/2014)

		ADF	PP	KPSS	DF-GLS
Log of Commodity Price Index - Emerging		1.22	1.16	0.30**	-1.15
Log of World Imports		-2.35	-2.73	0.23**	-2.40
Log of Real Effective Exchange Rate	Brazil	-2.50	0.29	0.17*	-2.09
	China	1.11	1.40	0.35**	-1.22
	India	-2.39	-2.63	0.15*	-1.86
	Russia	-2.16	-2.69	0.35**	0.10
	South Africa	-2.35	-2.26	0.10	-2.33
Log of Exports	Brazil	-3.30	-4.54**	0.27**	-2.76
	China	-1.59	-4.54**	0.35**	-1.35
	India	-1.76	-3.56*	0.22**	-2.00
	Russia	-2.23	-2.21	0.25**	-2.28
	South Africa	-5.20**	-5.09**	0.23**	-2.68
Real Effective Exchange Rate Volatility	Brazil	-4.95**	-4.894**	0.053	-5.11**
	China	-3.76**	-3.80**	0.14	-3.09*
	India	-1.78	-1.86	0.34**	-1.57
	Russia	-4.40**	-4.34**	0.08	-4.30**
	South Africa	-4.55**	-4.54**	0.07	-4.09**

Notes: * and ** mean rejection of the null hypothesis at 5% and 1% respectively
ADF, PP and DF-GLS: H_0 - unit root; KPSS: H_0 - stationarity

We allow each ARDL estimation to go up to 6 lags and the best model for each country is selected according to the Akaike Bayesian Criteria (AIC). The order of the variables for each ARDL model is as follows: Log of Exports, Log of Real Effective Exchange Rate, Real Effective Exchange Rate Volatility, Log of World Imports and Log of Commodity Price Index.

Table 2 reports the ARDL models for each country analyzed. The lags chosen for each variable vary amongst BRICS countries. In the case of Brazil and China, lagged 'exports' seems to play an important role, as 6 lags were chosen. As for Russia, 'world imports' is the variable with more lags chosen, whilst in India the 'real exchange rate volatility' is the variable with more lags chosen.

Table 2 also reports the Autocorrelation LM Test for each of the ARDL model chosen, and shows that all estimated models are free from serial correlation problems.[5] As for the CUSUM and the CUSUMSQ stability tests, which are reported in the appendix, they show some parameter instability in the case of China, South Africa and Russia.

Table 2

ARDL Models - Dependent Variable: Exports (of each country)

Country	ARDL Model	Autocorrelation LM Test (Prob) (H_0 - no autocorrelation)
Brazil	(6, 0, 0, 1, 2)[1]	0.737 (0.390)
Russia	(2, 0, 1, 6, 2)[1]	2.355 (0.124)
India	(2, 5, 6, 3, 0)[1]	0.774 (0.378)
China	(6, 1, 0, 6, 2)[1]	0.203 (0.652)
South Africa	(3, 1, 0, 2, 2)[3]	2.094 (0.147)

Note: 1 = with constant and trend; 2 = with constant and no trend; 3 = no constant. no trend.

We now turn to the examination of the existence of cointegration vectors amongst the variables, by applying the ARDL Bounds Testing Approach. Table 3 reports these results, taking into account Pesaran's et al. (2001) critical values. The null hypothesis of "no cointegration vectors" can be rejected (at 5%) for Brazil, Russia, India and China, once the F-statistics are greater than the critical values. As for South Africa, the long run relationship can only be detected at 10%, but we must remember that there is considerable parameter instability in the South African case. Overall, it seems that there is a long run relationship between the variables analyzed for each country-member of the BRICS group, with an exception of South Africa.

After applying the ARDL Bounds Testing Approach to all models, we estimate the long-run equilibrium coefficients, which are reported in Table 4. The empirical results suggest the existence of asymmetries among countries, when considering which variables play a significant role in the long run.

In the case of Brazil, its export performance relies mainly on foreign demand and commodity prices. These two factors point to China as the major importer of Brazilian goods. In fact, Brazil took great advantage of the considerable Chinese economic growth in the past few years and exported high quantities of agro and metal commodities, such as soybeans and related soy products, and iron ore.

Table 3

Cointegration Test (ARDL Bounds Testing Approach)

Country	F-Statistics	Critical Values				Long Run Cointegration
		I(0) Bound		I(1) Bound		
		10%	5%	10%	5%	
Brazil	12.783	2.68	3.05	3.53	3.97	Yes
Russia	4.336	2.68	3.05	3.53	3.97	Yes
India	10.193	2.68	3.05	3.53	3.97	Yes
China	8.512	2.68	3.05	3.53	3.97	Yes
South Africa	3.396	1.90	2.26	3.01	3.48	Yes at 10%; Inconclusive at 5%

Notes: H_0 (no long-run relationship)

As for Russia, its export performance relies on the level and volatility of real effective exchange rate, foreign demand and commodity prices. Russia is a major exporter of commodities such as crude oil, petroleum goods and natural gas, which account for about half of the country´s exports. This explains why our ARDL model selected the above mentioned variables.

India´s export performance depends on the level and volatility of real effective exchange rate and commodity prices. Gems and precious metals, petroleum products, automobiles and machinery are the main products exported by India.

China´s export performance relies on real effective exchange rate and foreign demand. There is no doubt China is one of the fastest growing economy nowadays, relying mainly on its exports around the world. In order to have such performance, the control of exchange rate is of utmost importance, as well as a strong foreign demand. But one must remember that there is considerable parameter instability in China´s ARDL model.

South Africa´s export performance depends heavily on foreign demand. The country´s export products are mainly mineral products, precious metals, iron and steel products and vehicles. As in the case of China, South Africa´s estimation also shows considerable parameter instability in the estimated ARDL model.

Table 4

ARDL Models: Long Run Coefficients (Dependent Variable: Log of Exports)

Country (Lags)	Brazil (6, 0, 0, 1, 2)	Russia (2, 0, 1, 6, 2)	India (2, 5, 6, 3, 0)	China (6, 1, 0, 6, 2)	S. Africa (3, 1, 0, 2, 2)
Variables	**Coeffic. (Prob.)**	**Coeffic. (Prob.)**	**Coeffic. (Prob.)**	**Coeffic. (Prob.)**	**Coeffic. (Prob.)**
Real Effective Exchange Rate	0.059 (0.521)	1.228* (0.006)	0.508** (0.093)	-1.168* (0.000)	0.224 (0.256)
REER Volatility	7.761 (0.631)	195.530* (0.018)	-683.751* (0.048)	491.079 (0.190)	-27.844 (0.519)
World Imports	0.649* (0.000)	2.158* (0.000)	0.175 (0.236)	0.881* (0.000)	1.089* (0.000)
Commodity Price Index	0.370* (0.000)	-0.569* (0.030)	0.665* (0.000)	0.034 (0.698)	-0.011 (0.959)
Trend	0.002 (0.009)	-0.004* (0.008)	0.007* (0.000)	0.009* (0.000)	-

The next question to be asked is related to the short run adjustment, via Error Correction Representation (ECM). In fact, if there is long-run equilibrium, any short run disequilibrium can be seen as a process of adjustment to the long run. Therefore, we must know whether this speed of adjustment is fast or slow. Table 5 reports the ECM results for the estimated ARDL models. As expected, the error-correction term (ECM_{t-1}) is negative for all estimations performed (on average ECM_{t-1} = -0.56). It means that, on average, 56% of the shock is corrected after the first month. The lowest speed of adjustment is found in South Africa (23%), showing that the long-run equilibrium relationship amongst its variables returns to the steady state very slowly. But, again, one must remember that South Africa shows a substantial parameter instability and its long run equilibrium is not as significant as in the other countries analyzed. On the other hand, the highest speed of adjustment is related to the case of

China (87%), followed by Brazil (81%), that is, in these two countries the adjustment process towards the long-run equilibrium is quite fast.

Table 5

Error Correction - Short Run Dynamics

Country (Lags)	ECM(-1)	Prob.
Brazil (6, 0, 0, 1, 2)	-0.818	0.000
Russia (2, 0, 1, 6, 2)	-0.295	0.000
India (2, 5, 6, 3, 0)	-0.582	0.000
China (6,1,0,6,2)	-0.871	0.000
South Africa (3, 1, 0, 2, 2)	-0.236	0.000

Conclusion

The main goal of this work was to investigate the export performance for Brazil, Russia, India, China and South Africa (BRICS) from January 2000 to December 2014, using autoregressive distributed lag (ARDL) models for cointegration.

We were able to reject the null of no long run relationship for each country, indicating the existence of cointegration among the variables used in our empirical analysis. The empirical results also suggested that in the long run, export performance depends heavily on the level and volatility real effective exchange rate and foreign demand, in the case of China and Russia, foreign demand and commodity prices, for Brazil, real effective exchange rate and commodity prices, for India and on foreign demand, in the case of South Africa.

Footnotes

[1] Sousa et al. (2008) develop a literature review based on 52 previous studies from 1998 to 2005 on the determinants of export performance and highlight that they can be characterized by fragmentation and diversity.

[2] Similar results for South Africa were found by Nyahokwe and Ncwadi (2013).

[5] i) 'L' indicates that the variables are in natural log form; ii) the real exchange rates volatility of each country was calculated via ARCH-GARCH; iii) world imports are used as proxy for international demand for exports; iv) exports and real effective exchange rate (level and volatility) refer to each country analyzed; v) the commodity price index refers to developing and emerging economies.

[4] We performed unit root tests and found no I(2) variable. We decided not to report the results to save page space.

[5] All estimations are available upon request.

References

Arize, A.; T. Osang and D. Slottje. “Exchange Rate Volatility and Foreign Trade: Evidence from Thirteen LDC’s.” *Journal of Business and Economic Statistics* 18, no. 1 (2000): 10-17.

Assery, A. and D. A. Peel. “The effects of exchange rate volatility on exports.” *Economics Letters* 37, no. 2 (1991): 173–177.

Aguirre, A.; A. Ferreira and H. Notini. “The Impact of Exchange Rate Volatility on Brazilian Manufactured Exports.” *Económica, La Plata* LIII, no. 1-2 (2007): p. 3-19.

Bahmani-Oskooee, M. and S. W. Hegerty. “Exchange rate volatility and trade flows: a review article.” *Journal of Economic Studies* 34, no. 3 (2007): 211-255.

Bojnec, S.; I. Ferto and J. Fogarasi. “Quality of institutions and the BRIC countries agro-food exports.” *China Agricultural Economic Review* 6, no. 3 (2014): p. 379 – 394.

Brown, R. L.; J. Durbin and J. M. Evans. “Techniques for Testing the Constancy of Regression Relationships over Time.” *Journal of the Royal Statistical Society B* 37, no. 2 (1975): 149–163.

Cavalcanti, M. A. F. H. and F. J. Ribeiro. “As exportações brasileiras no período 1977–96: desempenho e determinantes.” *IPEA Working Paper 545*. IPEA, Rio de Janeiro, 1988.

Chit, M. M. “Exchange rate volatility and exports: evidence from the ASEAN-China Free Trade Area.” *Journal of Chinese Economic and Business Studies* 6, no. 3 (2008): 261-277.

Clark, P. B. “Uncertainty, Exchange Risk, and the Level of International Trade.” *Economic Inquiry* 11, no. 3 (1973): 302-13.

De Grauwe, P. “Exchange Rate Variability and the Slowdown in Growth of International Trade.” *IMF Staff Papers* 35, no. 1 (1988): 63-84.

Dickey, D. A. and W. A. Fuller. “Distribution of the Estimators for Autoregressive Time Series with a Unit Root.” *Journal of the American Statistical Association* 74, no. 366 (1979): 427-431.

Ekanayake, E. M.; R. L. Thaver and D. Plante. "The Effects of Exchange Rate Volatility on South Africa's Trade with the European Union." *The International Journal of Business and Finance Research* 6, no. 3 (2012): 13-26.

Elliot, G.; T. Rothemberg and J. H. Stock. "Efficient Tests for an Autoregressive Unit Root." *Econometrica* 64, no. 4 (1996): 813-836.

Engle, R. F. and C. W. J. Granger. "Co-integration and Error Correction: Representation, Estimation and Testing." *Econometrica* 55, no. 2 (1987): 251-76.

Ethier, W. "International trade and the forward exchange market." *American Economic Review* 63, no. 3, (1973): 494-503.

Gouvea, R.; R. V. Mahto and M. J. R. Montoya. "BRIC national export performance: a portfolio approach." *Journal of Chinese Economic and Business Studies* 11, no. (2013): 47-58.

Hooper, P. and S. W. Kohlhagen. "The effect of exchange rate uncertainty on the prices and volume of international trade." *Journal of International Economics* 8, no. 4, (1978): 483-511.

Huchet-Bourdon, M. and J. Korinek. "To What Extent Do Exchange Rates and their Volatility Affect Trade?" *OECD Trade Policy Papers*, no. 119, 2011.

Johansen, S. "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models." *Econometrica* 59, no. 6 (1991): 1551–1580.

Kwiatkowski, D.; P. C. B. Phillips; P. Schmidt and Y. Shin. "Testing the Null Hypothesis of Stationary Against the Alternative of a Unit Root: How Sure are We that Economic Time Series are Non-Stationary?" *Journal of Econometrics* 54, no. 1-3 (1992): 159-178.

Kocourek, A. (2015). "Exports as a Driving Factor of Structural Changes in the BRICS Economies: 1995 – 2012." *American Journal of Economics* 5, no. 2 (2015): 119-127.

Markwald, R. and F. P. Puga. "Focando a política de promoção das exportações." In: Pinheiro, A. C.; R. Markwald and L. V. Pereira (Eds.): *O desafio das exportações.* Rio de Janeiro: BNDES, 2002.

McKenzie, M. D. (1999). "The Impact of Exchange Rate Volatility on International Trade Flows." *Journal of Economic Surveys* 13, no. 1 (1999): 71-106.

Naudé, W. and R. Rossouw, R. "Export diversification and economic performance: evidence from Brazil, China, India and South Africa." *Economic Change and Restructuring* 44, no. 1 (2011): 99–134.

Nyahokwe, O. and R. Ncwadi. "The Impact of Exchange Rate Volatility on South African Exports." *Mediterranean Journal of Social Sciences* 4, no. 3 (2013): 507-513.

Pesaran, M. H. and Y. Shin. "An Autoregressive Distributed-Lag Modelling Approach to Cointegration Analysis." In: Strøm, S. (ed.). *Econometrics and Economic Theory in the 20th Century*. Cambridge: Cambridge University Press, 1999.

Pesaran, M. H.; Y. Shin and R. J. Smith. "Bounds Testing Approaches to the Analysis of Level Relationships." *Journal of Applied Econometrics* 16, no. 3 (2001): 289-326.

Phillips, P. C. B. and B. E. Hansen. "Statistical Inference in Instrumental Variables Regression with I(1) Processes." *The Review of Economic Studies* 57, no. 1 (1990): 99-125.

Phillips, P. C. B. and P. Perron. "Testing for a Unit Root in Time Series Regression." *Biometrika* 75, no. 2 (1988): 335–346.

Sousa, C. M. P.; F. J. Martínez-López and F. Coelho. "The Determinants of Export Performance: A Review of the Research in the Literature between 1998 and 2005." *International Journal of Management Reviews* 10, no. 4 (2008): 343–374.

Srinivasan, P. and M. Kalaivani. "Exchange rate volatility and export growth in India: An ARDL bounds testing approach." *Decision Science Letters* 2, no. 3 (2013): 191–202.

Todani, K. R. and T. V. Munyama. "Exchange Rate Volatility and Exports in South Africa." *South African Reserve Bank Research Department,* TIPS/DPRU Forum 2005, Pretoria, South Africa, 2005.

Vieira, F. V. and R. MacDonald. “Exchange Rate Volatility and Exports: A Panel Data Analysis.” *Journal of Economic Studies* 43, no. 2 (2016): 203-221.

Vieira, F. V.; E. A. Haddad and C. R. Azzoni. “Export Performance of Brazilian States to Mercosul and Non-Mercosul Partners.” *Latin American Business Review* 15, no. 3-4 (2014): 253-267.

Ying, S.; L. Miao and C. Yibo. “High-Tech Products Export Competitiveness, BRIC Countries in U.S Market: A Comparative Analysis.” *The Journal of Developing Areas* 48, no. 3 (2014): 195-218.

Appendix

Figure 1A: Brazil – CUSUM and CUSUMQ

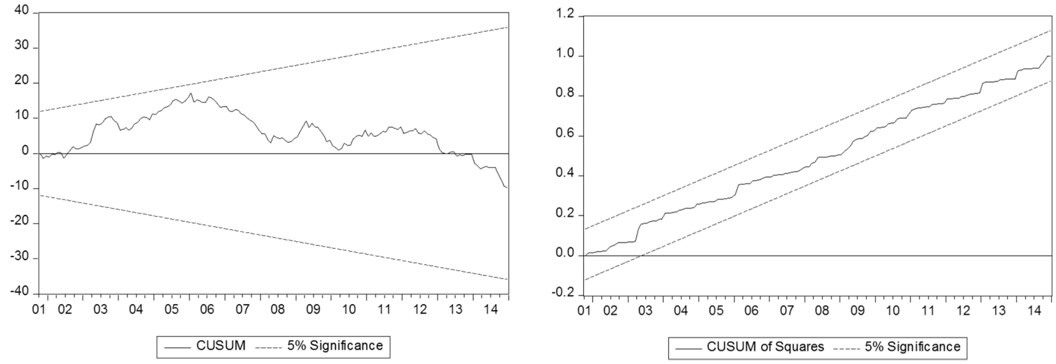


Figure 1B: Russia – CUSUM and CUSUMQ

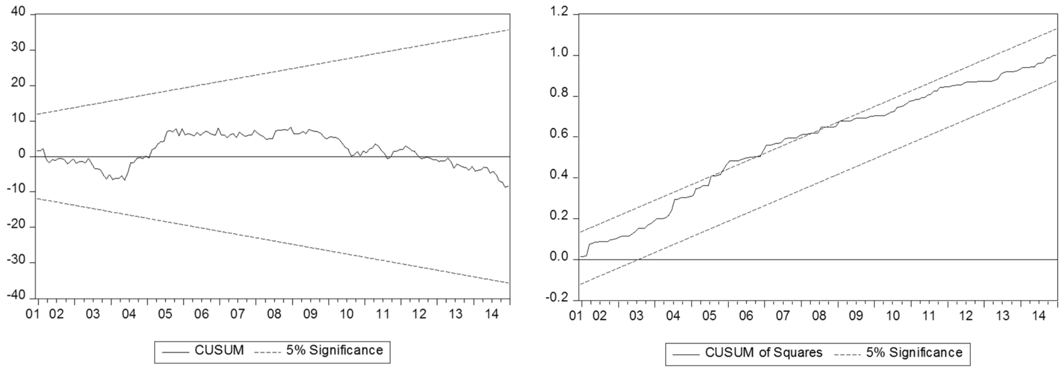


Figure 1C: India – CUSUM and CUSUMQ

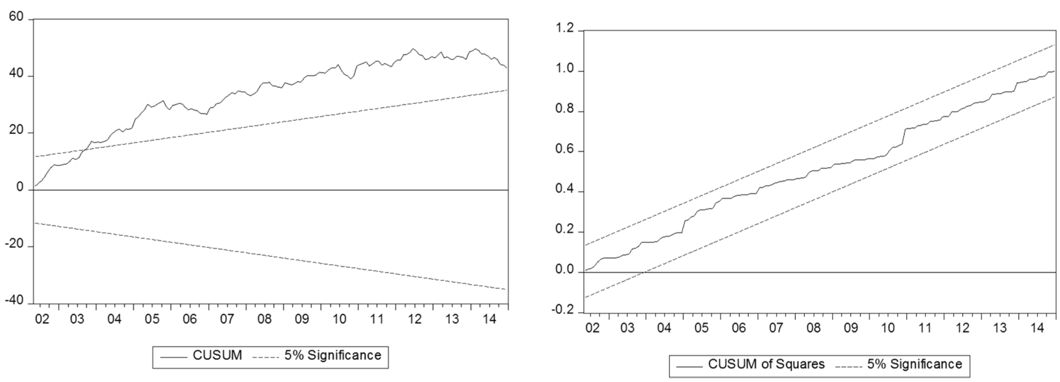
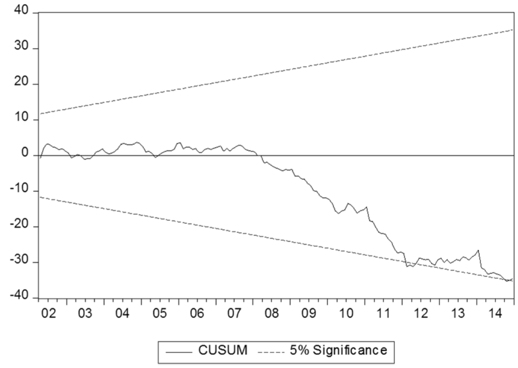


Figure 1D: China – CUSUM and CUSUMQ



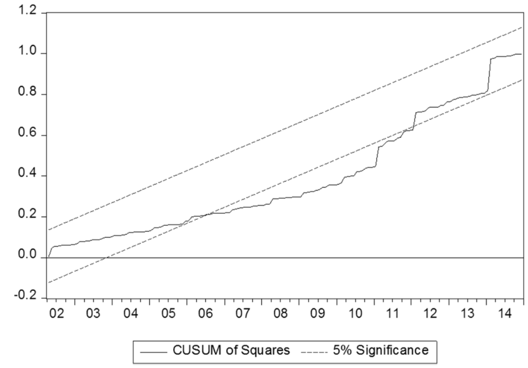


Figure 1E South Africa – CUSUM and CUSUMQ