Exchange Rate Volatility in BRICS Countries

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Introduction

Global economic leadership is progressively shifting from the G7 to the BRICS, the popular symbol use to refer to Brazil, Russia, India, China and South Africa. Goldman and Sachs (Wilson and Purushothaman, 2003) projects that the BRICS will "overtake" the G6 (UK, US, France, Italy, Japan and Germany) by 2040. Indeed, China passed Japan in 2010 to become the second largest economy (Dawson and Dean, 2011) while Brazil just overtook the UK (BBC, 2011). The BRICS are first characterized by an astonishing economic growth, from 5% to a two-digit annual growth, depending on the countries (The World Bank Indicators, 2011). Together, the BRICS represent 30% of the global economic growth, 40% of the world's population and 25% of the global land mass (Sule, 2011). Their combined GDP is estimated at $8.7 trillion (Sule, 2011). Consumption in the BRICS is high and increasing at a fast pace while the first economies (G3: US, Europe and Japan), affected by the recent financial crisis, have been penalized by a low final demand (Yamakawa et al., 2009). Not surprisingly, it is estimated that by 2032, four of these countries will be among the five largest economies (Sule, 2011).

The BRICS are also becoming dominant in international trade. Exports have recently been growing at a 38% per annum rate in Brazil, 28% in India, 25% in China and 18% in Russia (Vardi, 2011). Their combined trade was estimated at $4.4 trillion in 2008 (Sule, 2011). In addition, trade with developing countries is growing three times faster (25% per year) than among developed countries. BRICS have contributed up to 60% of the trade between low-income countries (Sule, 2011). As the bulk of this trade is done in USD, the BRICS have accumulated dollar reserves such that today, these countries hold 40% of the World's currency reserves (Sule, 2011). The U.S. dollar (USD) has lost some of its leadership as a stable and

strong currency, particularly now with the seemingly every increasing US national debt. This USD instability is an issue of concern for the leaders of the BRICS who have already proposed a move away from the use of the USD as vehicle currency. Most likely, they would use their local currencies in bilateral trade. As a matter of fact, China and Russia have already started to trade using their own currencies. There are strong reasons for this change. First, it would allow BRICS to diversify their foreign reserves as a way of managing the risk. Second, if the BRICS use their national currency to trade and they experience a bright future as predicted, their currencies may become global. Third, it is believed that the use of BRICS currencies would decrease transaction costs compared to the USD. Fourth, this would also allow the BRICS to have a greater political power in international negotiations. Finally, and much more hypothetically, by using their national currency, the BRICS may lay the foundation for a monetary union. Note however that in order to use their national currencies in lieu of the USD, the BRICS will have to face many constraints. The first is to select a particular currency of one of the members. Currently, the size of the Chinese economy and trade volume makes the YUAN the most likely currency. Another issue is that the trade among the BRICS is still very small compared to the bilateral trades with the US and European countries. This still obligates them to use the USD in the majority of their transactions.

The recent interest of the BRICS to develop a common currency was worthy of business news in 2011. While progress on this issue may seem latent, it appears timely to investigate such possibility. This paper introduces very preliminary empirical evidence on the impact of the USD, Euro and Yen (the three currencies of the so-called G-3) on the BRICS' trade. The question of interest in this paper is the examination of the effect of exchange rate volatility of the G-3 currencies on agricultural exports of each of the BRICS. To this aim, the paper is structured as

follows. The next section provides a brief review of literature. The methodology is presented in section 3, followed by the data section. Results and conclusions are the last two sections of the paper.

Literature Review

Under the Bretton Woods system the exchange rate between the US dollar and the other currencies was fixed. Following its collapse in 1973, economists' interest shifted towards the impact of exchange rate volatility, especially on trade and investment. In spite of a vast literature on the matter, the effect of floating exchange rates on trade remains controversial (Krugman and Obstfeld, 2003). Note also that even if the Bretton-Woods system is not in force anymore, the reserves of the central banks of the world remain constituted of few currencies which are generally the US dollar and the Euro (Krugman and Obstfeld, 2003). The theory behind the relationship between exchange rate volatility and trade is that if we consider two exporting countries and assuming that there is no future or forward market for foreign exchange such that the exporters cannot lock a price, they can incur a risk at the moment of the conversion (Bailey et al., 1987). Clearly, a company which is selling its goods abroad will be paid in the currency of the buyer (i.e. importer), and once the payment is made, the company will have to convert back to its home currency. The issue is that it can take a long time from the moment that the merchandise is on a ship to the moment the full payment is made such that the currency of the seller can depreciate or appreciate relative to the currency of the buyer. Depending on how currency fluctuates, she/he will gain or lose. The effect of exchange rate volatility on trade is closely tied to risk-aversion behavior. If the exporter is risk adverse, she/he will require a premium. Graphically, we can think of this phenomenom as a left shift of the supply curve (Bailey et al., 1987) which represents a decrease in trade. Foreign exchange markets allow the

exporter to hedge the risk without making it totally disappear. Many authors have attempted to measure the effect of exchange rate volatility on trade. One of the pioneer works is that of Hooper and Kohlhagen (1976). In their paper, they looked at the effect of dollar-deutschmark fluctuations on the trade of the US, Germany and other industrialized countries. They estimated a system of equations that include export supply and import demand functions. Exchange risk (uncertainty) was measured using the average absolute deviation. They disassociated the impact of exchange rate uncertainty on importers from the one on exporters. Depending on who is bearing the risk (i.e. importers or exporters), the effect on the price of traded goods will be positive (exporters) or negative (importers). Surprisingly they did not find any significant relationship between the exchange rate uncertainty and the volume of trade. A decade later, Bailey et al. (1987) assessed the effect of exchange rate volatility on export growth for eleven OECD countries, using quarterly data that covered the pre- and post-Bretton Woods collapse (1962-1974 and 1975-1985). They estimated a linear regression of exports (in volume) on a measure of economic growth in trade partner countries, a measure of export prices relative to those of trade partner countries, real export earnings of oil exporting countries and exchange rate variability. Two measures of variability were used for both nominal and real exchange rates. The first was the logarithms of the moving standard deviations. The second corresponds to polynomial distributed lag of the absolute-percentage-change. They found a positive relationship between real exports and nominal exchange rate variability but a negative relationship when the real exchange rate volatility was included (Bailey et al., 1987). With the development of new theories and methodologies in time-series econometrics such as cointegration and error correction models (Engle and Granger, 1987 and Johansen, 1988 and 1991), economists have started to look at the long-run relationships between exchange rate volatility and export flows.

Example of authors that have employed cointegration tests and error correction models are Arize et al. (2000). They have explored the effect of real exchange rate volatility on export flows for 13 developing countries. They found a negative and significant relationship in both short and long run (Arize et al., 2000). Other authors (e.g., Kroner and Lastrapes, 1990) have used (G)ARCH model (and extensions) to investigate the relationship between exchange rate volatility and trade on the premises that exchange rates cluster in period of high or low volatility (i.e. time-varying conditional volatility). Kroner and Lastrapes (1990) found a small but significant effect of exchange rate volatility on trade and observed that this effect varies across the countries. Koray and Lastrapes (1989) studied the relationships between real exchange rate volatility and US imports using a VAR model where macro variables are included and found a very weak effect. This literature is far from exhaustive but emphasized the diversity of methodologies and case-studies. An interested reader may want to refer to McKenzie (1999) for a complete literature review on the impact of exchange rate volatility on trade flows.

Since Europe, the US and Japan absorb a large portion of the World trade and the Euro, Dollar and Yen are the main vehicle currencies, developing countries' trade is most likely to be impacted by the volatility of the above-mentioned currencies. Cushman (1986) was the first to investigate these so-called third-country effects. He cleverly explains why we would expect these effects to be significant. "While increased dollar-pound risk would be expected to reduce US exports to the UK, increased dollar-mark might increase the US to UK flow as US exporters substitute British for German markets" (Cushman, 1986, p.361). He indeed found significant third-country effects analyzing bilateral exports between the US and its then main trading partners. More recently, Esquivel and Larraín (2002) have looked at the impact of G-3 (US, Japan and Germany) exchange rate volatility on developing countries. They used monthly data

from 1973 to 1998. The beginning of the studied period corresponds to the collapse of the Bretton-Woods system and the end, falls few years earlier than the introduction of the Euro. To measure volatility they used the standard deviation of the growth rates of real exchange rates (12-months moving-average) and the coefficient of variation of the real exchange rate. They then looked at the impact of the G-3 exchange rates on the effective real exchange rates of 28 developing countries by carrying out regressions of the log-differences (rate of changes) of the effective real exchange rate on the log-differences of the bilateral real exchange rate Deutsche mark/dollar and Yen/dollar (Esquivel and Larraín, 2002). They complemented their analysis by carrying out a series of regressions of the logarithm of real exports on the logarithm of GDP, the bilateral real exchange rate with respect to the dollar and a measure of exchange rate volatility (Esquivel and Larraín, 2002). They also explore the impact of G-3 currency volatility on foreign direct investment. They globally found that the G-3 exchange rate volatility has had a negative impact on the exports of developing countries. In particular, a 1% increase in volatility would result in a 2% decrease in developing countries real exports (Esquivel and Larraín, 2002). In addition, it seems that the G-3 exchange rate volatility depresses foreign direct investment in developing countries. The findings of Esquivel and Larraín (2002) have motivated the present research.

Methodology

The real exchange rate (RER) was computed by deflating exchange rates using the involved countries CPIs. Standard deviation and coefficient of variation of the RER rates of change are traditionally used in the economic literature as measures of volatility (e.g., Esquivel and Larraín (2002)). In order to compute the standard deviation of RER, the rates of change are calculated as the natural log of real exchange rate at month (t) minus the natural log of the real exchange rate

at a lagged month (t-1) and the resulting number multiplied by 100. For example, the January-2001 exchange rate volatility is the standard deviation of the monthly rates of change (ROC) of the previous year; February-2001 volatility is then computed using last year ROC (t-1) until January-2001 ROC; and the volatility for the subsequent months is computed in the same fashion.

$$ST_{t+p} = \sqrt{\left[\frac{1}{P}\sum_{i=1}^{P}(R_{t+i-1} - R_{t+i-2})^2\right]} \qquad (1)$$

The coefficient of variation is obtained in the same fashion as the standard deviation, except for the very last step on which the already computed standard deviation is divided by the average of the rates of change. Esquivel and Larraín (2002) found the coefficient of variation more efficient when predicting volatility. In the present paper both measures of volatility are used in the empirical analysis,

$$CV_{t+p} = \frac{\sqrt{\left[\frac{1}{P}\sum_{i=1}^{P}(\varepsilon_{t+i-1} - \bar{\varepsilon})^2\right]}}{\bar{\varepsilon}} \qquad (2)$$

Both monthly variables (STD and CV) are then converted into annual by taking the arithmetic average over 12 periods.

Economic Model

The role of exchange rate in trade flows is very well known in the field of international trade (Esquivel and Larraín (2002), McKenzie (1999), Dell'Ariccia (1999), and Arize et al. (2000)). Relative price changes also affect international flows of merchandise. For instance, a weaker USD is expected to impulse the export engine of the United States and at the same time decrease imports as foreign goods become relatively more expensive. According to Brodsky (1984) higher

exchange rate volatility may discourage risk averse and also perhaps risk neutral commodity

traders, leading to a decrease in exports as they may not want to put profits into higher

uncertainty. Esquivel and Larrain (2002) found that the instability of the major traded currencies

such as the DEM, USD, and JPY is transmitted to bilateral exchange rates which in turn may

reduce trade flows in developing countries. However the effect of third countries currency

exchange rates on emerging economies has seldom been addressed. It is well known that world

demand (i.e. exports) for goods goes along with the GDP, for example, there has beeb poor trade

performance during the global economic downturn. When the economy is in expansion the

amount of interaction between buyers and sellers is high and this determines exchange rates.

Equation 3 summarizes the factors affecting exports as suggested by the economic theory. Notice

that exports are a function of the world demand, bilateral and third country currency exchange

rates.

$$Exports{=}f\ (World\ Demand, Bilateral\ US\text{-}BRICS\ exchange\ rate, G{-}3\ Currency\ Volatility).$$
$$(3)$$

Econometric Model

We adopt a vector autoregressive model (VAR) for the specification of equation (3) and estimate

a separate model for each BRICS country as follows:

$$\begin{matrix} \Delta X_t \\ \Delta \text{GDPw}_t \\ \Delta \text{RERus}_t \end{matrix} = \begin{matrix} A_{10} \\ A_{20} \\ A_{30} \end{matrix} + \begin{matrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{matrix} \times \begin{matrix} \Delta X_{t-k} \\ \Delta \text{GDPw}_{t-k} \\ \Delta \text{RERus}_{t-k} \end{matrix} + \begin{matrix} B_{10} \\ B_{20} \\ B_{30} \end{matrix} \times VOL_{\textbf{JPY/USD}} +$$

$$\begin{matrix} C_{10} \\ C_{20} \\ C_{30} \end{matrix} \times VOL_{\textbf{EUR/USD}} + \begin{matrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{matrix} \qquad (4),$$

where X are real exports, GDPw is the world GDP, RERus is the real exchange rate of the

BRICS national currency per USD and k is the optimal lag length. The volatility of the yen-usd

exchange rate and the volatility of the euro-usd exchange rate are considered as exogenous in the

VAR. Before estimating the model, we carried out unit root tests (augmented Dickey-Fuller); these tests indicate that all variables expose I(2) behavior, except $VOL_{\mathbf{JPY/USD}}$ and $VOL_{\mathbf{EUR/USD}}$ which behave as I(0). The selection of the optimal lag length is based on the Akaike selection criterion (AIC), using undifferenced data as suggested by Enders (2004). The maximum lag length in the AIC was set to three because of the small sample size. Cointegration was tested for I(2) variables using the Johansen's procedure and the testing framework of RATS for I(2). A VAR (k) was estimated including a constant in the cointegrating vector as the variables did not have a clear tendency to increase or decrease. We used the modified Wald test introduced by Toda and Yamamoto (1995) to test Granger causality from exchange rate volatility to agricultural exports of each country by setting the d_{max} value to 2 for consistency with the unit-root results. This method is simple and easy to implement in testing for causality and has been shown in other studies (e.g., Zapata and Rambaldi (1997)) to work as well in small samples.

Data

National currency exchange rates per US dollars for Brazil, Russia, India, China, South Africa, Honduras, Euro Area and Japan were downloaded from the International Financial Statistics (IFS-IMF) browser (URL: http://www.imfstatistics.org/imf/logon.aspx). These data were obtained in a monthly frequency from January 1961 to December 2008. This data screening resulted in eight series containing 130 observations. Data for agricultural exports were found at the FAO website (URL: http://www.fao.org/economic/ess/countrystat/en/). Monthly and annual Consumer Price Indices (CPI-2005=100) for Euro-Area and each country were obtained from the Organization for Economic Co-Operation and Development (OECD, URL http://stats.oecd.org/index.aspx). Data for World Agricultural GDP and GDP deflator were downloaded from the World Bank website (URL: http://data.worldbank.org/). Monthly and Annual Free on Board (FOB) exports in millions of USD were downloaded from the IFS browser for the same period.

Results

The Augmented Dickey-Fuller test with a constant and a trend was used to test for unit roots. The lag length in the ADF tests was selected using a modified AIC criteria (Enders, 2010). Results are shown in Table 1. Real agricultural exports (RAGE), real agricultural GDP (RAGDP), exchange rates between a country's currency and the dollar (Bil R_Ex Rate) are mainly I(2) variables for each country. The last four columns in Table 1 related to the volatility measures (coefficients of variation between the Euro and USD (CVEUSD) and between the Yen and the USD (CVYENUSD), and the standard deviations of the same variables) which are all I(0) variables. These results suggest the possibility of cointegration for I(2) variables (e.g. Johansen (1995)—see also CATS in RATS which does I(2) analysis).

Table 1. Order of Integration of each series based on Dickey-Fuller tests

Model	Variable	RAGE	RAGDP	R_Ex Rate	CV EUSD	CV YENUSD	STD EUSD	STD YENUSD
1	Brazil	I(2)	I(2)	I(2)	I(0)	I(0)	I(0)	I(0)
2	China	I(2)	I(2)	I(2)	I(0)	I(0)	I(0)	I(0)
3	India	I(2)	I(2)	I(2)	I(0)	I(0)	I(0)	I(0)
4	Russia	I(0)	I(2)	I(2)	I(0)	I(0)	I(0)	I(0)
5	South Africa	I(2)	I(2)	I(1)	I(0)	I(0)	I(0)	I(0)

The volatility of the yen-usd and euro-usd exchange rates are stationary and enter the VAR as exogenous variables in levels. Real agricultural exports appear to be integrated of order two in most of the cases except for Russia. This result is however not surprising as there were only 17 observations for Russia. The real world agricultural GDP, common to all models, is I(2) and the bilateral exchange rates are generally I(2) except the Rand/USD. In view of these unit root test results, for Brazil, China and India the VAR models include real agricultural exports, real world agricultural GDP and bilateral exchange rates in addition to the exogenous variables

(volatility of the yen-usd and euro-usd). In the case of Russia only the world GDP and the bilateral exchange rate were included as endogenous variables in the VAR. For South Africa, only agricultural exports and world agricultural GDP were simultaneously determined in the VAR. The real exchange rate between the Rand and USD is I(1) such that we consider it as an exogenous variable and the first differences are used for the estimation.

Causality Tests

The aim of this paper was to provide initial empirical evidence on the relationship between exchange rate volatility (in G-3 countries) and agricultural exports. One could proceed, as in Johansen (1997), and use the ECM model via MLE to conduct the tests on noncausality or apply alternative methods such as in Toda and Yamamoto (1995). We chose to apply the modified Wald test of Toda and Yamamoto because of its simplicity relative to the alternative LR test of Johansen. Thus the null hypothesis becomes that volatility in exchange rates does not cause agricultural exports of each country. Table 3 presents the p-values from the Granger causality tests performed between agricultural exports and G-3 exchange rate (EUR/USD and JPY/USD) volatility (CV and STD). The null hypothesis is only rejected in the case of Brazil and China. This means that the volatility, more specifically, STD RER EUR/USD and JPY/USD Granger causes Brazilian agricultural exports. In the case of China, STD RER JPY/USD Granger Causes Chinese agricultural exports.

Table 2. Granger Causality test coefficient of variation of the real exchange rates

Ho (influenced by itself)	H1 (Rage is influced by)	DF	Den DF	F Value	Pr > F	Granger Cause
Rage Brazil	CV EUR/USD and JPY/USD	2	65	0.07	0.930	
Rage Brazil	CV EUR/USD	1	65	0.12	0.730	
Rage Brazil	CV JPY/USD	1	65	0.10	0.750	
Rage China	CV EUR/USD and JPY/USD	2	40	1.50	0.235	
Rage China	CV EUR/USD	1	40	0.85	0.362	
Rage China	CV JPY/USD	1	40	2.07	0.158	
Rage India	CV EUR/USD and JPY/USD	2	110	1.41	0.250	
Rage India	CV EUR/USD	1	110	1.92	0.168	
Rage India	CV JPY/USD	1	110	0.33	0.570	
Rage South Africa	CV EUR/USD and JPY/USD	2	110	0.66	0.519	
Rage South Africa	CV EUR/USD	1	110	1.31	0.255	
Rage South Africa	CV JPY/USD	1	110	0.08	0.778	
Rage Brazil	STD EUR/USD and JPY/USD	2	65	2.43	0.096	*
Rage Brazil	STD EUR/USD	1	65	4.81	0.032	**
Rage Brazil	STD JPY/USD	1	65	0.90	0.347	
Rage China	STD EUR/USD and JPY/USD	2	40	1.69	0.197	
Rage China	STD EUR/USD	1	40	0.21	0.650	
Rage China	STD JPY/USD	1	40	3.09	0.086	*
Rage India	STD EUR/USD and JPY/USD	2	110	0.45	0.639	

Rage India	STD EUR/USD	1	110	0.12	0.729	
Rage India	STD JPY/USD	1	110	0.86	0.356	
Rage South Africa	STD EUR/USD and JPY/USD	2	110	0.08	0.920	
Rage South Africa	STD EUR/USD	1	110	0.14	0.707	
Rage South Africa	STD JPY/USD	1	110	0.03	0.871	

Summary

This study investigated the relationship between volatility in exchange rates, Euro-USD and Yen-USD, on agricultural exports of Brazil, India, China and South Africa using a vector autoregressive model. We found that except for the volatility measures (coefficients of variation and standard deviations of monthly values), all variables were I(2). We conducted a preliminary analysis using Johansen (1997) ECM for I(2) variables and found cointegration for some countries but not for others. Given the small sample size for some countries, and the fact that some variables were I(0), I(1) and I(2), we opted for the modified Wald tests (Toda and Yamamoto) to test for noncausality. It was found that for China and Brazil, exchange rate volatility in the G-3 countries has a significant effect on agricultural exports. No significant effect was found for the other countries.

While these results are preliminary, and given the dominant exporting role that Brazil and China play in world trade, exchange rate volatility in some trade partners (U.S., Japan, and the Eurozone) raises the possibility that excessive volatility (such as the one experienced during the recent financial crises) may cause unwanted trade flows (increasing exchange rate risk may cause a decline in exports). While an intuitive argument could be made that the BRICS can be

better off by developing their own currency to price their commercial trade, or for issuing credits and grants to each other as signed in 2011, a more complete analysis that develops such currency or index is warranted and is a subject of future research.

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