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Exchange Rate Volatility Effects on BRICS Countries Exports

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EXCHANGE RATE VOLATILITY EFFECTS ON BRICS
COUNTRIES EXPORTS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
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To my son, wife, mother, father, sisters, and family in law.

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ACF: Autocorrelation Function
ADF: Augmented Dickey-Fuller
AIC: Akaike information Criterion
ARMA: Autoregressive-Moving-Average
BIC: Bayesian Information Criterion
BEC: Bayesian Estimation Criterion
BFGS: Broyden–Fletcher–Goldfarb–Shanno
BoP: Balance of Payments
BOVESPA: Bolsa de Valores de São Paulo; São Paulo Stock Exchange
CAT: Criterion Autoregressive Transfer function
CPI: Consumer Price Index
DF: Degrees of Freedom
DGP: Data Generating Process
DOTS: Direction of Trade Statistics (IMF)
ERS: Elliot, Rothenberg & Stock
FAO: Food and Agriculture Organization
FAS: Foreign Agricultural Service (USDA)
FDI: Foreign Direct Investment
Fed: Federal Reserve System
FPE: Final Prediction Error
GARCH: Generalized AutoRegressive Conditional Heteroskedasticity
GDP: Gross Domestic Product
GLS: Generalized Least Squares
H-O: Heckscher–Ohlin
HQ: Hannan-Quinn
IFS: International Financial Statistics (IMF)
iid: independent and identically distributed
IMF: International Monetary Fund
LM: Lagrange Multiplier
MA: Moving Average
MWALD: Modified Wald
MGARCH: Multivariate Generalized AutoRegressive Conditional Heteroskedasticity
MGARCH-M: Multivariate Generalized AutoRegressive Conditional
Heteroskedasticity in Mean
MIC: Modified Information Criterion
MLE: Maximum-Likelihood Estimation
MSE: Mean squared error
NEER: Nominal Effective Exchange Rate
OECD: Organisation for Economic Co-operation and Development
OLS: Ordinary Least Squares
PACF: Partial AutoCorrelation Function
PBOC: People's Bank of China
PIC: Post Information Criterion
PPI: Producer Price Index

REER: Real Effective Exchange Rate
SC/SBC: Schwarz (Bayesian) Criterion
SLR: Sim's Likelihood Ratio test
TYDL: Toda and Yamamoto (1995), and Dolado and Lütkepohl (1996)
USDA: United States Department of Agriculture
VAR: Vector Autoregressive
VARMA: Vector Autoregressive Moving Average
VECM: Vector Error Correction Model

ABSTRACT

The leaders of the leading emerging economies Brazil, Russia, India, China, and South Africa (BRICS) claim that increased currency exchange rate volatility (CERV) from USD, EUR, and JPY (G-3) negatively impacts their exports, and expressed their desire for less trade dependence on these currencies. The literature on the impact of CERV on trade is vast. However, no consensus on the impact's direction and significance has been reached yet. The motivation of this study was: first, to contribute to the existing empirical literature by using an alternative methodology; and second, to provide empirical evidence to the claim's validity or nullity by focusing on the case of BRICS, Turkey and Honduras. To this end, two general null hypotheses (objectives) were tested: 1) Unconditional (constant) CERV does not Granger cause exports, and 2) Conditional (stochastic) CERV does not impact exports.

To achieve the first objective, an export demand model was specified as a VAR dynamic system of exports, World GDP, relative prices, and own or third CERV. Quarterly time-series from 1973 to 2013 were used. Using a battery of unit root tests, including the latest developments, different orders of integration were identified. Therefore, to test this hypothesis it was opted for the Toda Yamamoto, and Dolado and Lütkepohl procedure. It consists in estimating an augmented VAR and test for Granger non-causality using MWald tests. In total 84 models were estimated.

To accomplish the second objective, Bivariate VAR-GARCH(1,1)-M models of exports and exchange rates were estimated and the significance of the volatility coefficient was tested via t-tests. Data were log first-differenced as monthly exports and exchange rates were I(1) for the 1973 to 2013 period. In total, 42 estimations were performed.

The major results provide empirical evidence that support the claim for some countries. Model results indicate that Brazilian agricultural and total exports have been significantly and negatively impacted by own and third country currency volatility, while Chinese and Honduran exports have been positively or not significantly affected. In the case of Turkey no significant effects were found. And the remaining countries Russia, India, and South Africa presented mixed results.

1   INTRODUCTION

1.1   BRICS Background

It has been 12 years since the acronym "BRIC" in reference to the leading

emerging economies of Brazil, Russia, India, and China was coined by Jim O'Neill in

his 2001 seminal paper entitled *"Building Better Global Economic BRICs."* One of

the purposes of the Goldman Sachs Research Group through this publication was to

put in the spotlight how these emerging economies could potentially change the

"global economic landscape," and calls for more presence of the BRICs in world

policymaking forums, in particular to address issues pertaining to the global

economic impact of fiscal and monetary policy. In 2003, the same research group

published another influential paper *"Dreaming With BRICs: The Path to 2050,"* that

used forecasts of Gross Domestic Product (GDP) based on Purchasing Power Parity

(PPP) to predict a continuous transition in global economic leadership from the

wealthiest nations G7 (the US, Japan, Germany, France, the UK, Italy, and Canada)

to BRIC. Particularly the paper projected BRICs overtaking the G6 by 2040 (Wilson

and Purushothaman, 2003). Indeed, according to the Centre for Economics and

Business Research (*Cebr, World Economic League Table*), China passed Japan in

2010 to become the second largest economy, while Brazil passed the UK in 2013 to

become the world's sixth largest economy (IMF, World Economic Outlook). The

BRICs are characterized by an astonishing economic growth that ranges between five

percent to double digit annual growth (World Bank Indicators, 2011). Together, the

BRICs represent 30% of total global economic growth, 40% of the world's

population, 25% of the global land mass, and their combined GDP was estimated at

$8.7 trillion (Sule, 2011). Consumption in the BRICs grows at a faster pace than in

the first economies (G3: the US, Europe and Japan) in which final demand has been

affected by the recent economic crisis (Yamakawa et al., 2009). The BRICs are also

becoming dominant in international trade. In 2011, exports were growing at 38%

(Brazil), 28% (India), 25% (China) and 18% (Russia) (Vardi, 2011). In 2012 their

combined total exports are estimated at $3.2 trillion (UNcomtrade data, Figure 1-1).

In some countries the agricultural sector represents up to 32% of total exports (Figure

1-2). In addition, trade with developing countries is growing three times faster (25%

per year) than among developed countries. The BRICs contributed up to 60% of the

trade between low-income countries (Sule, 2011).
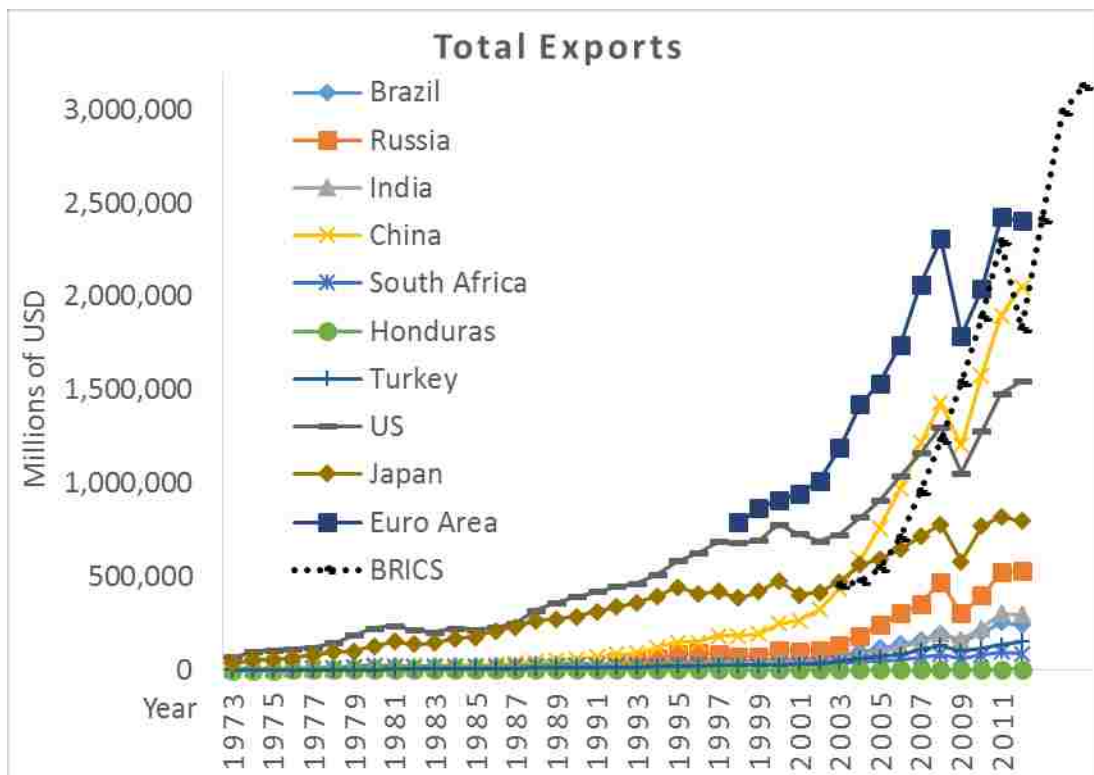
Figure 1-1. Total Exports by Country, Source: UNComtrade.
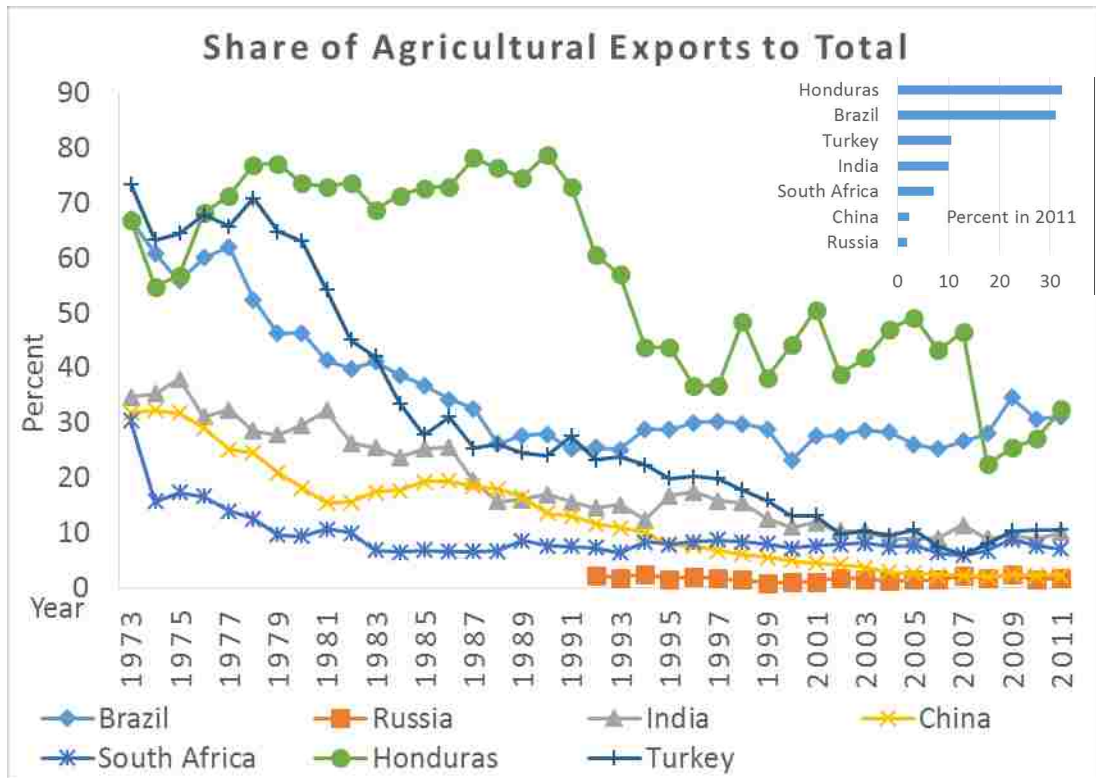
Figure 1-2. Proportion of Agricultural to Total Exports by Country, Source: FAO.

In an interview offered to CNNMoney, Mr. O'Neil affirms he did not imagine that his publication/acronym would have that impact. The acronym really was the impetus and inspired the launch of BRICs summits which started in Yekaterinburg, Russia on June 16, 2009. The summit has been held every year since, and hosted in a rotational manner by every member state. The second BRICs summit was held in Brasilia, Brazil on April 16, 2010. BRICs became BRICS when South Africa was invited to join the club at the third summit held in Sanya on the island of Hainan, China, on April 14, 2011. During the summits, BRICS leaders gather to discuss global economic and political problems, their role in the world, and potential policies and reforms. One of the issues of concern for the BRICS that was raised in 2011 was the future of the U.S. Dollar (USD). Even though the Bretton-Woods system is not in

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force anymore, the reserves of the central banks of the world remain comprised of a few currencies which are generally the USD and the Euro (Krugman and Obstfeld, 2003). Besides, being the currencies of the two major economic blocks, these currencies are perceived as stable and secure, and hence used as vehicle currencies for international transactions by most countries in the world. As the bulk of BRICS trade is conducted in USD, the BRICS have accumulated dollar reserves such that in 2011, these countries held 40% of the World's currency reserves (Sule, 2011). However, due to the large US trade and budget deficits, the USD has been losing some of its prominence as a stable and strong currency. In efforts to stimulate the economy during the most recent economic recession of 2007-8, the United States Federal Reserve (FED) used three rounds of quantitative easing (QE) which presumably added extra volatility to the USD. With the weakening of the USD it became less attractive for foreign investors and central banks to invest in US assets that were declining in value. This USD instability is an issue of continuing concern for the leaders of the BRICS who consider that extra volatility has negatively impacted their exports, one of the engines of their economic growth. The EUR was considered as a future replacement to the USD and the BRICS increased the proportion of their reserves in this currency. However with the Greek debt crisis of 2010, the vulnerability of the EUR was exposed due to a potential break of the indebted state from the Euro-Zone, and created concerns about the future of the EUR as well. At the 2012 fourth BRICS summit in New Delhi, India, these factors motivated BRICS' leaders to take a series of steps towards a gradual move away from the use of the USD as vehicle currency. One piece of evidence for this move is the proposal drafted

to create a Global Development Bank that issues credits and grants in their local currencies (an institution similar to the World Bank or IMF). Another proposition was the creation of a BRICS currency, considered as a less viable option by some economists (e.g., Lo and Hiscock (2014)). The main reasons are that BRICS do not fulfil the basic requirements for an optimum currency area (OCA) due to the members' geographical dispersion, and lower BRICS intra-trade 8.81% compared to trade with the US (13.70%), EU (16.24%), and the Rest of the World (-ROW-55.39%) in 2012. This still obligates them to use the USD and EUR for most of their transactions. Most likely, they would use their local currencies in bilateral trade. As a matter of fact, in 2010 China and Russia agreed to trade using their own currencies. On March 26, 2013 at the fifth BRICS summit in Durban, South Africa, China and Brazil have signed an agreement to trade up to $30 billion per year in their own currencies representing about 40% of the total trade between the two countries in 2012. In addition, in June 2012 China and Japan launched direct trading of Chinese Yuan (CNY)-Japanese Yen (JPY). With all the swap arrangements and currency deals that China is undertaking, it will accelerate the internationalization of the CNY. If the BRICS were to choose a different currency for intra-trade, as a means to reduce the USD dependence, the size of the Chinese economy and its trade volume make the Yuan the most likely candidate. For the BRICs countries there are several reasons to move away from the use of the USD. First, it would allow BRICS to diversify their foreign reserves as a way of managing risk. Second, if the BRICS use their national currencies 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 use of USD. Fourth, this would also allow the BRICS to have 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 and the creation of a potential "Basket Currency."

At the 44th World Economic Forum Annual Meeting in Davos, Switzerland, BRICS leaders reiterated their concerns about currency volatility as a result of the normalization process that the FED is undertaking with the gradual "tapering" of the U.S. quantitative easing. Their main concerns are: would the tapering lead to balance sheet problems? Would the world misunderstand the robustness of their currencies and economies that may affect trade?

1.2   Empirical Research Background

From the above context, the potential effects of exchange rate volatility on trade is of particular interest. 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 fix a future price, they can incur additional risk at the moment of the conversion (Bailey et al., 1987). Foreign exchange markets allow the exporter to hedge the risk without making it totally disappear and a common problem in emerging and developing countries is that these markets are not well developed. Most likely, a firm which is selling its goods abroad will be paid in one of the vehicle currencies, and once the payment is made, the company will have to convert back to its home currency. The issue is that there is a significant lag from the moment that the merchandise is loaded to 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 and in which currency the merchandise is paid, merchants may gain or lose. The effect of exchange rate volatility on trade is closely tied to the degree of risk-aversion. If the exporter is risk averse, she/he will require a premium that will tend to reduce the volume of trade (Hooper and Kohlhagen (1978)). Graphically, we can think of this phenomenon as a leftward shift of the supply curve which represents a decrease in trade (Bailey et al., 1987). Exchange rate dynamics are complex, and in a macroeconomic environment of global financial concerns, exchange rate volatility is pervasive. As decision theory would predict, high exchange rate volatility tends to affect trade among nations because increased variation in relative prices makes revenue uncertain, and risk averse traders tend to engage in less international transactions than their less risk averse counterparts.

Under the Bretton Woods system, exchange rates between the US Dollar (USD) and the other currencies were fixed. Following the system's collapse in 1973, economists' interest shifted towards the quest of the potential impacts of exchange rate volatility, especially on trade and investment. The review works of McKenzie (1999), and Bahmani-Oskooee and Hegerty (2007) show a number of empirical papers using different countries, data spans, trade flows (e.g., aggregate, bilateral, and sector specific), series transformations (e.g., nominal and real, first differences, log differences, etc.), exchange rates (exchange rates and real effective exchange rates), volatility measures (e.g., moving standard deviation, coefficient of variation, and GARCH), economic models (e.g., gravity models, income and substitution effects,

and export demand models), and econometric procedures (OLS; SUR; VAR; Co-integration: Engle-Granger, Johansen). Despite of a vast literature on the matter, the effect of floating exchange rates on trade remains controversial (Krugman and Obstfeld, 2003). The findings support negative, positive, and zero effects. Hence there is still need for more empirical evidence on this issue.

Arize et al., (2000) indicated that although there are many studies for developed countries (e.g., Chowdhury (1993), Cushman (1988), Thursby and Thursby (1987), and Kenen and Rodrik (1986)), more empirical analysis on the issue in developing and emerging economies (e.g., Arize et. al., (2008), and Chit et al., (2010)) is needed in the literature. Arize et al., (2008) highlighted the need for more studies for Latin American countries. A common factor in developing and emerging economies is that the agricultural sector tend to be one of the pillars of their economies. Cho et al., (2002) appeal for more studies in the understanding of the effects of exchange rate volatility on agricultural exports. There have been contributions from the agricultural economics profession using agricultural exports at the aggregated and disaggregated levels (Coes (1981), Maskus (1986), Kumar (1992), Cho et al., (2002), Giorgioni and Thompson (2002), Langley et at., (2003), Kandilov, (2008), Erdal, et al., (2012)). Nevertheless, there are few studies for developing and emerging economies using low frequency aggregated agricultural data (quarterly and monthly).

Because exports are not only impacted by changes in relative prices and volatility between trading partners, Cushman (1986) highlighted the need to consider third country (competitors) exchange rate volatility. However, there are few studies

that use third country exchange rate (e.g., Cushman (1986); Anderton and Skudelny (2001); Cho et al., (2002); Wei (1996); Dell'Ariccia (1999); Esquivel and Larraín (2002); Maradiaga et al., (2012); and Pujula (2013)).

One of the biggest financial agreements in international finance of the century was the creation of the EUR and it has been in circulation since 2002. Yet, it is surprising that there are not many papers studying the effects of its volatility on agricultural trade (e.g., Maradiaga et al., (2012); and Pujula (2013)). The results from previous studies might have been compromised due to short sample sizes and with VAR time series models degrees of freedom can be quickly consumed. It is now timely to carry out such analyses, as samples sizes are larger and with the aid of some data transformations frequencies can be increased to quarterly and monthly.

The empirical literature has kept pace with the advances in econometric techniques for this type of model's estimation. Nevertheless, there is a drawback in the identification of the time series properties. Most of the studies test for non-stationarity using either Augmented Dickey Fuller (ADF) and/or Phillips-Perron (PP) unit root tests. Monte Carlo studies have demonstrated that ADF and PP tests suffer severe finite sample power against the alternative hypothesis, and size distortions in the presence of large negative moving averages (MA) coefficients. The appropriate identification of the times series processes is essential in the selection of the subsequent estimation procedures (VAR in levels or in differences, or a VECM if co-integration exist). But if we fail to render series stationarity, as demonstrated by Granger and Newbold (1974), spurious results are possible when fitting a regression with non-stationary variables. Hence McKenzie (1999) advocates that the

identification of the times series processes should be based on a battery of unit roots

tests including new developments that correct the pitfalls of ADF and PP tests. When

specifying a VAR model and the interest is to test for Granger non-causality of

exchange rate volatility on exports, it is possible to find different orders of integration

in the system. Consequently estimating a VECM Johansen (1991) procedure becomes

challenging. In this situation is surprising that, except for Maradiaga et al., (2012), the

empirical literature does not list the implementation of widely known alternative

methods like TYDL (Toda and Yamamoto (1995), and Dolado and Lütkepohl

(1996)).

Bahmani-Oskooee and Hegerty (2007) implied that the debate on which of the

measures of exchange rate volatility performs best remains open. Therefore there is

still need for studies comparing different volatility measures. There are many papers

using Moving Standard Deviation (M-STD) and Coefficient of Variation (CV) as

measures of volatility, however few studies (e.g., Kroner and Lastrapes (1993), Grier,

K. B., & Smallwood (2013), and Pujula (2013)) the Multivariate (VAR)-

GARCH(1,1)-M model has not been used to analyze this issue. It seems worthwhile

to compare GARCH results against TDYL results that use CV and M-STD as

measures of volatility.

1.3   Problem Statement

From this context the general research question emerges: "Have own and/or

third country exchange rate volatilities impacted BRICS exports, and if that is the

case, what is the direction of this impact?" That general question subsumes two

research hypotheses (specific objectives):

1) Unconditional (constant) currency exchange rate volatility (own and G-3) does not Granger cause BRICS exports.

2) Conditional (stochastic) currency exchange rate volatility (own and G-3) does not impact BRICS exports.

1.4   Justification of the Study

The main objective of this study is to provide empirical evidence of the effects of volatility in G-3 currency exchange rates on BRICS' agricultural exports and total exports. With leaders of emerging economies repeatedly claiming increased G-3 volatility negatively affects trade, it appears timely to investigate such possibility as more empirical evidence on this issue is needed. Because in some of the BRICS agricultural commodity exports are very important, there is an added value in carrying out the analysis for agricultural exports. The analysis results could lead BRICS' leaders to the identification of appropriate agricultural strategies. Findings from this study would provide a basis for discussion as to whether BRICS countries would be better off by trading with a currency other than the USD.

The main contribution to the empirical literature in agricultural economics in this matter is: first, the use of new unit root tests developments in the identification of time series properties; and second, testing the effects of exchange rate volatility on exports using the Granger non-causality test (MWald test TYDL), as an alternative procedure when there is a mix of unit roots in the variables of an export demand equation. Therefore using new unit root test developments with more statistical power, and quarterly instead of annual data we extend the TYDL application of

Maradiaga et. at., (2012). Also a comparison of three types of volatility measures (CV, M-STD and GARCH) is presented.

Other contributions include: an assessment of the risk faced by the BRICS quarterly agricultural exports due to exchange rate volatility compared to total exports, analysis which can also be extended to non-agricultural exports (agricultural-total); an extensive comparison between sources of potential mixed results in past works like different types of series (real and nominal); longer sample size, extended time series since the end of Breton Woods system in 1973 to the first quarter of 2013 thanks to various data transformations;[1] a modest update on the literature review since the review article of Bahmani-Oskooee and Hegerty (2007); and a comparison between the results of TYDL with quarterly data and bivariate-GARCH(1,1)-M using monthly data.

The analysis is extended beyond the BRICS to include Turkey and Honduras. Turkey is included because it is an emerging tiger with a strong agricultural sector. Including Turkey as part of the analysis is a way to keep up with Jim O'Neil's lexicon and new acronym "MINT" in reference to Mexico, Indonesia, Nigeria, and Turkey. Albeit not an emerging economy, Honduras was included to cover the expressed necessity of more studies for Latin American countries (Arize et al., (2008)).

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[1] *Actual World GDP is reported only as annually basis, while World GDP growth rates can be obtained in quarterly basis, thereby increasing the number of observations..*

1.5 An Overview of the Methodology

1.5.1 Pretesting (Variable's Processes Identification)

A battery of unit root tests (ADF, PP, Elliott-Rothenberg-Stock -ERS-, Ng-Perron (NP: DFGLS, MPT MSB, MZ, MZa, and PT), and Kwiatkowski-Phillips-Schmidt-Shin -KPSS-) indicated that there is a mix of orders of integration in the variables of the export demand equation for quarterly data while the monthly variables were I(1) processes.

1.5.2 Unconditional exchange rate volatility does not cause exports.

The MWald tests are carried out following the TYDL procedure to test for Granger non-causality in the context of a Vector Autoregressive (VAR) dynamic system (the economic model) of exports, foreign income (GDP), relative prices (Exchange rates vis-à-vis the USD), and own and third country currency exchange rate volatilities (EUR/USD, JPY/USD). It was opted for TYDL instead of Johansen's (1991) procedure due to the mix of unit root in the VAR system. In total 84 models are estimated and they differ according to country, series type (real or nominal), type of unconditional volatility (M-STD and CV), exchange rates (own and third country), and exports (agricultural and total) using quarterly data from 1973 to 2013. There are different types of series used in previous studies, thus our models and test results allow for a broader comparison.

The null hypotheses were tested separately for the national (own) vis-à-vis USD currency exchange rate volatility, and for third country currency exchange rate volatility (G-3: EUR/USD and/or JPY/USD).

1.5.3 Conditional exchange rate volatility does not impact exports.

The second objective was accomplished by estimating six sets of bivariate GARCH(1,1)-M models for each of the seven countries and test for the significance of the volatility parameter estimate via t-tests. The models used monthly data in log first differences as unit root test suggested I(1) process in all variables. The mean equations were bivariate VAR(k) which k lags were selected according to statistical selection criteria AICc and SBC, and ACFs and PACFs. The variance or volatility equations are time-invariant following Bollerslev (1990) procedure.

1.6 The Dissertation Structure

To this aim, this dissertation is structured as follows. Chapter 2 provides a brief review of literature. The methodology is presented in Chapter 3, followed by the data section. The estimation results are shown in Chapter 4. Summary and conclusions appear in Chapter 5.

2   LITERATURE REVIEW

The Bretton Woods system collapsed in 1973, and after that the currency exchange rates regimes of most countries became floating. It was hypothesized that the volatility under flexible exchange rates might have a negative impact on trade. This was based on the notion that risk averse traders will reduce trade volumes in the event of increased exchange rate uncertainty. Therefore, this issue became an interesting research question for many economists that embarked themselves into the formulation of theories and the quest of empirical evidence to probe such hypothesis. Some pioneer works in the theoretical literature are those of Ethier (1973) and Clark (1973) which results, from the perspective of risk averse firms, supported the hypothesis that exchange rate volatility negatively impacts trade. Deemers (1991) found support to the negative effects without requiring the risk averse assumption, the author instead assumed risk neutrality. However, Franke (1991) shows support for positive effects of exchange rate risk on trade when assuming firms are risk neutral. In theoretical works the direction of the effect is influenced by the assumptions made about firms' risk preferences, their decision making under different risk scenarios, capital availability, traders' time lags, and the firm's business sector (McKenzie, (1999)).

In the literature, there are various ways to estimate exchange rate volatility. We divide them into two dominant schools. The researchers that used unconditional and conditional measures of volatility. Unconditional measures can be the ad hoc estimates of volatility such as moving standard deviation and coefficient of variation (e.g., Cushman 1983, 1986, 1988a,b; Kenen and Rodrik 1986; Caballero and Corbo

1989; Koray and Lastrapes 1989; Arize 1995, 1996,1997,1998; and De Vita and Abbott (2004b)). On the other hand, there are researchers that employ conditional volatility in the form of different generalizations of the simple ARCH model (e.g., Pozo (1992), Kroner and Lastrapes (1993), Caporale and Doroodean (1994), Qian and Varangis (1994), McKenzie and Brooks (1997), McKenzie (1998), Arize and Ghosh (1994), Arize and Malindretos (1998), Arize et al., (2005), Chou (2000), Cushman (1983), De Vita and Abbott (2004a), Doroodian (1999), Doyle (2001), Grobar (1993), Pujula (2013), and Grier and Smallwood (2013)).

A pioneer paper in the empirical literature is that of Hooper and Kohlhagen (1978). The authors looked at the effect of USD vis-à-vis Deutsch-Mark (DM) fluctuations on the trade between the US, Germany, France, the UK, Japan, and Canada. They estimated a system of equations that includes export supply and import demand functions. The volatility 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). Their results do not support any significant relationship between the exchange rate volatility and the volume of trade.

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 trading partner countries, a measure of export prices relative to those of trading partner countries,

real export earnings of oil exporting countries and exchange rate volatility. Two measures of volatility 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 volatility but a negative relationship when the real exchange rate volatility was included (Bailey et al., 1987).

Most of the trade has traditionally been between developed nations and most of the applications found in the literature deal with these countries as well. Nevertheless, with more participation of least developed countries (LDC) and emerging economies in international trade, analysis using data from these countries are needed. Early contributions to the literature using developing countries includes the works of Coes (1981) and Rana (1983). They independently applied Hooper and Kohlhagen (1978) methodology. Coes had a vast majority of positive and zero effects of exchange rate volatility on Brazilian exports, while Rana showed evidence of negative significant effects on ASEAN countries. Caballero and Corbo (1989) used and moving standard deviation of exchange rates as volatility measure and implemented ordinary least squares (OLS) and instrumental variables (IV) procedures to estimate export demand equations for Chile, Colombia, Peru, Philippines, Thailand and Turkey. They found negative significant effects of exchange rate volatility on exports. Medhora (1990) studied six countries (Benin, Burkina-Faso, Côte d'Ivoire, Niger, Senegal, and Togo) from the West African Monetary Union for the 1976-82 period. The common currency of these countries is the CFA which remained pegged to the French Franc since 1948 (today to the EUR). Hence, after 1973, the volatility

experienced by the French Franc against other currencies was the same for the CFA. The model was an import demand function of domestic income, index of import prices relative to domestic prices, and the standard deviation of the nominal effective exchange rate index (NEER) as volatility measure. The conclusion was that exchange rate volatility had not affected imports. Kumar and Dhawan (1991) implementing Cushman's (1983) model to Pakistan's quarterly exports for own country and third country volatility effects, independently. The volatility measures were: a nominal and real moving standard deviation and coefficients of variation for the 1974-1985 period. They found negative significant results with respect to own country effects with nominal data. There was significant evidence of third country effects and it improved the model specification. However its direction was different for West Germany and Japan. Doroodian (1999) studied the exports of India, Malaysia, and South Korea for the 1973Q2-1996Q3 period. The volatility measures used were ARMA residuals and GARCH. The study concludes there was a negative effect of exchange rate volatility on trade flows. Doğanlar (2002) found negative effects of volatility on the exports of Turkey, South Korea, Malaysia, Indonesia, and Pakistan. Poon et al. (2005) found positive effect of volatility on exports from Thailand, while the effect was negative for Japan, South Korea, and Singapore. Sauer and Bohara's (2001) work included 69 LDC's and implemented both the fixed- and random-effect models using panel data. Their findings indicate that there is no significant effect on Asian countries while there are negative effects on Latin American countries. Arize et al., (2000) advocate for more empirical evidence on the issue in developing and emerging economies.

Eight years later, Arize et al., (2008) reiterated the need of more studies for developing countries, especially Latin American nations.

In studying agricultural exports, again the number of studies for developing economies is very small compared to the research done for developed countries (e.g., Maskus (1986), Giorgioni and Thompson (2002)). A common feature in developing and some emerging countries is that the agriculture sector contributes more to the economy than in the case of developed nations. Hence it is important to survey the literature on the impacts of exchange rate volatility on agricultural exports for developing and emerging economies. Coes (1981) studied Brazilian agricultural and manufacturing sectors using data from 1957 to 1974 (only one year of post Bretton Woods). The author found positive and zero volatility effects in agricultural and manufacturing sectors. However, the author reported potential misspecification in the model which warrants revisiting this exploration with improved methods and including the floating exchange rate system with larger sample size. Langley et al., (2003) work is a compendium of papers that explores the exchange rate volatility effects on agricultural trade, and it includes a chapter for Thailand's Poultry and Rice sectors. Kandilov (2008) replicates Cho et al., (2002) gravity model application, incorporating developing countries and agricultural exports. Kadilov's conclusion was that agricultural exports tend to be negatively impacted, and yet that impact is larger for developing countries than it is for developed nations. In addition, Cho et al., (2002) found that the volatility effects are more significant for agricultural exports than for other sector exports. There is a general conception that the effect of exchange rate risk is different amongst sectors, however more empirical evidence in the

difference of risk faced by agricultural exports versus non-agricultural exports is needed in the literature. Erdal et al., (2012) studied the effect of real effective exchange rate volatility (REERV) on agricultural exports and imports. REERV were estimated by a GARCH(1,1). The authors implemented Johansen's (1991) procedure to test for co-integration and estimate long-run relationships. The direction of the effect was determined using pairwise granger causality tests. The authors found a positive effect of exchange rate volatility on exports, while the effect was negative for imports. Cho et al., (2002) appealed for more studies to better understand the effects of exchange rate volatility on agricultural exports. Chit et al., (2010) suggest more research focused on developing countries.

Because Europe, the US, and Japan absorb a large portion of the World's trade, the Euro, USD, and Yen are the world's main vehicle currencies. Developing and emerging countries' trade is most likely to be impacted by the volatility of these vehicle currencies. Cushman (1986) was the first to investigate these so-called third-country currency exchange rate volatility effects. He cleverly explains why we would expect these effects to be significant. "While increased USD-British Pound risk would be expected to reduce US exports to the UK, increased USD-Deutsche 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. Cho et al., (2002) found significant effects of third country exchange rate volatility while the works of Wei (1996) and Dell'Ariccia (1999) concluded no significant effects. Also Esquivel and Larraín (2002) considered third country effects (Deutsche Mark and

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Yen) in their export demand equation. 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. The authors found evidence of both positive and negative effects for the 1975-1998 period. However, they did not report any formal stationarity inspection through unit root tests prior OLS estimation. Because it is not known whether the variables are stationary (equal variance) or non-stationary, and if the latter is the case, then estimation results are spurious (Granger and Newbold (1974)). Homoscedastic variance is a necessary assumption for OLS to yield reliable results.

With the development of new theories and methodologies in time-series econometrics such as co-integration and error correction models (Engle and Granger, 1987; and Johansen, 1988 and 1991), economists started to look at the long-run relationships between exchange rate volatility and export flows (e.g., Erdal et al., (2012); and Arize et al., (2000)). Arize et al. (2000) found negative and significant relationship in both short and long-run effects of real effective exchange rate volatility on export flows from 13 developing countries (Ecuador, Mexico, Mauritius, Morocco, Malaysia, Malawi, Indonesia, Korea, Philippines, Sri Lanka, Taiwan, Thailand, and Tunisia) for the 1973-1996 period. Using the same approach Arize et al. (2008) also found negative effects for Latin American countries (Bolivia, Colombia, Costa Rica, The Dominican Republic, Ecuador, Honduras, Peru and Venezuela). Vergil (2002) examined the effect of exchange rate volatility on Turkish bilateral trade flows to the United States, Germany, France, and Italy. The authors used moving standard deviation of rates of change of exchange rates as measure of

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volatility. Their approach was to test for co-integrating relations and then estimate error correction models. The conclusion was that Turkish real exports are negatively affected by real exchange rate volatility. Koray and Lastrapes (1989) using a VAR model including several macroeconomic variables found a very weak effect between real exchange rate volatility and US imports. Kroner and Lastrapes (1990) used GARCH model (and its extensions) to investigate the relationship between exchange rate volatility and trade on the premise that exchange rates show up in clusters of periods of high and low volatility (i.e. time-varying conditional volatility). They found a small but significant effect of exchange rate volatility on trade and observed that this effect varies across countries. Pujula (2013) estimated a Multivariate GARCH-M model with the mean equation specified as a VAR model of two variables exports and exchange rates. The author found positive own country volatility effects and negative third country volatility effects (EUR/USD) on Ghanaian total exports. Similarly, Grier and Smallwood (2013) applied a Multivariate GARCH-M and specified the mean equation with three variables growth rates of exports, foreign income, and the real exchange rate. Their findings support negative effects of real exchange rate volatility on exports from both developed and developing countries.

It is surprising that the new unit root test developments (e.g., Elliott-Rothenberg-and-Stock -ERS- (1996), and Ng and Perron -NP- (2001)) which improves upon ADF and PP, are rarely used in assessing the time series properties of exchange rates, exports, exchange rate volatility variables, and economic activity proxies. In identifying the time series properties of exports and exchange rates from

Brazil, Russia, India, China and South Africa, Maradiaga et al., (2012) found a mix of orders of integration. Hence to estimate an export demand equation it was opted for the TYDL procedure to test for Granger non-causality the effect of exchange rate volatility on exports. The conclusions were no effects, except for China which effect was even positive and significant. It is surprising that we have not yet found another study that applies the TYDL procedure to this issue. Thus we extend Maradiaga et al., (2012) by including new unit root test developments and higher frequency data (quarterly instead of annual) that will give more degrees of freedom to the TYDL model. Also the analysis is extended beyond the five listed countries to include Turkey and Honduras.

This literature is far from exhaustive but emphasized the diversity of methodologies and case-studies that have been employed to empirically unveil relationships between currency exchanges and exports. An interested reader may want to refer to the review works of McKenzie (1999), and Bahmani-Oskooee and Hegerty (2007). These authors show numerous studies using different approaches and applications to several countries (e.g., developed, emerging, and LDC), data spans, data frequencies (annual, quarterly, and monthly), trade flows (e.g., aggregate, bilateral, and sector specific), series transformations (e.g., nominal and real, first differences, log differences, etc.), exchange rates (exchange rates and real effective exchange rates), volatility measures (e.g., moving standard deviation, coefficient of variation, and GARCH), economic models (e.g., gravity models, income and substitution effects, and export demand models), econometric procedures (OLS; SUR; VAR; Co-integration: Engle-Granger, Johansen). In spite of a vast literature on

the subject, the effect of floating exchange rates on trade remains controversial

(Krugman and Obstfeld, 2003). The findings support negative, positive, and zero

effects. Hence there is still need for more empirical evidence on this issue.

3 METHODOLOGY

To assess the effect of exchange rate volatility on BRICS exports, we rely on the fundamental economic trade theory that gave birth to export demand functions, and also on decision theory that explains risk aversion. This approach appears in the review articles of McKenzie (1999), and Bahmani-Oskooee and Hegerty (2007) as a paramount methodology in numerous empirical analyses of the impact of exchange rate volatility on international trade flows. The methodology roadmap is organized in three sections. First we summarize the economic theory. Also risk and volatility concepts are reviewed. Second, econometric methods and estimation techniques for each specific hypothesis are presented in two parts: Granger Non-Causality tests of unconditional volatility in exchange rates on exports; and GARCH models to tests for the effect of conditional volatility on exports. In addition, the stationarity concept and time series property identification are summarized. And third, data sources, variables, computations, and frequencies are presented.

3.1 Economic Theory

3.1.1 Summary of Trade Theory

The derivation of the aggregate export demand equation originates with the imperfect substitutes models whose key underlying assumption is that imported and exported goods are not perfect substitutes. As explained in Goldstein and Khan (1985), the hypothesis of perfect substitutes is ruled out because it predicts either the domestic or foreign good to consume the entire market, and a country to be either the exporter or importer of a good, but not both roles. What it is seen in the marketplace is that both imported and domestically produced goods are available for consumers,

and the emergence of "two way trade". Recent authors favor imperfect substitutes over perfect substitutes due to the failure of the law of one price at the most disaggregated levels in several empirical studies. Pujula (2013) and other empirical assessments of the determinants of export performance opted for the imperfect substitutes model since it has been applied to cases in which the bulk of trade is highly composed of differentiated goods and cases in which commodities play a significant role.

The following equations summarize the imperfect substitutes model of country i's exports to and imports from the rest of the world (ROW*) as presented by Goldstein and Khan (1985):

$$X_i^d = f(Y^*e, PX_i, P^*e), \quad f_1, f_3 > 0, \qquad f_2 < 0 \qquad (3.1)$$

$$I_i^d = g(Y_i, PI_i, P_i), \qquad g_1, g_3 > 0, \qquad g_2 < 0 \qquad (3.2)$$

$$X_i^s = h[PX_i(1 + S_i), P_i], \quad h_1 > 0, \qquad h_2 < 0 \qquad (3.3)$$

$$I_i^s = j[PI^*(1 + S^*), P^*], \qquad j_1 > 0, \quad j_2 < 0 \qquad (3.4)$$

$$PI^* = PX_i(1 + T^*)/e, \qquad (3.5)$$

$$PI_i = PX^*(1 + T_i)e, \qquad (3.6)$$

$$X_i^d = X_i^s, \qquad (3.7)$$

$$I_i^d = I_i^s e. \qquad (3.8)$$

Where X_i^d are exports demanded by the rest of the world (ROW*) from country i, I_i^d country i's demand for imports, X_i^s country i's export supply to the ROW, I_i^s are imports supplied to country i coming from the ROW, PX_i and PX^* are local currency prices paid to the exporters in country i and ROW, respectively. In the

same fashion, PI_i and PI^* are local currency prices paid by the importers in country i and ROW, respectively. Exogenous variables were defined as income levels in country i (Y_i) and in ROW (Y^*), prices of locally produced items in country i (P_i) and ROW (P^*), the trade barriers such as tariffs and subsidies to import and exports in country i (T_i, S_i) and ROW (T^*, S^*), and the exchange rate represented by (e).

The features of this model are:

- Consumers maximize utility subject to a budget constraint.
- When dealing with aggregated imports and exports, it is common that inferior goods and domestic complements for imports are removed from consideration by assuming positive income elasticities (f_1 g_1) and cross price elasticities of demand (f_3 g_3); naturally negative own price elasticity (f_2 g_2) are expected.
- No money illusion, there is no effect on demand by changing income and prices by the same proportion, that is $f_1 + f_2 + f_3 = 0$ and $g_1 + g_2 + g_3 = 0$.
- $I_i^d = g[(Y_i/P_i), (PI_i/P_i)]$ is the homogeneity of demand, where its arguments are real income (Y_i/P_i) and relative prices (PI_i/P_i).

It is often the case, in practice, that infinite export supply price elasticities are assumed, and thus the eight equations above representing the imperfect substitutes model can be reduced to a single equation. Equalizing export demand and export supply as in equation 3.7 above $f(Y^*e, PX_i, P^*e) = h[PX_i(1 + S_i), P_i]$ and assuming that there are no subsidies so that $PX_i(1 + S_i)$ on the left hand side becomes PX_i, then imperfect substitutes can be expressed as:

$$X_i^d = f\left(\frac{Y^*e}{P_i}, \frac{P^*e}{P_i}\right)$$ (3.9)

Where Y*e/P$_i$ is the level of real income in ROW and P*e/P$_i$ is relative prices.

3.1.2 Export Demand Model

In deriving a tractable model of aggregate export demand the most important

considerations (assumptions) made by Senhadji and Montenegro (1998) were: time

series properties, a model which data requirements do not exceed data availability,

and a model that makes no difference between producer goods and consumer goods

("no production sector"). These strong assumptions are in line with the

methodological design of the present work as it is very common in developing and

emerging countries that disaggregated data are nonexistent or difficult to obtain.

Furthermore, Senhadji and Montengro (1998) assumed a two country world where the

home country is defined as the exporter and ROW as the importer. Therefore home

export demand (x_t) is equal to ROW import demand (I_t^*).[2] Import decisions in ROW

are taken by an "infinitely-lived representative agent" who maximizes utility by

allocating consumption between domestic (d_t^*) and imported goods (I_t^*):

$$\max_{\{d_t^*, I_t^*\}t=0} E_0 \sum_{t=0}^{\infty} (1+\delta)^{-1} u(d_t^*, I_t^*)$$ (3.10)

Subject to:

$$b_{t+1}^* = (1+r)b_t^* + (e_t^* - d_t^*) - p_t I_t^*$$ (3.11)

$$e_t^* = (1-\rho)\bar{e}^* + \rho e_{t-1}^* + \varepsilon_t^*$$ (3.12)

$$\lim_{T \to \infty} \frac{b_{T+1}^*}{\prod_{t=0}^{T}(1+r)^{-1}}$$ (3.13)

---

[2] x_t and I_t^* are the same as X^d_i and I^d_i, respectively, in the imperfect substitutes model.

Where δ represents consumer's subjective discount rate, r the world interest rate, and p_t relative prices. Equations 3.11, 3.12, and 3.13 represent the current account, the stochastic endowment process (e_t^*),[3] and the transversality condition to exclude Ponzi schemes, respectively. In the current account equation, if b_{t+1}^* is positive, then it denotes the amount of home stock bonds held by ROW, and the opposite if negative. The F.O.C. are:

$$u_t^{d^*} = \lambda_t. \tag{3.14}$$

$$u_t^{I^*} = \lambda_t p_t. \tag{3.15}$$

$$\lambda_t = (1 + \delta)^{-1}(1 + r)E_t\lambda_{t+1}. \tag{3.16}$$

Where λ_t is the Lagrange multiplier on equation 3.11, and ROW "consumer's marginal utility for domestic goods" on equation 3.14. Assuming that the utility function is addilog:

$$u(d_t^*, I_t^*) = A_t(d_t^*)(1 - \alpha)^{-1} + B_t(I_t^*)(1 - \beta)^{-1}, \text{ α, β>0} \tag{3.17}$$

$$A_t = e^{a_0 + \epsilon_{A,t}}. \tag{3.18}$$

$$B_t = e^{b_0 + \epsilon_{B,t}}. \tag{3.19}$$

Where A and B are random shocks to preferences. Equating 3.14 to the partial derivative of 3.17' $[u(d_t^*, I_t^*)]$ w.r.t. d_t^*, yields:

$$d_t^* = A_t^{1/\alpha}\lambda_t^{-1/\alpha}. \tag{3.20}$$

Equating 3.14 to the partial derivative of 3.17' $[u(d_t^*, I_t^*)]$ w.r.t. I_t^*, yields:

$$I_t^* = \lambda_t^{-1/\beta}B_t^{1/\beta}P_t^{-1/\beta}. \tag{3.21}$$

Substituting $3.18 - 3.20$ into 3.21 equation (in log-log form), yields:

---

[3] In this notation e_t^* does not longer represent exchange rates as in the case of the imperfect substitutes model.

$$\log(I_t^*) = c - \frac{1}{\beta}\log(p_t) + \frac{\alpha}{\beta}\log(d_t^*) + \epsilon_t \tag{3.22}$$

Where $c = (1/\beta)(b_0 - a_0), \epsilon_t = (1/\beta)(\epsilon_{B,t} - \epsilon_{A,t})$, and $I_t^* = x_t$, that is

ROW's import demand (I_t^*) equal to export demand from home country (x_t). Notice

that in the original specification, $d_t^* = GDP_t^* - x_t^*$, where x_t^* are the exports from

ROW. The last step to achieve an aggregate export demand equation is to rewrite

equation 3.22 as:

$$\log(x_t) = c - \frac{1}{\beta}\log(p_t) + \frac{\alpha}{\beta}\log(GDP_t^*) + \epsilon_t \tag{3.23}$$

3.1.3 Exchange Rate Risk in Exports

The general assumption, in theoretical models, [4] is that there is a percentage of

risk averse traders, and also perhaps risk neutral, who in view of increased exchange

rate volatility will engage in less international trade as they may not want to put trade

volumes, revenue and/or profits into higher uncertainty (Brodsky (1984)). This action

is independent of whether the risk is borne by exporters or importers (Hooper and

Kohlhagen (1978)). Following the literature, other assumption are made in the

analysis. The forward exchange markets in BRICS countries, Honduras, and Turkey

are still underdeveloped for the analysis period considered, and so traders have not

been locking in currency prices through contracts in the FOREX market to reduce

risk associated with exchange rates. Production decisions are taken at current time for

delivery in a future time for which relative prices (exchange rates) at present moment

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[4] Exchange rate risk theoretical works are Ethier (1973), Clark (1973), Baron (1976), and Hooper and Kohlhagen (1978).

are uncertain (Cushman, 1983). In this study, the own and third country exchange rate volatility impacts on exports are evaluated. To illustrate, a hypothetical scenario of a three-market world is presented. Let us assume that Brazil has a comparative advantage in producing ethanol relative to the U.S. and Europe. Therefore, following trade theory, the U.S. and Europe are Brazil customers for ethanol. It is further assumed that Brazilian exports of ethanol could be denominated in the importers' currencies (USD, EUR). If there is an increase in the volatility of BRL/USD while holding BRL/EUR constant, then in order to diminish risk, Brazilian exporters may choose to sell more to Europe than to the U.S. That is shifting product exports to the less risky market. However, if there is a volatility increase in the USD/EURO. Assuming that developing and emerging countries' currency exchange rate may follow any G-3 currency, then Brazilian exporters face increased risk in its two main markets and so risk averse and neutral traders are discouraged to engage in international transactions, and exports may decrease. [5]

3.1.4   Volatility Measures

Risk averse behavior with respect to volatility in exchange rates is traditionally modeled by assuming that traders maximize a linear utility function which is positively correlated with the expected value of nominal (real) profits and negatively with unanticipated events that appear as squared deviations from expected values.[6] Hence, in line with this assumption are measures of unconditional and conditional volatility. It is important to explore the distinction between them.

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[5] See Cushman (1983) and Esquivel and Larrain (2002)
[6] See Hooper and Kohlhagen (1978), and Cushman (1983)

Unconditional volatility main assumption is that volatility exhibits a constant variance (homoskedasticity) and is estimated by *ad hoc* variable data transformations such as rolling standard deviation, and coefficient of variation. Unlike the estimates of unconditional moments, conditional volatility takes into account the fact that exchange rate volatility may likely show up in clusters, periods of considerably high amplitude followed by periods of low fluctuations. Thus, it assumes a time varying variance. Conceptually this solves the unconditional volatility estimates' problem which is remaining apparently high when the underlying volatility is passing through a tranquil phase and low over periods when the actual volatility is high. Conditional volatility is estimated through an autoregressive conditional heteroskedasticity (ARCH) model.

3.1.5 The Model

Considering exchange rate volatility, the export demand equation becomes: [7]

$$\log(x_t) = c + \frac{\alpha}{\beta}\log(GDP_t^*) - \frac{1}{\beta}\log(p_t) - \gamma VOL + \epsilon_t \qquad (3.24)$$

Equation 3.24 summarizes the factors affecting exports as suggested by economic theory. Notice that exports are a function of the world demand, bilateral country currency exchange rates, and a measure of exchange rate volatility. According to economic literature, higher economic activity (GDP_t) is expected to have a positive effect on the amount of traded goods and services (exports) as people tend to consume more during periods of economic expansion. Relative price changes

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[7] See Kenen and Rodrik (1986) work.

affect international flows of merchandise. Of course a weak Real will enhance

Brazilian exports and discourage imports. Higher than usual volatility is expected to

have a negative impact on exports. Two cases of exchange rate volatility are

examined. One is the volatility from national currency per USD called "own". The

other type is the volatility from EUR/USD and JPY/USD called "third country"

volatility or G-3 volatility. Stable bilateral exchange rates (ExRUSDt) are expected to

have a positive impact on the international flows of goods and services as it assures

traders a more steady certain revenue than when there are periods of instability in

exchange rates. And in the case of G-3 currency volatility depends on the

comparative advantage of each country.

Enders (2004) recommends the use of a vector autoregressive (VAR (k))

model treating each variable symmetrically when one is not certain whether the

exogenous condition holds. In our specific case, a VAR(k) model allows the time

paths of $Exports_t$ to be affected by current and past realizations of WGDP$_{t-p}$ and

ExRUSD$_t$ sequence; the time paths of WGDP$_{t-p}$ be affected by current and past

realizations of $Exports_t$ and ExRUSD$_t$ sequence; and in the same fashion for

ExRUSD$_t$ and the rest of the equations that could be added within the multivariate

systems below. In the case of own country volatility:

$$
\begin{bmatrix} Exports_t \\ WGDP_t \\ ExRUSD_t \\ VOL_{\frac{OWN}{USD}\,t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \\ \alpha_{40} \end{bmatrix} + \begin{bmatrix} \alpha_{11}(1) & \alpha_{12}(1) & \alpha_{13}(1) & \alpha_{14}(1) \\ \alpha_{21}(1) & \alpha_{22}(1) & \alpha_{23}(1) & \alpha_{24}(1) \\ \alpha_{31}(1) & \alpha_{32}(1) & \alpha_{33}(1) & \alpha_{34}(1) \\ \alpha_{41}(1) & \alpha_{42}(1) & \alpha_{43}(1) & \alpha_{44}(1) \end{bmatrix} * \begin{bmatrix} Exports_{t-1} \\ WGDP_{t-1} \\ ExRUSD_{t-1} \\ VOL_{\frac{OWN}{USD}\,t-1} \end{bmatrix} +
$$

$$
\begin{bmatrix} \alpha_{11}(k) & \alpha_{12}(k) & \alpha_{13}(k) & \alpha_{14}(k) \\ \alpha_{21}(k) & \alpha_{22}(k) & \alpha_{23}(k) & \alpha_{24}(k) \\ \alpha_{31}(k) & \alpha_{32}(k) & \alpha_{33}(k) & \alpha_{34}(k) \\ \alpha_{41}(k) & \alpha_{42}(k) & \alpha_{43}(k) & \alpha_{44}(k) \end{bmatrix} * \begin{bmatrix} Exports_{t-k} \\ WGDP_{t-k} \\ ExRUSD_{t-k} \\ VOL_{\frac{OWN}{USD}\,t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix}
$$

(3.25)

In the case of third country volatility:

$$
\begin{bmatrix} Exports_t \\ WGDP_t \\ ExRUSD_t \\ VOL_{\frac{EUR}{USD}\,t} \\ VOL_{\frac{JPY}{USD}\,t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \\ \alpha_{40} \\ \alpha_{50} \end{bmatrix} + \begin{bmatrix} \alpha_{11}(1) & \alpha_{12}(1) & \alpha_{13}(1) & \alpha_{14}(1) & \alpha_{15}(1) \\ \alpha_{21}(1) & \alpha_{22}(1) & \alpha_{23}(1) & \alpha_{24}(1) & \alpha_{25}(1) \\ \alpha_{31}(1) & \alpha_{32}(1) & \alpha_{33}(1) & \alpha_{34}(1) & \alpha_{35}(1) \\ \alpha_{41}(1) & \alpha_{42}(1) & \alpha_{43}(1) & \alpha_{44}(1) & \alpha_{45}(1) \\ \alpha_{51}(1) & \alpha_{52}(1) & \alpha_{53}(1) & \alpha_{54}(1) & \alpha_{55}(1) \end{bmatrix} * \begin{bmatrix} Exports_{t-1} \\ WGDP_{t-1} \\ ExRUSD_{t-1} \\ VOL_{\frac{EUR}{USD}\,t-1} \\ VOL_{\frac{JPY}{USD}\,t-1} \end{bmatrix} +
$$

$$
\begin{bmatrix} \alpha_{11}(k) & \alpha_{12}(k) & \alpha_{13}(k) & \alpha_{14}(k) & \alpha_{15}(k) \\ \alpha_{21}(k) & \alpha_{22}(k) & \alpha_{23}(k) & \alpha_{24}(k) & \alpha_{25}(k) \\ \alpha_{31}(k) & \alpha_{32}(k) & \alpha_{33}(k) & \alpha_{34}(k) & \alpha_{35}(k) \\ \alpha_{41}(k) & \alpha_{42}(k) & \alpha_{43}(k) & \alpha_{44}(k) & \alpha_{45}(k) \\ \alpha_{51}(k) & \alpha_{52}(k) & \alpha_{53}(k) & \alpha_{54}(k) & \alpha_{55}(k) \end{bmatrix} * \begin{bmatrix} Exports_{t-k} \\ WGDP_{t-k} \\ ExRUSD_{t-k} \\ VOL_{\frac{EUR}{USD}\,t-k} \\ VOL_{\frac{JPY}{USD}\,t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix}
$$

(3.26)

Where *Exports*$_t$ are either FOB agricultural exports or FOB total exports from one of the countries being studied to the world, WGDP is world GDP, ExRUSD is the bilateral exchange rate as national currency per USD (i.e. if the model is for Chinese *Exports*, then Chinese Yuan, CNY, per USD currency exchange is used). In equation 3.25 $VOL_{\frac{OWN}{USD}\,t-k}$ describes own currency volatility *vis–à–vis* USD, 3.26, $VOL_{\frac{EUR}{USD}\,t-k}$ and $VOL_{\frac{JPY}{USD}\,t-k}$ represent EUR-USD and YEN-USD exchange rate volatilities. A(k)=[$\alpha_{ij}(k)$] is a matrix of four by four (five by five) lagged polynomials in the case of own (third) country volatility.

3.2 Econometric Methods

There are two main procedures implemented: Granger Non-Causality tests and GARCH models. As implied by the null hypotheses, these procedures are separated according to the volatility type, unconditional and conditional, being tested.

3.2.1   Granger Non-Causality Test (Hypothesis 1).

Hypothesis 1: Unconditional (constant) currency exchange rate volatility (own and G-3) does not Granger cause BRICS exports.

Causality tests are carried out to test hypothesis 1. A test of causality seeks to determine whether one variable improves the forecasting performance of another variable. A causality test as the one devised by Granger (1969) is essentially testing if the lags of one variable are present in the equation for another variable. In the multiple equation model (VAR(k)) shown in the section above, and using the econometric jargon, the null hypothesis is defined as $VOL_{\frac{EUR}{USD}t-p}$ does not **Granger cause** exports, if and only if all the coefficients of $A_{14}(L)$ are equal to zero. Nevertheless, this procedure will be correct only if all the variables in the VAR model are stationary (I(0)) processes. When the variables are non-stationary, share the same order of integration, and cointegrated,[8] an alternative methodology is to proceed as in Johansen (1991). This procedure involves constructing an Error Correction Model (ECM) via MLE to conduct tests on non-causality on the restricted forms of the co-integrated vectors. In the event of no co-integration, a VAR model with transformed variables in d-differences is estimated. A frequent problem in time series models is, however, the presence of variables that do not share the same order of integration, and rather a mix of I(0), I(1), I(2), and even I(3) variables is found.[9] In such circumstances, an alternative methodology is to test for noncausality with the

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[8] Cointegration is a linear combination of nonstationary variables that is actually stationary.
[9] In the empirical works that use traditional unit root test like Augmented Dickey-Fuller and Phillips-Perron, cases of higher than one order of integration in economic variables are rare.

modified Wald test introduced by Toda and Yamamoto (1995), and Dolado and Lütkepohl (1996).[10] The TYDL method is easy to implement in testing for Granger causality even if the processes are stationary, integrated or cointegrated of an arbitrary order. This method has been shown in other studies (e.g., Zapata and Rambaldi (1997), and Pujula (2013)) to work as well in small samples.

The procedure implemented to test whether exchange rate volatility Granger cause exports is as follows:

1. Determine the highest order of integration of any variable in the VAR(k) system (*dmax*). This is accomplish by testing all the variables for stationary using unit root tests like ADF, PP, ERS, and a stationary tests called KPSS.

2. Determine the optimal lag length of the multiple equation system VAR (k) model. Optimal Lag Length is chosen with the AICc statistical selection criterion (k) that performs well in small samples. The idea is to select a long enough lag-length to capture the system dynamics. We begin with the longest possible lag length, considering degrees of freedom, and then prune down until no better fit is found.

3. Estimate a VAR (p=*k+dmax*). Note that this procedure is only valid if and only if *dmax* ≤ k.

4. Perform the MWald tests for Granger non-causality on the volatility parameters.

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[10] Many practitioners refer to Toda and Yamamoto (1995), and Dolado and Lütkepohl (1996) as the TYDL procedure.

As an illustration let us assume that we are working with a bivariate model (j=2), and further assume that x1 and x2 are I(1), so dmax=1, and satisfying a VAR(k=1). [11] The next step is to estimate the augmented model (p=k+*dmax*) via Ordinary Least Squares (OLS) as in Dolado and Lütkepohl (1996), that is VAR(2):

$$\begin{bmatrix} X_{1t} \\ X_{2t} \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11}(1) & a_{12}(1) \\ a_{21}(1) & a_{22}(1) \end{bmatrix} * \begin{bmatrix} X_{1t-1} \\ X_{2t-1} \end{bmatrix} + \begin{bmatrix} a_{11}(2) & a_{12}(2) \\ a_{21}(2) & a_{22}(2) \end{bmatrix} * \begin{bmatrix} X_{1t-2} \\ X_{2t-2} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \qquad (3.27)$$

Where the expected value of the error is $E(e_t) = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = 0$ and $E(e_t e_t') = \Sigma$.

Testing the parameter restriction $a_{12}(1) = 0$, is testing that x2 does not Granger cause x1 by computing the Wald test from the model estimates.

Let us expand the bivariate example above to the case of testing Granger non-causality of volatility on exports. [12] Let x_t be the vector that contains the five variables (j=5) in the model 3.28 where x_{1t}=exports, x_{2t}=WGDP$_t$, x_{3t}=ExRUSD$_t$, x_{4t}=Vol$_{EUR/USDt}$, x_{5t}=Vol$_{JPY/USDt}$, satisfying a VAR(5) process and *dmax*=1, p=6.

$$\begin{aligned}
\begin{matrix} Exports_t \\ WGDP_t \\ ExRUSD_t \\ VOL_{\frac{EUR}{USD}t} \\ VOL_{\frac{JPY}{USD}t} \end{matrix} = A_0 + A_1 \begin{bmatrix} Exports_{t-1} \\ WGDP_{t-1} \\ ExRUSD_{t-1} \\ VOL_{\frac{EUR}{USD}t-1} \\ VOL_{\frac{JPY}{USD}t-1} \end{bmatrix} + A_2 \begin{bmatrix} Exports_{t-2} \\ WGDP_{t-2} \\ ExRUSD_{t-2} \\ VOL_{\frac{EUR}{USD}t-2} \\ VOL_{\frac{JPY}{USD}t-2} \end{bmatrix} + A_3 \begin{bmatrix} Exports_{t-3} \\ WGDP_{t-3} \\ ExRUSD_{t-3} \\ VOL_{\frac{EUR}{USD}t-3} \\ VOL_{\frac{JPY}{USD}t-3} \end{bmatrix} +
\end{aligned}$$

$$A_4 \begin{bmatrix} Exports_{t-4} \\ WGDP_{t-4} \\ ExRUSD_{t-4} \\ VOL_{\frac{EUR}{USD}t-4} \\ VOL_{\frac{JPY}{USD}t-4} \end{bmatrix} + A_5 \begin{bmatrix} Exports_{t-5} \\ WGDP_{t-5} \\ ExRUSD_{t-5} \\ VOL_{\frac{EUR}{USD}t-5} \\ VOL_{\frac{JPY}{USD}t-5} \end{bmatrix} + A_6 \begin{bmatrix} Exports_{t-6} \\ WGDP_{t-6} \\ ExRUSD_{t-6} \\ VOL_{\frac{EUR}{USD}t-6} \\ VOL_{\frac{JPY}{USD}t-6} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix}, \qquad (3.28)$$

t=p+1,...,T

---

[11] See Rambaldi and Doran (1996)
[12] We adapt Rambaldi and Doran (1996) example to our case.

$$\text{Where } A_p = \begin{bmatrix} \alpha_{11}(p) & \alpha_{12}(p) & \alpha_{13}(p) & \alpha_{14}(p) & \alpha_{15}(p) \\ \alpha_{21}(p) & \alpha_{22}(p) & \alpha_{23}(p) & \alpha_{24}(p) & \alpha_{25}(p) \\ \alpha_{31}(p) & \alpha_{32}(p) & \alpha_{33}(p) & \alpha_{34}(p) & \alpha_{35}(p) \\ \alpha_{41}(p) & \alpha_{42}(p) & \alpha_{43}(p) & \alpha_{44}(p) & \alpha_{45}(p) \\ \alpha_{51}(p) & \alpha_{52}(p) & \alpha_{53}(p) & \alpha_{54}(p) & \alpha_{55}(p) \end{bmatrix},$$

$e_{p+1}, \ldots, e_T$ are independent and identically distributed (i.i.d.) $(0, \Sigma)$. This is a reduced form system because only lagged values of the endogenous variables on the right hand side are allowed. Therefore the variance-covariance matrix of errors captures the contemporaneous co-variation among the variables.

The null hypothesis to test $Vol_{EUR/USD}$ does not Granger cause *Exports* is H_0: $\alpha_{14}(1) = \alpha_{14}(2) = \alpha_{14}(3) = \alpha_{14}(4) = \alpha_{14}(5) = 0$. That is testing that $Vol_{EUR/USDt-1}$, $Vol_{EUR/USDt-2}$, $Vol_{EUR/USDt-3}$, $Vol_{EUR/USDt-4}$, and $Vol_{EUR/USDt-5}$ are not present in the *Exports* equation. In the same fashion, the null hypothesis to test $Vol_{JPY/USD}$ does not Granger cause *Exports* is H_0: $\alpha_{15}(1) = \alpha_{15}(2) = \alpha_{15}(3) = \alpha_{15}(4) = \alpha_{15}(5) = 0$. That is testing that $Vol_{JPY/USDt-1}$, $Vol_{JPY/USDt-2}$, $Vol_{JPY/USDt-3}$, $Vol_{JPY/USDt-4}$, and $Vol_{JPY/USDt-5}$ are not significant in the *Exports* equation.

A joint test of $Vol_{EUR/USD}$ and $Vol_{JPY/USD}$ do not Granger cause *Exports* is also conducted in the form H_0: $\alpha_{14}(1) = \alpha_{14}(2) = \alpha_{14}(3) = \alpha_{14}(4) = \alpha_{14}(5) = \alpha_{15}(1) = \alpha_{15}(2) = \alpha_{15}(3) = \alpha_{15}(4) = \alpha_{15}(5) = 0$. And as already said above, that is the same as testing that all the lags but the last of both volatilities are not significant in the Exports equation.

If the null hypothesis is true, then the Modified Wald test statistic λw is distributed as $\chi^2_{(J)}$, where J represents the number of restrictions on the parameters.

In practice, the model is estimated and the Modified Wald test (MWald) statistic λw is obtained in the framework of a seemingly unrelated regressions (SUR)

with vertically stacked data (see Rambaldi and Doran, 1996). With this data arrangement the least squares estimate and the variance-covariance is equal to the SUR estimate and variance-covariance matrix. Rambaldi and Doran (1996) warned that in obtaining the MWald test statistic **λw,** software routines may produce an F-test statistic, and so **λw** is simply equal to JF. In this research, the Syslin procedure in SAS® 9.3 Software is programed to estimate the system of equations and obtain the test statistics to carry out hypothesis testing.

The combination of two types of export series (agricultural and total); two ways of analyzing economic series (nominal and real),[13] two variables representing volatility (M-STD and CV), [14] yields eight VAR(p) models per country or 56 total in the case of third country volatility, and four per country or 28 total in the case of own exchange rate volatility.

3.2.2 GARCH (Hypothesis 2)

Hypothesis 2: Conditional (stochastic) currency exchange rate volatility (own and G-3) does not impact BRICS exports.

Conditional volatility as introduced by Engle (1982) is estimated through an autoregressive conditional heteroskedasticity (ARCH) model and/or its extensions. This method is used extensively by financial economists. The fact that it considers time-varying variance (heteroskedasticity) through the simultaneous estimation of mean and variance of a series, yields superior volatility estimates. The advantage,

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[13] Superiority of one measure of exchange rate volatility, nominal or real, over the other in empirical research remains still an open question. Hence in the present work both measures are use.
[14] See variable computation subsection under data.

simply stated, is on the ability to model changes in volatility over time. A time series

like currency exchange rates exhibits conditional heteroskedasticity if it has highly

volatile periods followed by tranquil phases.

A basic ARCH model is composed of a mean equation and a variance

equation.

$$
\begin{aligned}
r_t &= \mu_0 + e_t, & e_t|I_{t-1} &\sim N(0, h_t) \\
h_t &= \alpha_0 + \alpha_1 e_{t-1}^2, & \alpha_0 &> 0, 0 \le \alpha_1 < 1
\end{aligned} \tag{3.29}
$$

In the mean equation, r_t is explained by an intercept μ_0 and an error term e_t.

This is an ARCH(1) because in the variance equation, h_t depends on a constant term

and the squared error in the previous period. Where h_t is time-varying variance, I_t is

the information available at t-1, the distribution of the error term is conditionally

normal (or conditional on the squared error term in the previous period), the non-

negativity restriction on the coefficients, α_0 and α_1, warrants a positive variance. This

model explains volatility as function of errors e_t or shocks. The basic notions of

ARCH are: 1) "shocks," e_t, of exchange rates are serially uncorrelated, but dependent,

and 2) the dependence of e_t can be represented in a conditional variance function of

its lagged values. Considering these notions and in our particular case, the basic

ARCH(1) could be extended to ARCH(q):

$$
h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \alpha_2 e_{t-2}^2 + \cdots + \alpha_q e_{t-q}^2 \tag{3.30}
$$

There are q+1 parameters to estimate in ARCH(q). Accuracy in the estimation

is compromised when there are long lagged effects. Introduced by Bollerslev (1986),

the Generalized-ARCH (GARCH) was designed to capture these effects with fewer

parameters than in the case of ARCH and permits the conditional volatility to be an

ARMA (p,q) process:

$$h_t = \omega + \sum_{i=1}^{q} \alpha_i e_{t-1}^2 + \sum_{i=1}^{p} \beta_i h_{t-1}$$

$$p \geq 0, q > 0, \omega_0 > 0, \alpha_1 > 0, \beta_1 > 0$$

(3.31)

The above is the "Plain Vanilla" GARCH(p,q), where p and q are the number

of lagged h and e_2 terms, respectively. It can be derived by transforming equation 3.30

using a geometric lag structure:

$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 \alpha_1 e_{t-2}^2 + \beta_1^2 \alpha_1 e_{t-3}^2 \dots$$

(3.32)

equation 3.32 lagged one period,

$$h_{t-1} = \alpha_0 + \alpha_1 e_{t-2}^2 + \beta_1 \alpha_1 e_{t-3}^2 + \beta_1^3 \alpha_1 e_{t-4}^2 \dots$$

(3.33)

by inserting in equation 3.33 into 3.32 GARCH(1,1)

$$h_t = \omega_0 + \alpha_1 e_{t-2}^2 + \beta_1 h_{t-1},$$
$$\omega_0 > 0, 0 \leq \alpha_1 < 1, 0 \leq \beta_1 < 1$$

(3.34)

GARCH-in-mean model is an extension that allows using volatility to explain,

in our case, exchange rates. Hence the mean equation in 3.34 includes volatility.

$$r_t = \mu_0 + \gamma h_t + e_t$$
$$h_t = \omega + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1},$$

(3.35)

It is of our interest to test the impact of conditional volatility of exchange rates

on exports. To this end the following extension of the GARCH model are estimated.

3.2.2.1   VAR GARCH-in mean

There are many ways to extend the GARCH model for a multivariate case.[15]

However, we confront with a major problem, the curse of dimensionality. There is a

family of GARCH models introduced by Bollerslev (1990) called constant correlation

models and is used to test hypothesis 2. Its main feature is imposing the restriction of

time-invariant correlation coefficients ($\rho_{21,t}= \rho_{21}$) between $e_{1,t}$ and $e_{2,t}$ to keep the

number of volatility equations low.

Mean equations:

$$
\begin{aligned}
r_{1,t} &= \gamma_{10} + \gamma_{11,t-1}r_{1,t-1} + \cdots + \gamma_{11,t-k}r_{1,t-k} \\
&\quad + \gamma_{12,t-1}r_{2,t-1} + \cdots + \gamma_{12,t-k}r_{2,t-k} \\
&\quad + \gamma_{13}h_{1,t} + \gamma_{14}h_{2,t} + e_{1,t} \\
r_{2,t} &= \gamma_{20} + \gamma_{21,t-1}r_{1,t-1} + \cdots + \gamma_{21,t-k}r_{1,t-k} \\
&\quad + \gamma_{22,t-1}r_{2,t-1} + \cdots + \gamma_{22,t-k}r_{2,t-k} \\
&\quad + \gamma_{23}h_{1,t} + \gamma_{24}h_{2,t} + e_{2,t}
\end{aligned}
\tag{3.36}
$$

Volatility equations:

$$
\begin{aligned}
h_{1,t} &= \omega_1 + \alpha_{11}e_{1,t-1}^2 + \beta_{11}h_{1,t-1}. \\
h_{2,t} &= \omega_2 + \alpha_{22}e_{2,t-1}^2 + \beta_{22}h_{2,t-1}.
\end{aligned}
\tag{3.37}
$$

Notice that in equation 3.37, cross parameters α_{12}, α_{21}, β_{12}, and β_{21} are

missing. That is because by imposing the time-invariant restriction, these parameters

become equal to zero thereby reducing the number of parameters to be estimated. Yet

we sacrifice the original export demand equation and limit the number of variables to

only two to avoid over-parameterization. The way we proceed is by estimating

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[15] Tsay (2005)

bivariate GARCH-in-mean model for pairs of variables as follows: Exports and Own Country Exchange Rates, and Exports and Third Country Exchange Rates.

The estimation procedure includes estimating first a VAR(k) to obtain the optimal number of lags for the mean equation using the AIC statistical criterion. Then, estimate the Bivariate GARCH(1,1)-in mean model using a maximum likelihood method (MLE). Analytical solutions to the MLE are complex in the presence of time varying variances, and so reaching convergence could be an issue in these type of models. Consequently, we try to reach convergence, by changing either the number of iterations, 500 to 1000, or the numerical optimization algorithms Broyden-Fletcher-Goldfarb-Shanno (BFGS) and Berndt-Hall-Hall-Hausman (BHHH) to maximize the likelihood function:

$$l = \sum_{t=1}^{N} \frac{1}{2} \left[-\ln(2\pi) - \ln(h_t) - e_t^2/h_t \right] \tag{3.38}$$

Model fit is evaluated with analogous measures to AIC and SBC selection criteria. For model specification, the Ljung-Box statistics of the standardized residuals and their squared series is used. No serial correlation and no remaining conditional volatility assure model adequacy, especially in regards to capturing all dynamic features of the mean equation and variance equation. Serial correlation implies that the mean equation has been improperly specified. And an important property is "volatility persistence," the degree AR decay of squared residuals is ($\alpha_1 + \beta_1$), and so the ACF of an ARMA(1,1) is similar to GARCH(1,1).

3.2.3   Stationarity Definition

A great deal of importance is given to the stationarity assumption in this research as is a very important split point in the methodology roadmap in estimation dealing with time series data. A stationary process is defined as series that always come back to the mean, have an equal variance and the covariance between any two values in the series depends solely in the interval of time that separates them (e.g., white noise process). Time series data with changing means and variances are referred as non-stationary (Hamilton, 1994). One of the processes that is often associated with such data is a random walk, meaning that the series behaves in an unpredictable pattern similar to that of a winding road. In model estimation, especially when using econometric estimators that depend on the stationary assumption, non-stationary series result in estimation, inference and forecasting problems. Granger and Newbold (1974) demonstrated that when fitting a regression with two random walk variables, spurious results are possible. In order to attain consistent and reliable results, the consensus in the literature (e.g., Hamilton (1994), and Enders (2004)) is to first determine the type of time series process and then use filtering techniques accordingly. That is to transform deterministic trends using detrending (demeaning), and stochastic trends employing differencing or ARIMA filters. Simply stated, the goal is to convert the unpredictable process to one that has a mean coming back to a long term average and a variance that does not depend on time.

3.2.3.1 Variable Process Identification (Unit Root Tests)

The variable process identification is accomplish by testing all the variables for unit roots (or non-stationarity): Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Elliott-Rothenberg-and-Stock (ERS), and Ng and Perron (NP). To illustrate how the tests work, the ADF procedure is explained because the majority of test include similar set of steps. ADF tests are carried out with the estimation of three models (steps) that differ from the presence of a constant and a trend terms (see Enders 2004). Step one starts by estimating the most general equation using OLS:

$$\Delta y_t = \alpha_0 + \alpha_2 t + \gamma y_{t-1} + \sum_{s-1}^{m} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad (3.39)$$

Where Δy_t is the variable of interest in differences, α_0 is a constant term, $a_2 t$ is a linear trend, γy_{t-1} are one period lagged levels, and ($\sum_{s-1}^{m} \beta_i \Delta y_{t-i}$) are dependent variable lagged differences to capture the whole dynamic nature of the process and fix residuals autocorrelation. The optimal lag length is based on the lowest estimate of the Akaike's information criterion (AIC). The null hypothesis is non-stationarity or unit-root process (H_o: $\gamma=0$) and is tested using the τ_τ statistic. Alternatively, it is possible to carry out a joint test for the presence of a trend and a unit-root (H_o: $a_2=\gamma=0$) using the φ_3 statistic. If the restriction is not binding, the second step is to estimate a model with a constant term without a trend:

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{s-1}^{m} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad (3.40)$$

Then test for the significance of the constant term and a unit-root (Ho: $a0=\gamma=0$) using the φ_1 statistic.

If we fail to reject the null hypothesis, then the third step is executed, that is to estimate a regression without constant term:

$$\Delta y_t = \gamma y_{t-1} + \sum_{s-1}^{m} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad (3.41)$$

The null of a unit root (H_o: $\gamma=0$) is tested using the τ statistic. If the null is rejected, then the conclusion is that the series is generated from a stationary process I(0). Otherwise, the series are generated from a non-stationary process. If the series is non-stationary in levels, in order to detect higher orders of integration [e.g., I(1), I(2), I(3)], the series are transformed to first differences and a second unit root test is carried. If the series are stationary in first differences, the series are I(1), in other words the series only need to be differenced once. Otherwise, if the series are non-stationary in first differences, then a third unit root test is carried and in the same fashion higher orders of integration for non-stationary variables are identified.

ADF tests use a parametric method to correct for serial correlation while PP tests a semi-parametric procedure. Both tests are asymptotically equivalent. Nevertheless, Monte Carlo studies have unveiled that ADF and PP tests suffer potentially severe finite sample power (low power against the alternative hypothesis) and size problems (size distortions in the presence of large negative MA coefficients). In short they have problem in distinguishing those processes with error roots close to a unit circle. Hence, besides these two traditional tests, variable process identification is also based on other modified efficient unit root test developments. The ERS test is a modified version of ADF t-test including a GLS detrending method which provides greater power. NP tests (modified efficient) innovates modified versions of PP ($MZ\alpha$,

MZt and MSB) tests by doing what ERS did to ADF, include a GLS detrending for modified PP tests. Overall, the modifications improve finite sample performance when the AR root is large, and size distortions when there is large negative MA root. Proper choice of the optimal lag-length also helps in achieving good size and power in the modified unit root tests. The Ng and Perron (2001) recommendation is to base the choice on the minimum value of the modified AIC (MAIC) criterion.

Contrary to the unit root tests described above, in the Kwiatkowski-Phillips-Schmidt-and-Shin (KPSS) procedure, the null hypothesis of trend (or level) stationarity against the alternative of a unit root is tested. In this research KPSS tests are used as complementary test to unit root tests.

3.3 Data

The empirical analysis uses data from Brazil, Russia, India, China, South Africa, Honduras, Turkey, Japan, Eurozone, the United States, and World economic performance indicators. The studied period includes data from 1973 to 2013. Data frequencies are monthly and quarterly.

3.3.1 Data Sources

Nominal and real, monthly and Quarterly, national currency exchange rates per USD for Brazil, Russia, India, China, South Africa, Honduras, Turkey, and Japan were downloaded from the International Financial Statistics from the International Monetary Fund (IFS-IMF: elibrary-data.imf.org), and from IHS Global Insight via Wharton Research Data Services (WRDS: wrds-web.wharton.upenn.edu). Euro/USD

series was obtained from the Economic Research Service from the United States Department of Agriculture (ERS-USDA: www.ers.usda.gov).

Monthly, Quarterly, and Annual Free on Board (FOB) exports in millions of USD were downloaded from the IFS-IMF browser and from the United Nations Comtrade Database (http://comtrade.un.org/). Annual data for agricultural exports were found at the Statistics Division from the Food and Agriculture Organization (FAOSTAT: faostat.fao.org).

Monthly, quarterly and annual Consumer Price Indices (CPI-2005=100) were obtained from the Organization for Economic Co-Operation and Development (OECD: stats.oecd.org) and from WRDS.

Annual World GDP and Agricultural GDP in levels are provided at the World Bank (WB: data.worldbank.org). Annual and Quarterly World Real GDP percentage change and World Real GDP Deflator percentage change were found at IFS-IMF.

3.3.2   Computed Series

Real versions of the variables were computed by deflating using the involved countries CPIs. This step helped to fill out missing data from directly downloaded real series and as a benchmark to evaluate data quality.

Unconditional exchange rate volatility measures, M-STD and CV, were computed. In the case of M-STD: first, the rates of change are calculated as the natural log of real exchange rate (RER) at month (t) minus the natural log of the RER 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

48

change (ROC) of the previous year (2000); February-2001 volatility is then computed using ROC from February 2000 until January-2001; and the volatility for the subsequent months is computed in the same fashion:

$$STD_{t+p} = \sqrt{\left[\frac{1}{P}\sum_{i=1}^{P}(ROC_{t+i-1} - ROC_{t+i-2})^2\right]} \qquad (3.42)$$

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: [16]

$$CV_{t+p} = \frac{\sqrt{\left[\frac{1}{P}\sum_{i=1}^{P}(RER_{t+i-1} - \overline{RER})^2\right]}}{\overline{RER}} \qquad (3.43)$$

In order to avoid loss of observations due to the computation of moving CV and STD, the construction of these series included data prior to 1973.

The lowest frequency agricultural exports are reported is annual (FAOSTAT). Since annual agricultural exports are a percentage of a year total exports, quarterly agricultural exports were computed from quarterly total exports, using that proportion of a particular year. Likewise monthly agricultural exports were computed.

For the years prior the Euro entered circulation, 1973-2001, the **EUR/USD exchange rate** was obtained from a GDP weighted average of the currencies which were merged into the Euro. After 2001, the actual exchange rates were used.

---

[16] Esquivel and Larraín (2002) found the CV more efficient when predicting volatility.

The **actual quarterly World GDP** was generated from its growth rates published by the IMF. The following shows how this was accomplished.

3.3.3 Data Issues

The export demand model requires information on World GDP as a proxy for world economic activity. Nonetheless, quarterly World Real GDP is only reported in percentage changes along with the quarterly GDP Deflator Percentage Change. A simple algebraic operations along with one Actual GDP annual record suffices to reproduce actual GDP values for the entire period of nominal and real series. Yet, the transformation needs careful attention to how data were first constructed. For example, the growth rates are not from one quarter to another quarter. Instead they are from the same quarter in the previous year. In Table 3-1 the percentage change in 2000 Q1 is with respect to 1999 Q1. Indeed, the key is to appropriately sort the series by quarter and year of the growth rates prior actual GDP series computation. Once the series are computed, a re-sorting by year and quarter will display Actual GDP values.

Table 3-1. Quarterly GDP Computation Example.

Date	RGDP %Δ CORR PER PREV YEAR	GDP DEF %Δ OVER CORR PER PREV YEAR	GDP DEF Index	RGDP World	GDP World
2004Q4	4.63	6.78	95.42	4.20233E+13	4.0097E+13
2005Q4	4.62	4.80	100.00	4.39657E+13	4.39657E+13
…					
2011Q1	3.72	4.17	126.52	5.20793E+13	6.58916E+13
2012Q1	2.99	3.05	130.38		

$$World\ Real\ GDP\ 2011\ Q1\ = \frac{Actual\ RGDP\ 2012}{\left(\frac{RGDP\ \%\Delta}{100} + 1\right)} \qquad (3.44)$$

In order to obtain Nominal GDP Series, the GDP deflator percentage change was converter to an actual index.

$$GDP\ DEF\ \%\Delta\ 2005\ Q4 = \frac{x_2 - x_1}{x_1} * 100 = 4.80 \qquad (3.45)$$

$$GDP\ DEF\ Index\ 2004\ Q4 \rightarrow x_1 = \frac{100}{1.048} = 95.42 \qquad (3.46)$$

Models used in this research requires as many degrees of freedom as possible. Some series were extended using either information from different sources and data transformations. For example in the case of Chinese exchange rates, the data provided started in 1993 for real series. With CPI%Δ series available from IMF-IFS we were able to construct the actual CPI index, and using nominal series allowed us to extend six years the original starting period for real exchange rates, so from 1993 to 1987. Some series for quarterly data as provided from some sources were not as complete as if monthly data were used to obtain quarterly observations. For example in the case of Russia, the nominal quarterly RUB/USD exchange rates series provided by IMF-IFS starts in 1992Q3, ERS-USDA provides monthly data for the same series since 1970, hence, quarterly observations were complemented with this last information.

3.3.4   Plots of the Series

Some plots are provided to give a notion of the time series. The volatility of nominal and real exchange rates are presented In Figures 3-1 and 3-2, respectively.

Monthly FOB Nominal Agricultural Exports and its real counterparts are presented in Figures 3-3 and 3-4, respectively. Notice that exchange rates and exports present that time varying variance characteristic as described in the GARCH section. And Figure 3-5 describes quarterly nominal and real world GDP (economic activity).
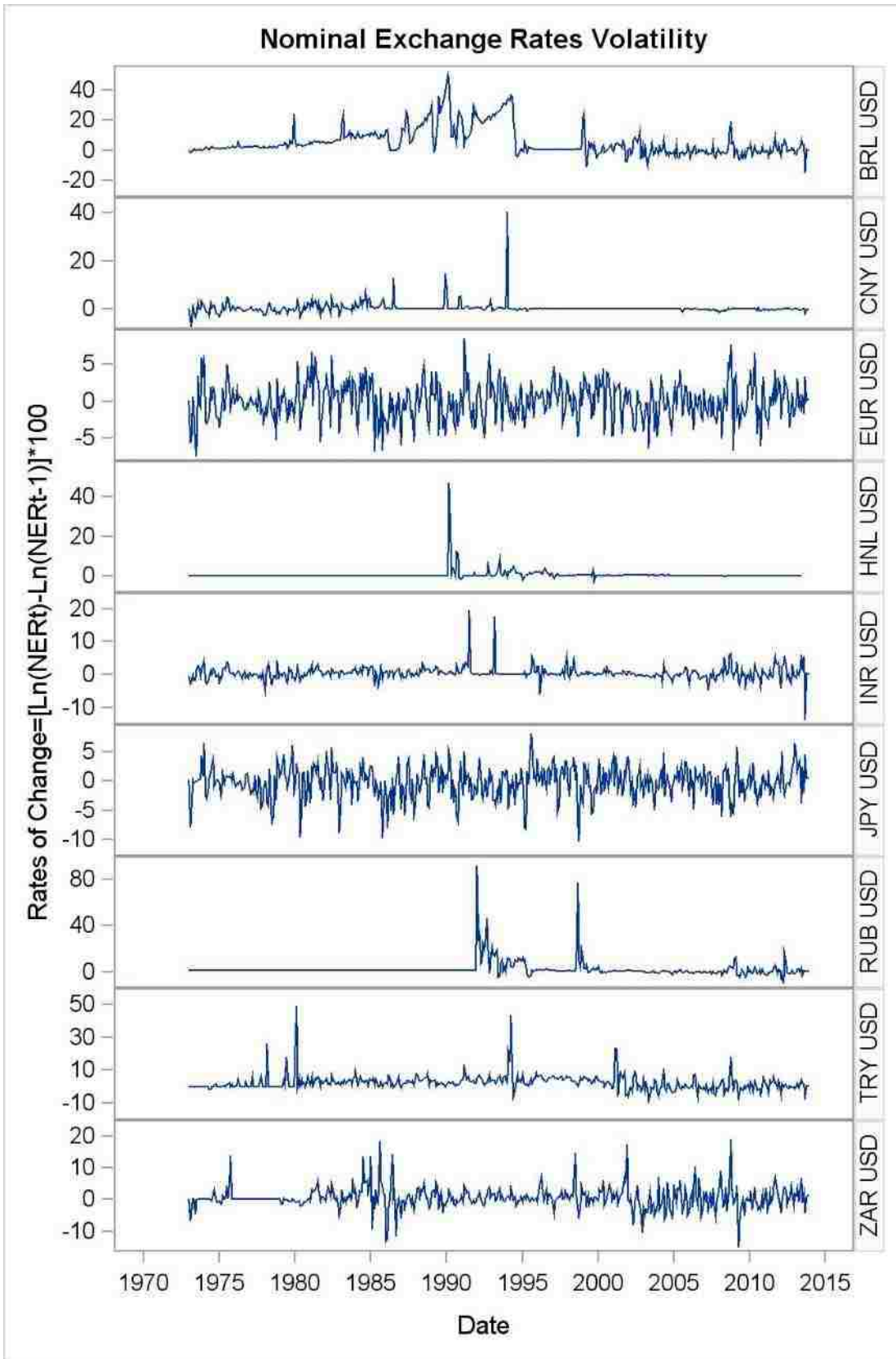
Figure 3-1. Nominal Exchange Rates Volatility.
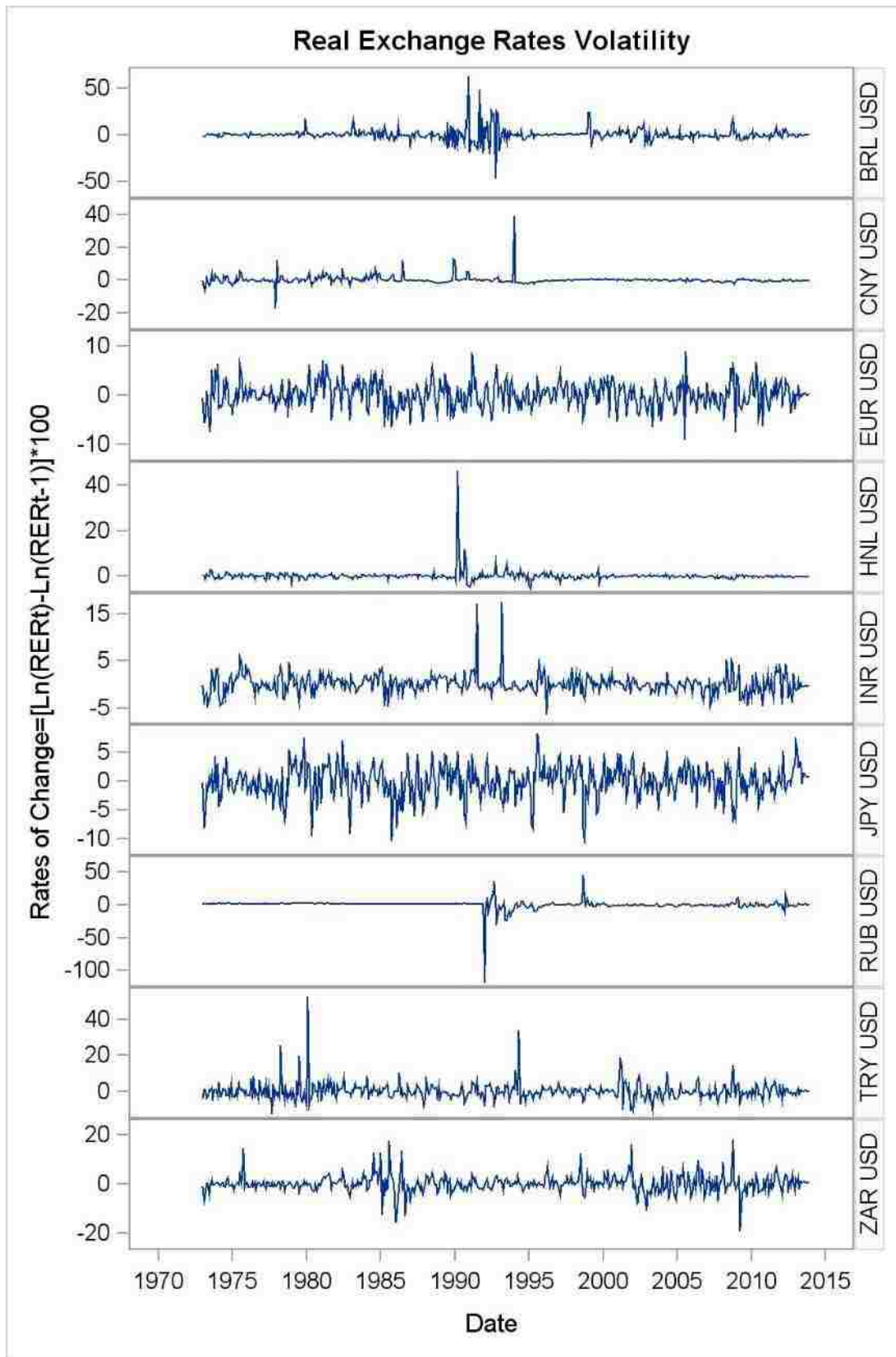
Figure 3-2. Real Exchange Rates Volatility.
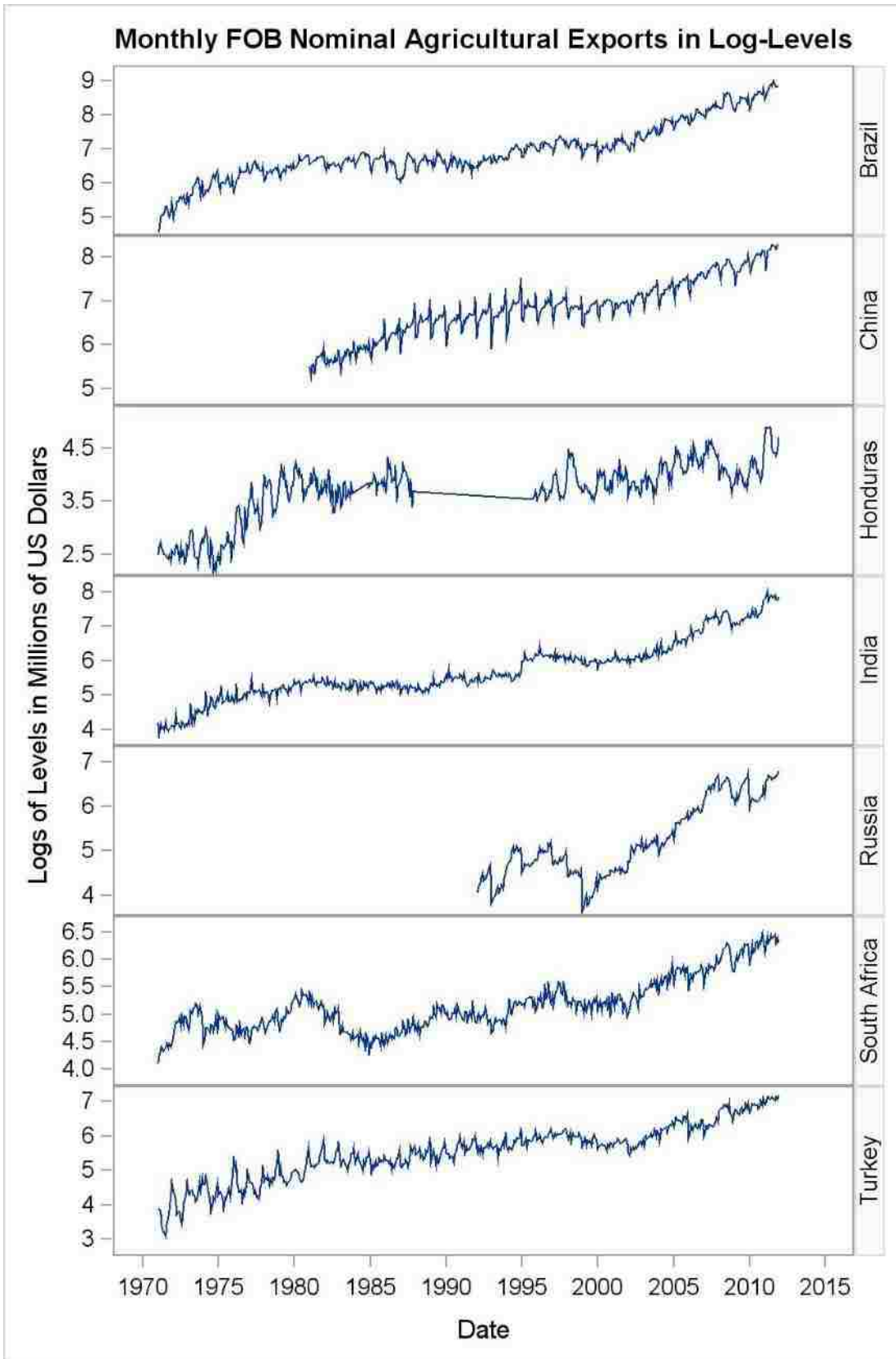
Figure 3-3. Monthly FOB Nominal Agricultural Exports.
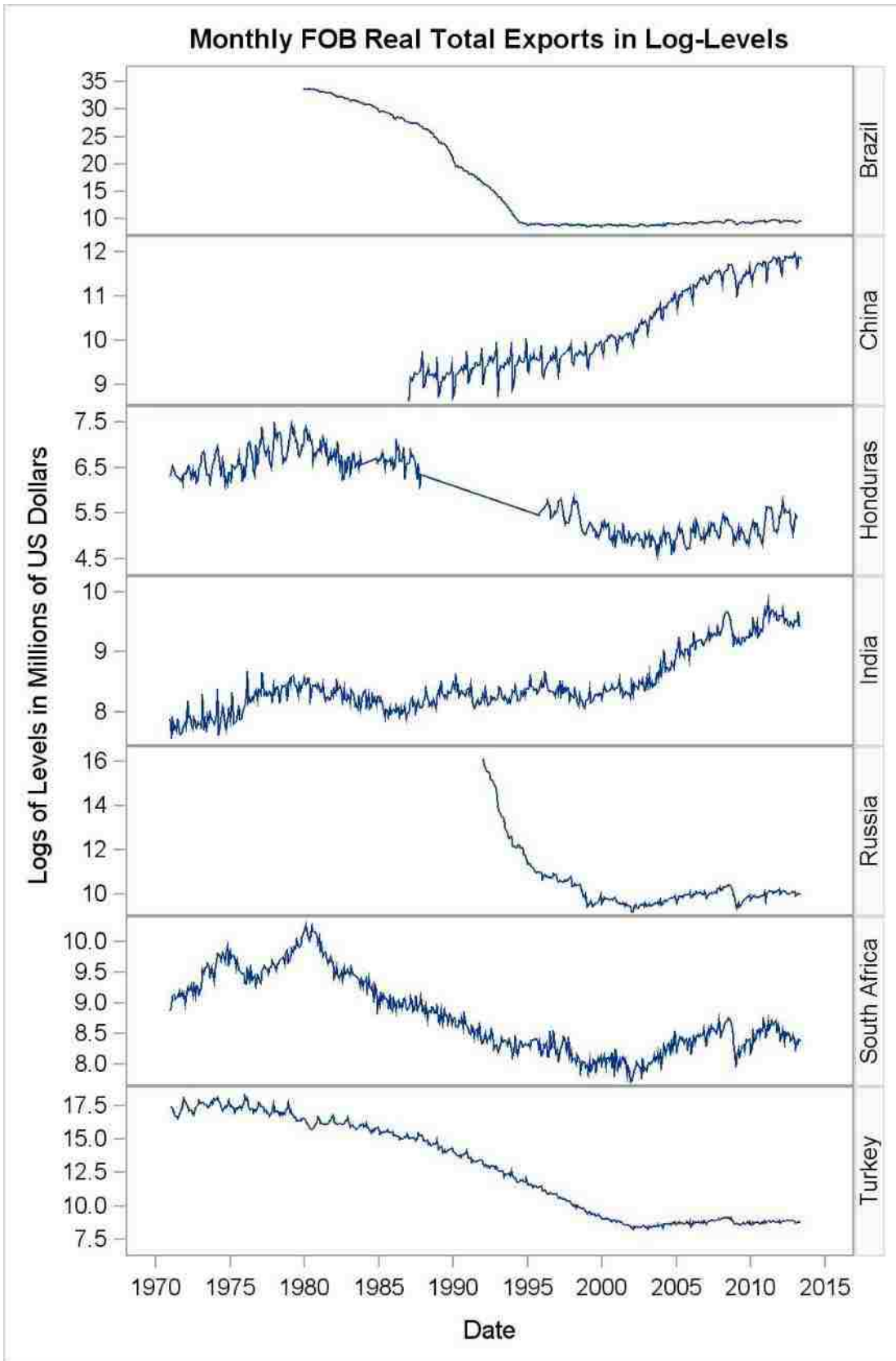
Figure 3-4. Monthly FOB Real Total Exports.
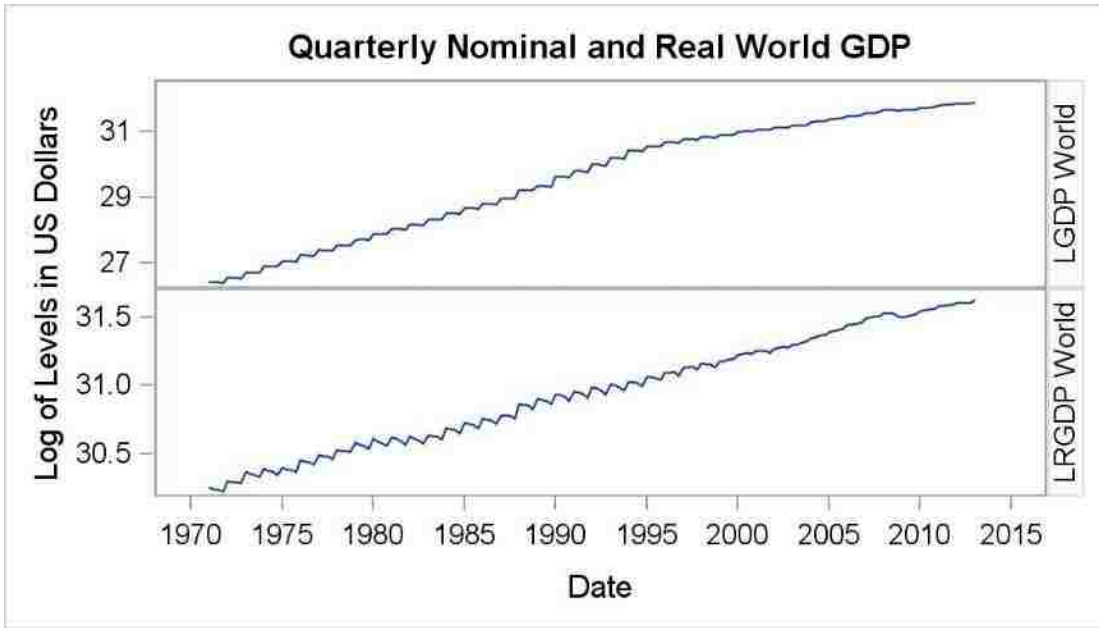
Figure 3-5. Quarterly Nominal and Real World GDP.

4   RESULTS

This chapter presents the estimation results from the different models proposed in the methodology. The aim of this research is to provide initial empirical evidence on the effects of exchange rate volatility (in own country and G-3 currencies) on agricultural and total exports from Brazil, Russia, India, China, South Africa, (BRICS), Turkey (Part of MINT) and Honduras (a LMIC). In particular, one motivation is to examine the validity of the claims of the leaders of emerging economies: "export are being negatively impacted by G-3 currency volatility. To this end, two main hypotheses are tested. Hypothesis 1: Unconditional (constant) currency exchange rate volatility (own and G-3) does not Granger cause BRICS exports. Hypothesis 2: Conditional (stochastic) currency exchange rate volatility (own and G-3) does not impact BRICS exports. The results from the testing of these hypotheses are provided in the next subsections.

4.1   Hypothesis 1

4.1.1   Pretesting

In most analyses using time series data it is imperative to carry out pretesting to identify the data generating process of the variables. Monte Carlo studies have confirmed low statistical power of ADF and PP tests, especially in cases with roots very close to the unit circle. Low power translates into low probability of rejecting the null hypothesis when is false. In practice, more unit roots will be identified than there actually are. One way to increase statistical power is by increasing the significance level (α) of the test to a more conservative level, 10 % (α=0.10).

Through a battery of unit root tests ADF, PP, ERS, NP (DFGLS, MPT MSB, MZ, MZa, and PT), and KPSS variable processes I(0), I(1), I(2), and I(3) were identified. [17] Tables 4-1 to 4-3 present a summary of unit root test results for quarterly data in log-levels, log-first-differences, and log-second-differences, respectively.[18] The first column contains information about the unit-root test type. The second column is the number of variables that were tested. The third column shows the number of non-stationary variables at the α=0.10. The fourth column is a percentage of non-stationary to total number of variables tested at the α=0.10. Columns five and six, and seven and eight contain similar information to the third and fourth, at α=0.05 and α=0.01, respectively. To illustrate, in Table 4-1, for the ADF test there are 31 out of 58 variables for which the unit-root test null hypothesis could not be rejected at the α=0.10.

Table 4-1. Stationary Tests (Unit Root) in Log Levels

Test	Total Series	Stochastic Trends in Log Levels					
		0.10*	%	0.05*	%	0.01*	%
Augmented Dickey-Fuller	58	31	53.45	37	63.79	45	77.59
ERS^	58	46	79.31	50	86.21	50	86.21
KPSS†	58	39	67.24	31	53.45	8	13.79
Ng and Perron -DFGLS	58	53	91.38	57	98.28	58	100.00
Ng and Perron -MPT	58	49	84.48	55	94.83	57	98.28
Ng and Perron -MSB	58	51	87.93	54	93.10	57	98.28
Ng and Perron -MZ	58	49	84.48	54	93.10	57	98.28
Ng and Perron -MZalpha	58	50	86.21	54	93.10	57	98.28
Ng and Perron -PT	58	49	84.48	57	98.28	57	98.28
Phillips-Perron	58	25	43.10	29	50.00	34	58.62
Total	580	442	76.21	478	82.41	480	82.76

^ Elliott-Rothenberg-Stock, †Kwiatkowski-Phillips-Schmidt-Shin, *Significance level (α).

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[17] KPSS is a test for stationarity, carried out to complement unit root tests.
[18] See appendices for complete tests details.

On the other hand, rejection of the null hypothesis implies stationary, hence the remaining 27 variables are identified as stationary processes I(0). Since it is possible for non-stationary variables to have orders of integration higher than one, and because the ADF tests consider only one unit root, the resulting non-stationary variables need to be re-tested in first-differences. Accordingly, Table 4-2 presents the results of a second unit root test only on the 31 non-stationary variables detected at $\alpha=0.10$ in first run of the test. These tests are for series in log first differences. Variables for which the null hypothesis of non-stationarity is rejected are profiled as I(1), that is they only need to be differenced once in order to achieve stationarity.

Table 4-2. Stationary Tests (Unit Root) in Log First Differences

Test	Total Series	Stochastic Trends in Log First Differences					
		0.10*	%	0.05*	%	0.01*	%
Augmented Dickey-Fuller	31	0	0	0	0	0	0
ERS^	46	13	28.3	13	28.3	22	47.83
KPSS†	39	8	20.5	5	12.8	0	0
Ng and Perron -DFGLS	53	24	45.3	28	52.8	32	60.38
Ng and Perron -MPT	49	31	63.3	32	65.3	37	75.51
Ng and Perron -MSB	51	31	60.8	34	66.7	38	74.51
Ng and Perron -MZ	49	31	63.3	32	65.3	37	75.51
Ng and Perron -MZalpha	50	31	62	33	66	38	76
Ng and Perron -PT	49	30	61.2	32	65.3	37	75.51
Phillips-Perron	25	0	0	0	0	0	0
Total	442	199	45	209	47.3	241	54.52

^ Elliott-Rothenberg-Stock, †Kwiatkowski-Phillips-Schmidt-Shin, *Significance level (α).

On the other hand, variables for which the null hypothesis could not be rejected, need to pass once again through a third set of unit root tests, this time in log second-differences as shown in Table 4-3. In the same fashion higher orders of integration I(2), and I(3) are identified. It is evident that variables present a mix of orders of integration, some are I(0), others I(1), and I(2), and even I(3). And as

explained in the methodology, TDYL procedure is handy to test for Granger non-causality in such circumstances.

Table 4-3. Stationary Tests (Unit Root) in Log Second Differences

Test	Total Series	Stochastic Trends in Log Second Differences					
		0.10*	%	0.05*	%	0.01*	%
ERS^	13	11	84.62	12	92.31	12	92.31
KPSS†	8	0	0.00	0	0.00	0	0.00
Ng and Perron -DFGLS	24	20	83.33	20	83.33	20	83.33
Ng and Perron -MPT	31	26	83.87	26	83.87	26	83.87
Ng and Perron -MSB	31	26	83.87	26	83.87	26	83.87
Ng and Perron -MZ	31	26	83.87	26	83.87	26	83.87
Ng and Perron -MZalpha	31	26	83.87	26	83.87	26	83.87
Ng and Perron -PT	30	26	86.67	26	86.67	26	86.67
Total	199	161	80.90	162	81.41	162	81.41

^ Elliott-Rothenberg-Stock, †Kwiatkowski-Phillips-Schmidt-Shin, *Significance level (α).

4.1.2 TYDL VAR(p) Lag Length

The first step in the TDYL procedure is to determine the maximum order of integration in the system of equations (*dmax*). Pretesting together with an organization of the specific variables that enter into model estimation helps to accomplish this task in a very didactic way. To illustrate, every row in Table 4-4 and Table 4-5 depicts a model which change according to country, total or agricultural exports, series type nominal or real, unconditional volatility measure standard deviation or coefficient of variation, and own country currency exchange rate volatility or third country currency exchange rate volatility. Every column represents a variable along with its process type in the following column. Curiously enough, *dmax* is of order three for all 84 models.

The second step is to determine the lag-length of the system. The selection of the optimal lag length involved the estimation of VAR(k) models with long AR lags

(10) and then prune down based on the minimum AICc statistical criterion which has demonstrated to perform well in small samples (Pujula, (2013)). MA lags were not considered. Model specification inspection relies on Jarque-Berra test for non-normality of the residuals, and Portmanteau test for serial correlation, which is not too restrictive as any remaining serial correlation is fixed by adding more k=AR lags.

The variables used in this first VAR(k) model are in log-levels in a quarterly frequency starting in quarter one, 1973. Though some countries like Russia, China, and Honduras have less data points, we strived to include most of the information available. More specifically, for every country two main models are estimated, the own currency volatility vis-à-vis the USD as in equation 3.25, and the G-3 currency volatility as in equation 3.26.

Tables 4-4 and 4-5 columns 9 and 10 show the resulting lag length and the minimum AICc associated to that chosen model. With the exception of Indian and Russian exports, most optimal lag lengths are of order five. Column labeled "TDYL Var(p)" is the lag length of the second VAR(p) model that is estimated to test for Granger non-causality of exchange rate volatility on exports, where p is the sum of *dmax + k (from VAR(k)).* Due to space limitations, we first include the granger non-causality tests results. Then present the parameter estimates of the VAR(p) models in which the null hypothesis are rejected. The interpretation of the parameter estimates from these models is not straight forward, instead they are used to give an idea of the direction of impact of volatility on exports, and hence, they are complementary to Granger non-causality tests.

Table 4-4.TYDL VAR(p) Lag Length for Own Country Volatility Models.

Exports (Models)	OI Exp	GDP	OI GDP	Bilateral Exchange Rates	OI ER	Bilateral Exchange Rate Volatility	OI VO	VAR (k)	AICc	D MAX	TYDL VAR (p)
LAGExp_BR	I(3)	LGDP	I(0)	L_BRL_USD	I(2)	STD_L_BRL_USD	I(0)	5	-23.16	3	8
LExp_BR	I(3)	LGDP	I(0)	L_BRL_USD	I(2)	STD_L_BRL_USD	I(0)	6	-23.41	3	9
LRAGExp_BR	I(3)	LRGDP	I(3)	LR_BRL_USD	I(2)	STD_LR_BRL_USD	I(0)	6	-23.81	3	9
LRExp_BR	I(3)	LRGDP	I(3)	LR_BRL_USD	I(2)	STD_LR_BRL_USD	I(0)	6	-23.90	3	9
LAGExp_CN	I(3)	LGDP	I(0)	L_CNY_USD	I(2)	STD_L_CNY_USD	I(0)	5	-28.74	3	8
LExp_CN	I(3)	LGDP	I(0)	L_CNY_USD	I(2)	STD_L_CNY_USD	I(0)	5	-29.08	3	8
LRAGExp_CN	I(3)	LRGDP	I(3)	LR_CNY_USD	I(1)	STD_LR_CNY_USD	I(0)	5	-29.66	3	8
LRExp_CN	I(3)	LRGDP	I(3)	LR_CNY_USD	I(1)	STD_LR_CNY_USD	I(0)	5	-30.08	3	8
LAGExp_HN	I(3)	LGDP	I(0)	L_HNL_USD	I(1)	STD_L_HNL_USD	I(0)	5	-32.89	3	8
LExp_HN	I(3)	LGDP	I(0)	L_HNL_USD	I(1)	STD_L_HNL_USD	I(0)	5	-33.89	3	8
LRAGExp_HN	I(3)	LRGDP	I(3)	LR_HNL_USD	I(1)	STD_LR_HNL_USD	I(0)	5	-30.17	3	8
LRExp_HN	I(1)	LRGDP	I(3)	LR_HNL_USD	I(1)	STD_LR_HNL_USD	I(0)	5	-31.24	3	8
LAGExp_IN	I(3)	LGDP	I(0)	L_INR_USD	I(2)	STD_L_INR_USD	I(0)	5	-27.67	3	8
LExp_IN	I(3)	LGDP	I(0)	L_INR_USD	I(2)	STD_L_INR_USD	I(0)	5	-28.15	3	8
LRAGExp_IN	I(3)	LRGDP	I(3)	LR_INR_USD	I(1)	STD_LR_INR_USD	I(0)	6	-29.38	3	9
LRExp_IN	I(3)	LRGDP	I(3)	LR_INR_USD	I(1)	STD_LR_INR_USD	I(0)	6	-30.02	3	9
LAGExp_RU	I(3)	LGDP	I(0)	L_RUB_USD	I(1)	STD_L_RUB_USD	I(0)	5	-24.01	3	8
LExp_RU	I(3)	LGDP	I(0)	L_RUB_USD	I(1)	STD_L_RUB_USD	I(0)	5	-25.53	3	8
LRAGExp_RU	I(2)	LRGDP	I(3)	LR_RUB_USD	I(2)	STD_LR_RUB_USD	I(0)	5	-24.10	3	8
LRExp_RU	I(2)	LRGDP	I(3)	LR_RUB_USD	I(2)	STD_LR_RUB_USD	I(0)	5	-25.42	3	8
LAGExp_SA	I(3)	LGDP	I(0)	L_ZAR_USD	I(1)	STD_L_ZAR_USD	I(0)	5	-25.04	3	8
LExp_SA	I(3)	LGDP	I(0)	L_ZAR_USD	I(1)	STD_L_ZAR_USD	I(0)	5	-25.52	3	8
LRAGExp_SA	I(3)	LRGDP	I(3)	LR_ZAR_USD	I(1)	STD_LR_ZAR_USD	I(0)	5	-27.10	3	8
LRExp_SA	I(3)	LRGDP	I(3)	LR_ZAR_USD	I(1)	STD_LR_ZAR_USD	I(0)	5	-27.79	3	8

Table 4-4. Continued.

Exports (Models)	OI Exp	GDP	OI GDP	Bilateral Exchange Rates	OI ER	Bilateral Exchange Rate Volatility	OI VO	VAR (k)	AICc	DMAX	TYDL VAR (p)
LAGExp_TR	I(3)	LGDP	I(0)	L_TRY_USD	I(2)	STD_L_TRY_USD	I(0)	5	-23.95	3	8
LExp_TR	I(3)	LGDP	I(0)	L_TRY_USD	I(2)	STD_L_TRY_USD	I(0)	5	-24.21	3	8
LRAGExp_TR	I(3)	LRGDP	I(3)	LR_TRY_USD	I(1)	STD_LR_TRY_USD	I(0)	5	-25.57	3	8
LRExp_TR	I(3)	LRGDP	I(3)	LR_TRY_USD	I(1)	STD_LR_TRY_USD	I(0)	5	-25.79	3	8

Table 4-5. TYDL VAR(p) Lag Length for G-3 Volatility Models.

Exports (Models)	OI Exp	GDP	OI GDP	Bilateral Exchange Rates	OI ER	Vol (EUR/USD)	OI VEU	Vol (JPY/USD)	OI VJU	VAR (K)	AICC	DMAX	TYDL VAR (p)
LAGExp_BR	I(3)	LGDP	I(0)	L_BRL_USD	I(2)	CV	I(3)	CV	I(1)	5	-13.56	3	8
LAGExp_BR	I(3)	LGDP	I(0)	L_BRL_USD	I(2)	STD	I(1)	STD	I(1)	5	-13.74	3	8
LExp_BR	I(3)	LGDP	I(0)	L_BRL_USD	I(2)	CV	I(3)	CV	I(1)	5	-13.79	3	8
LExp_BR	I(3)	LGDP	I(0)	L_BRL_USD	I(2)	STD	I(1)	STD	I(1)	5	-13.93	3	8
LRAGExp_BR	I(3)	LRGDP	I(3)	LR_BRL_USD	I(2)	CV_R	I(2)	CV_R	I(1)	5	-14.56	3	8
LRAGExp_BR	I(3)	LRGDP	I(3)	LR_BRL_USD	I(2)	STD_R	I(1)	STD_R	I(1)	5	-15.01	3	8
LRExp_BR	I(3)	LRGDP	I(3)	LR_BRL_USD	I(2)	CV_R	I(2)	CV_R	I(1)	5	-14.77	3	8
LRExp_BR	I(3)	LRGDP	I(3)	LR_BRL_USD	I(2)	STD_R	I(1)	STD_R	I(1)	5	-15.19	3	8
LAGExp_CN	I(3)	LGDP	I(0)	L_CNY_USD	I(2)	CV	I(3)	CV	I(1)	5	-16.06	3	8
LAGExp_CN	I(3)	LGDP	I(0)	L_CNY_USD	I(2)	STD	I(1)	STD	I(1)	5	-16.24	3	8
LExp_CN	I(3)	LGDP	I(0)	L_CNY_USD	I(2)	CV	I(3)	CV	I(1)	5	-16.48	3	8
LExp_CN	I(3)	LGDP	I(0)	L_CNY_USD	I(2)	STD	I(1)	STD	I(1)	5	-16.63	3	8

Table 4-5. Continued.

Exports (Models)	OI Exp	GDP	OI GDP	Bilateral Exchange Rates	OI ER	Vol (EUR/USD)	OI VEU	Vol (JPY/USD)	OI VJU	VAR (K)	AIC C	DMAX	TYDL VAR (p)
LRAGExp_CN	I(3)	LRGDP	I(3)	LR_CNY_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-18.72	3	8
LRAGExp_CN	I(3)	LRGDP	I(3)	LR_CNY_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-18.57	3	8
LRExp_CN	I(3)	LRGDP	I(3)	LR_CNY_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-19.33	3	8
LRExp_CN	I(3)	LRGDP	I(3)	LR_CNY_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-18.98	3	8
LAGExp_HN	I(3)	LGDP	I(0)	L_HNL_USD	I(1)	CV	I(3)	CV	I(1)	5	-16.38	3	8
LAGExp_HN	I(3)	LGDP	I(0)	L_HNL_USD	I(1)	STD	I(1)	STD	I(1)	5	-16.62	3	8
LExp_HN	I(3)	LGDP	I(0)	L_HNL_USD	I(1)	CV	I(3)	CV	I(1)	5	-17.07	3	8
LExp_HN	I(3)	LGDP	I(0)	L_HNL_USD	I(1)	STD	I(1)	STD	I(1)	5	-17.36	3	8
LRAGExp_HN	I(3)	LRGDP	I(3)	LR_HNL_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-18.14	3	8
LRAGExp_HN	I(3)	LRGDP	I(3)	LR_HNL_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-18.35	3	8
LRExp_HN	I(1)	LRGDP	I(3)	LR_HNL_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-19.13	3	8
LRExp_HN	I(1)	LRGDP	I(3)	LR_HNL_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-19.09	3	8
LAGExp_IN	I(3)	LGDP	I(0)	L_INR_USD	I(2)	CV	I(3)	CV	I(1)	5	-16.42	3	8
LAGExp_IN	I(3)	LGDP	I(0)	L_INR_USD	I(2)	STD	I(1)	STD	I(1)	5	-16.66	3	8
LExp_IN	I(3)	LGDP	I(0)	L_INR_USD	I(2)	CV	I(3)	CV	I(1)	5	-17.09	3	8
LExp_IN	I(3)	LGDP	I(0)	L_INR_USD	I(2)	STD	I(1)	STD	I(1)	5	-17.17	3	8
LRAGExp_IN	I(3)	LRGDP	I(3)	LR_INR_USD	I(1)	CV_R	I(2)	CV_R	I(1)	6	-18.28	3	9
LRAGExp_IN	I(3)	LRGDP	I(3)	LR_INR_USD	I(1)	STD_R	I(1)	STD_R	I(1)	6	-18.68	3	9
LRExp_IN	I(3)	LRGDP	I(3)	LR_INR_USD	I(1)	CV_R	I(2)	CV_R	I(1)	6	-18.87	3	9
LRExp_IN	I(3)	LRGDP	I(3)	LR_INR_USD	I(1)	STD_R	I(1)	STD_R	I(1)	6	-19.12	3	9
LAGExp_RU	I(3)	LGDP	I(0)	L_RUB_USD	I(1)	CV	I(3)	CV	I(1)	5	-13.24	3	8
LAGExp_RU	I(3)	LGDP	I(0)	L_RUB_USD	I(1)	STD	I(1)	STD	I(1)	5	-13.69	3	8
LExp_RU	I(3)	LGDP	I(0)	L_RUB_USD	I(1)	CV	I(3)	CV	I(1)	5	-15.22	3	8
LExp_RU	I(3)	LGDP	I(0)	L_RUB_USD	I(1)	STD	I(1)	STD	I(1)	4	-15.16	3	7
LRAGExp_RU	I(2)	LRGDP	I(3)	LR_RUB_USD	I(2)	CV_R	I(2)	CV_R	I(1)	5	-14.72	3	8

Table 4-5. Continued.

Exports (Models)	OI Exp	GDP	OI GDP	Bilateral Exchange Rates	OI ER	Vol (EUR/USD)	OI VEU	Vol (JPY/USD)	OI VJU	VAR (K)	AIC C	DM AX	TYDL VAR (p)
LRAGExp_RU	I(2)	LRGDP	I(3)	LR_RUB_USD	I(2)	STD_R	I(1)	STD_R	I(1)	5	-15.28	3	8
LRExp_RU	I(2)	LRGDP	I(3)	LR_RUB_USD	I(2)	CV_R	I(2)	CV_R	I(1)	5	-16.39	3	8
LRExp_RU	I(2)	LRGDP	I(3)	LR_RUB_USD	I(2)	STD_R	I(1)	STD_R	I(1)	5	-16.34	3	8
LAGExp_SA	I(3)	LGDP	I(0)	L_ZAR_USD	I(1)	CV	I(3)	CV	I(1)	5	-15.09	3	8
LAGExp_SA	I(3)	LGDP	I(0)	L_ZAR_USD	I(1)	STD	I(1)	STD	I(1)	5	-15.43	3	8
LExp_SA	I(3)	LGDP	I(0)	L_ZAR_USD	I(1)	CV	I(3)	CV	I(1)	5	-15.63	3	8
LExp_SA	I(3)	LGDP	I(0)	L_ZAR_USD	I(1)	STD	I(1)	STD	I(1)	5	-15.86	3	8
LRAGExp_SA	I(3)	LRGDP	I(3)	LR_ZAR_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-17.10	3	8
LRAGExp_SA	I(3)	LRGDP	I(3)	LR_ZAR_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-17.48	3	8
LRExp_SA	I(3)	LRGDP	I(3)	LR_ZAR_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-17.83	3	8
LRExp_SA	I(3)	LRGDP	I(3)	LR_ZAR_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-18.00	3	8
LAGExp_TR	I(3)	LGDP	I(0)	L_TRY_USD	I(2)	CV	I(3)	CV	I(1)	5	-13.61	3	8
LAGExp_TR	I(3)	LGDP	I(0)	L_TRY_USD	I(2)	STD	I(1)	STD	I(1)	5	-13.86	3	8
LExp_TR	I(3)	LGDP	I(0)	L_TRY_USD	I(2)	CV	I(3)	CV	I(1)	5	-13.97	3	8
LExp_TR	I(3)	LGDP	I(0)	L_TRY_USD	I(2)	STD	I(1)	STD	I(1)	5	-14.27	3	8
LRAGExp_TR	I(3)	LRGDP	I(3)	LR_TRY_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-16.01	3	8
LRAGExp_TR	I(3)	LRGDP	I(3)	LR_TRY_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-16.33	3	8
LRExp_TR	I(3)	LRGDP	I(3)	LR_TRY_USD	I(1)	CV_R	I(2)	CV_R	I(1)	5	-16.31	3	8
LRExp_TR	I(3)	LRGDP	I(3)	LR_TRY_USD	I(1)	STD_R	I(1)	STD_R	I(1)	5	-16.63	3	8

4.1.3 TYDL Granger Non-Causality (MWALD) Test Results

4.1.3.1 Case 1: Own Country Currency Volatility

Granger non-causality tests results are presented in Table 4-6 for own country currency case. In general, the null hypothesis that own currency exchange rate volatility does not Granger cause exports was rejected nine times out 28.

Table 4-6. Volatility in National Currency/USD does not Granger Cause Exports.

Country Model H₀: National Currency/USD ↛Exp	Num DF	Den DF	F Value	Prob F	Sig nifi- cance
Brazil, Nominal Series, Ag Exports	5	496	0.746	0.590	
Brazil, Nominal Series, Total Exports	6	496	1.400	0.213	
Brazil, Real Series, Ag Exports	6	336	2.256	0.038	**
Brazil, Real Series, Total Exports	6	356	2.966	0.008	***
China, Nominal Series, Ag Exports	5	336	2.067	0.069	*
China, Nominal Series, Total Exports	5	356	4.914	0.000	***
China, Real Series, Ag Exports	5	240	1.481	0.197	
China, Real Series, Total Exports	5	260	1.827	0.108	
Honduras, Nominal Series, Ag Exports	5	192	0.389	0.856	
Honduras, Nominal Series, Total Exports	5	208	0.544	0.743	
Honduras, Real Series, Ag Exports	5	192	0.279	0.924	
Honduras, Real Series, Total Exports	5	208	0.307	0.908	
India, Nominal Series, Ag Exports	5	496	0.225	0.952	
India, Nominal Series, Total Exports	5	516	1.175	0.320	
India, Real Series, Ag Exports	6	476	1.320	0.247	
India, Real Series, Total Exports	6	496	3.328	0.003	***
Russia, Nominal Series, Ag Exports	5	160	0.989	0.426	
Russia, Nominal Series, Total Exports	5	180	0.196	0.964	
Russia, Real Series, Ag Exports	5	160	2.559	0.029	**
Russia, Real Series, Total Exports	5	180	0.464	0.803	
South Africa, Nominal Series, Ag Exports	5	496	0.768	0.573	
South Africa, Nominal Series, Total Exports	5	516	0.880	0.494	
South Africa, Real Series, Ag Exports	5	496	1.918	0.090	*
South Africa, Real Series, Total Exports	5	516	2.370	0.038	**
Turkey, Nominal Series, Ag Exports	5	496	3.429	0.005	***
Turkey, Nominal Series, Total Exports	5	516	1.270	0.276	
Turkey, Real Series, Ag Exports	5	496	0.838	0.523	
Turkey, Real Series, Total Exports	5	516	0.902	0.479	

*Significance level (α=0.1), ** is α=0.5, and *** is α=0.01.

More specifically, the test lead us to conclude that real exchange rate volatility between BRL *vis-à-vis* USD does cause Brazilian agricultural and total exports. Likewise, we reject the null hypothesis for Chinese nominal agricultural and total exports, Indian real total exports, Russian real agricultural exports, South Africa real agricultural and total exports, and Turkish nominal agricultural exports.

The estimated VAR(p) models are presented in Table 4-7. To preserve space, we present only models in which the null hypothesis of granger non-causality is rejected. Because each VAR (p) model has at least four different variables, times eight lags, times four equations resulting in 128 parameters, only the exports equations along with volatility parameter estimates are shown. [19] The first column "model" shows the export equation from VAR(p) models. The second column "estimates" shows the statistical information: estimate (Est), standard error (SE), Probt (Pt), and the significance (Sig) level at which the coefficients are statistically significant. The next six columns are the lagged unconditional volatilities (M-STD) of national currency per USD (NATUSD$_{t-i}$). [20] The last column "Sum Est" is an aggregated sum of only those statistically significant parameter estimates. The sign of this aggregation may give a notion of the direction in which currency volatility causes exports. The results show that real exchange rate volatility of BRL *vis-à-vis* USD negatively impacts Brazilian real agricultural exports, and total exports.

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[19] Remember that in the VAR(p) model, as shown in the methodology (equation 3.28), first equation is exports, followed by GDP, Bilateral Exchange Rate, and Volatility.

[20] Notice that although the models are estimated with p=(*dmax*+k) lags, *dmax* lags are not reported. *Dmax* lags are not even used for the causality tests, they only serve to fix the asymptotic properties.

Table 4-7. Parameter Estimates National Currency (Own) per USD Volatility.

Models	Estimates	Volatility						Sum Est
		NAT USD$_{t-1}$	NAT USD$_{t-2}$	NAT USD$_{t-3}$	NAT USD$_{t-4}$	NAT USD$_{t-5}$	NAT USD$_{t-6}$	
BR_R_AG	Est	0.543	-0.191	-1.492	2.126	-2.580	0.587	**-1.946**
BR_R_AG	SE	0.539	0.770	0.778	0.789	0.804	0.743	
BR_R_AG	Pt	0.317	0.805	0.059	0.009	0.002	0.431	
BR_R_AG	Sig			*	***	***		
BR_R_TE	Est	0.294	0.210	-1.912	2.707	-3.138	1.038	**-2.344**
BR_R_TE	SE	0.513	0.736	0.745	0.766	0.791	0.732	
BR_R_TE	Pt	0.568	0.776	0.012	0.001	0.000	0.160	
BR_R_TE	Sig			**	***	***		
CN_N_AG	Est	1.865	-0.057	-5.496	5.351	-2.111		**-0.145**
CN_N_AG	SE	1.285	2.376	2.571	2.330	1.386		
CN_N_AG	Pt	0.151	0.981	0.035	0.024	0.131		
CN_N_AG	Sig			**	**			
CN_N_TE	Est	1.768	-0.719	-5.792	5.057	-1.505		**1.033**
CN_N_TE	SE	1.063	1.978	2.172	2.002	1.223		
CN_N_TE	Pt	0.100	0.717	0.009	0.013	0.222		
CN_N_TE	Sig	*		***	**			
IN_R_TE	Est	1.062	-1.494	2.448	-2.361	1.947	0.082	**1.602**
IN_R_TE	SE	0.482	0.699	0.741	0.747	0.766	0.792	
IN_R_TE	Pt	0.030	0.035	0.001	0.002	0.012	0.918	
IN_R_TE	Sig	**	**	***	***	**		
RU_R_AG	Est	-2.422	3.665	-3.037	0.761	1.632		**-0.162**
RU_R_AG	SE	0.684	1.082	1.145	0.911	0.760		
RU_R_AG	Pt	0.001	0.002	0.011	0.408	0.038		
RU_R_AG	Sig	***	***	**		**		
SA_R_AG	Est	0.289	-0.634	-0.428	1.562	-2.041		**-0.480**
SA_R_AG	SE	0.411	0.603	0.655	0.657	0.664		
SA_R_AG	Pt	0.483	0.296	0.515	0.019	0.003		
SA_R_AG	Sig				**	***		
SA_R_TE	Est	0.241	-0.292	-0.087	1.103	-2.166		**-1.063**
SA_R_TE	SE	0.356	0.512	0.562	0.574	0.584		
SA_R_TE	Pt	0.500	0.569	0.878	0.057	0.000		
SA_R_TE	Sig				*	***		
TR_N_AG	Est	0.983	0.458	0.807	-1.097	2.420		**2.420**
TR_N_AG	SE	0.768	1.067	1.075	1.032	0.817		
TR_N_AG	Pt	0.203	0.669	0.454	0.290	0.004		
TR_N_AG	Sig					***		

*Significance level (α=0.1), ** is α=0.5, and *** is α=0.01.

Nominal exchange rate volatility of CNY *vis-à-vis* USD positively impacts

Chinese nominal agricultural exports, but negatively impacts Chinese nominal total

exports; real exchange rate volatility of INR *vis-à-vis* USD positively impacts Indian real total exports; real exchange rate volatility of RUB *vis-à-vis* USD negatively impacts Russian agricultural export; real exchange rate volatility of ZAR *vis-à-vis* USD negatively affects South African real agricultural, and total exports; and nominal exchange rate volatility of TRY *vis-à-vis* USD positively affects Turkish agricultural exports.

As a complementary analysis to the aggregated sum of lag coefficients above, we present **impulse → response** Functions (IRFs) as they may give a perception of the economic significance of the variables in the VAR system. IRF show the reaction of the estimated dynamic VAR systems in response to an impulse of exchange rate volatility variables. These reactions are depicted as orthogonalized responses of exports, GDP, and exchange rates to a forecast error impulse in exchange-rate-volatility (STD) with two standard errors in Figures 4.1 to 4.6. In Figure 4-1, for example, notice that the response of export growth to an impulse in BRL/USD exchange rate is positive at first lag and then negative (holding everything else constant). While the impact of one unit change in exchange rate BRL/USD volatility in exports at the first lag seems to be positive or not different from zero, it appears to have an overall negative effect after the third lag. This result agrees with the results of the aggregated sum of coefficients from Brazilian models and it also follow the same pattern (see Table 4-7). The same IRF was obtained for the case of Brazilian total exports and so it is not reported.
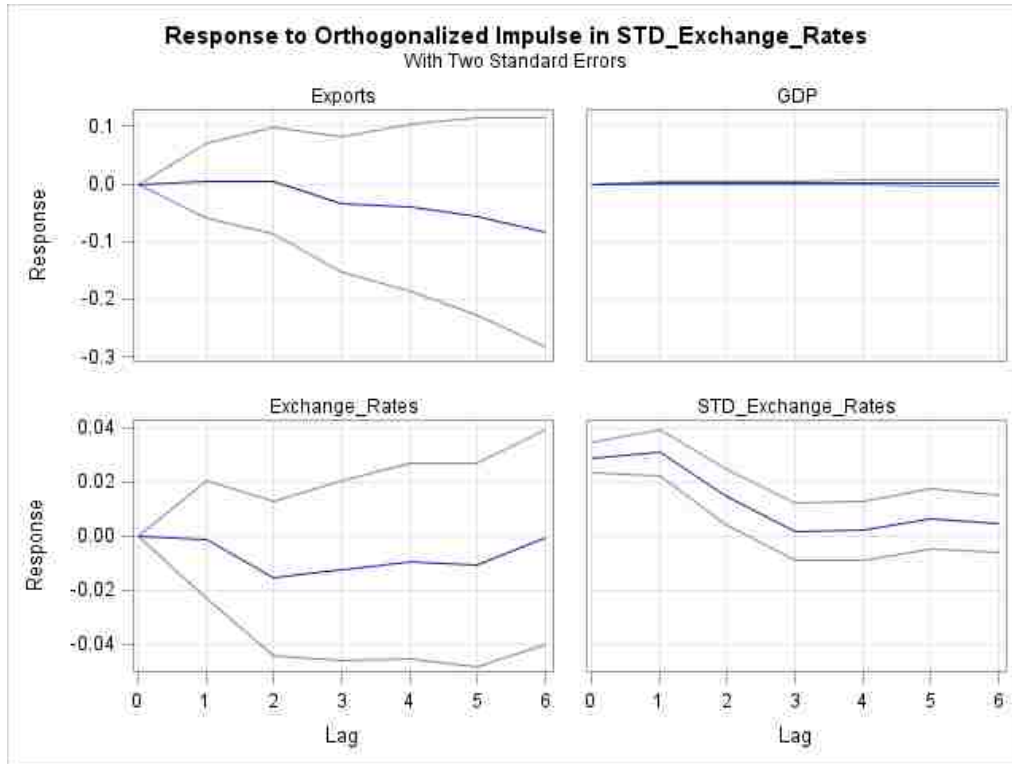
Figure 4-1. IRF: BRL/USD Volatility → Brazil, Real Series, Ag Exports.

In Figure 4-2, the response of Chinese nominal agricultural exports to one unit change in exchange rate CNY/USD volatility is slightly positive or not significant at the first two lags. This impact attenuates and goes negative after the third lag. While not presented here to preserve space, the IRF for the second Chinese model of total exports has a very similar reaction with the only difference that the positive effects offset the negative ones leading to an overall positive impact which magnitude is stronger than in the case of agricultural exports. The model for India is the only one that presents five consecutive significant lags and they alternate from positive to negative, the IRF in Figure 4-3 shows the same pattern. Yet the response of exports to a one unit change in exchange rate (INR/USD) volatility seems to oscillate between positive and negative, an overall positive impact is detected at lag six.
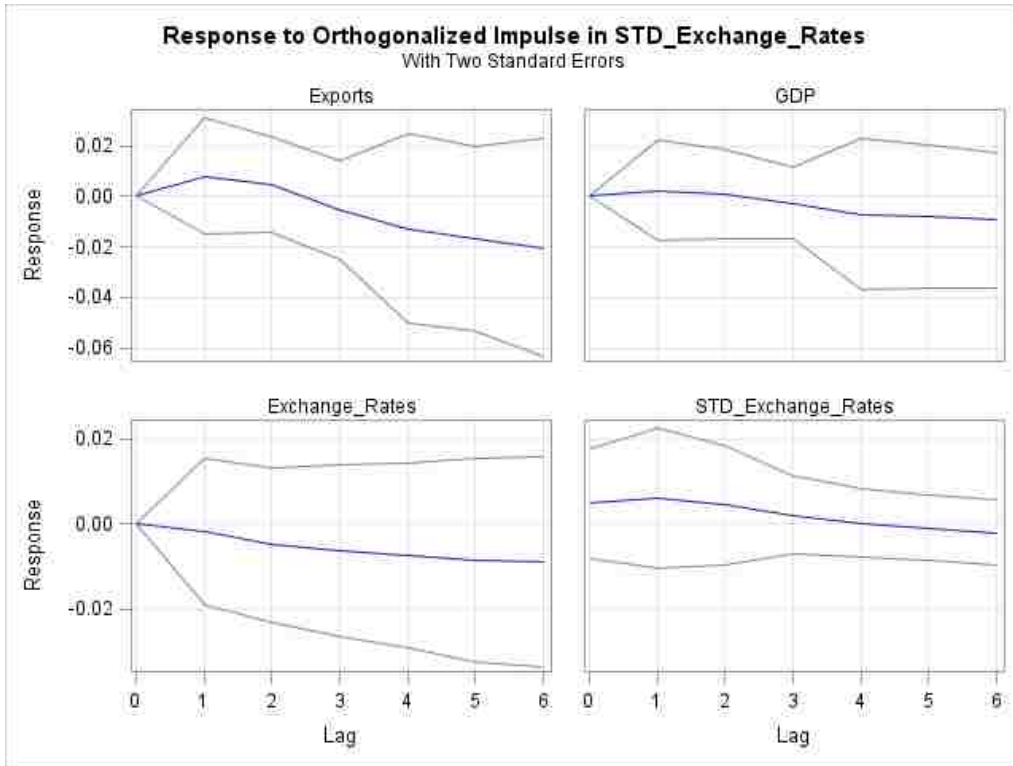
Figure 4-2. IRF: CNY/USD Volatility → China, Nominal Series, Ag Exports.
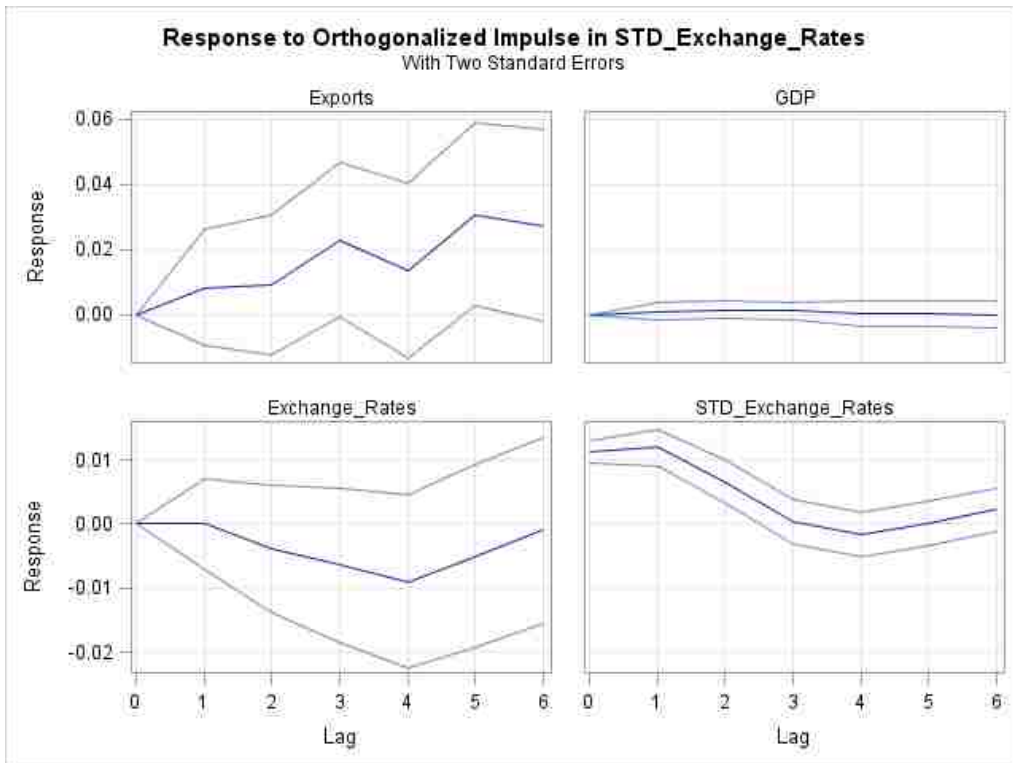
Figure 4-3. IRF: INR/USD Volatility → India, Real Series, Total Exports.

In Figure 4-4, it is evident that Russian real agricultural exports responded

negatively, at early periods, to forecast error impulse in exchange rate (RUB/USD)

volatility, and positively at later times. Notice that in Figure 4-4 there is slightly more

area under the zero line than above it, so the overall effect is negative, same

conclusion was reached in the analysis of Table 4-7 for Russian exports.
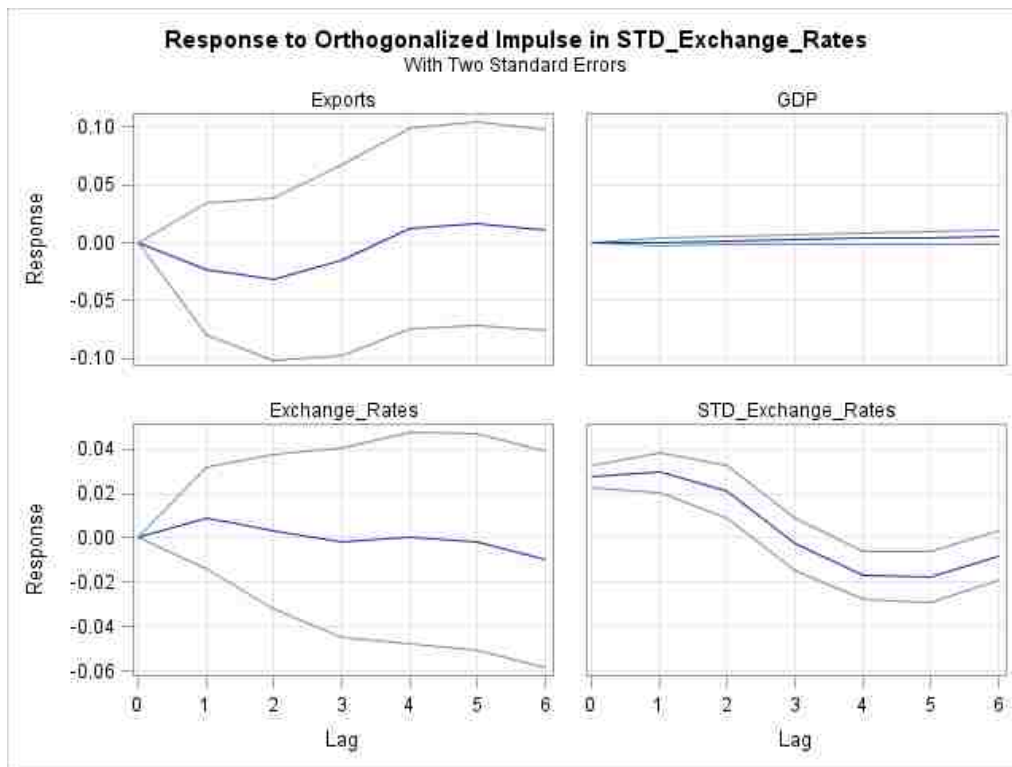
Figure 4-4. IRF: RUB/USD Volatility → Russia, Real Series, Ag Exports.

In Figure 4-5 the response of South African agricultural exports to one change

in exchange rate (ZAR/USD) volatility is all the way negative. Same happens in the

case of total exports. Conversely, in Figure 4-6, the response of Turkish nominal

agricultural exports to impulses in exchange rate (TRY/USD) is positive all the way.

The responses of GDP to impulse shocks in exchange rates are practically zero in the

majority of cases, except in the case of China.
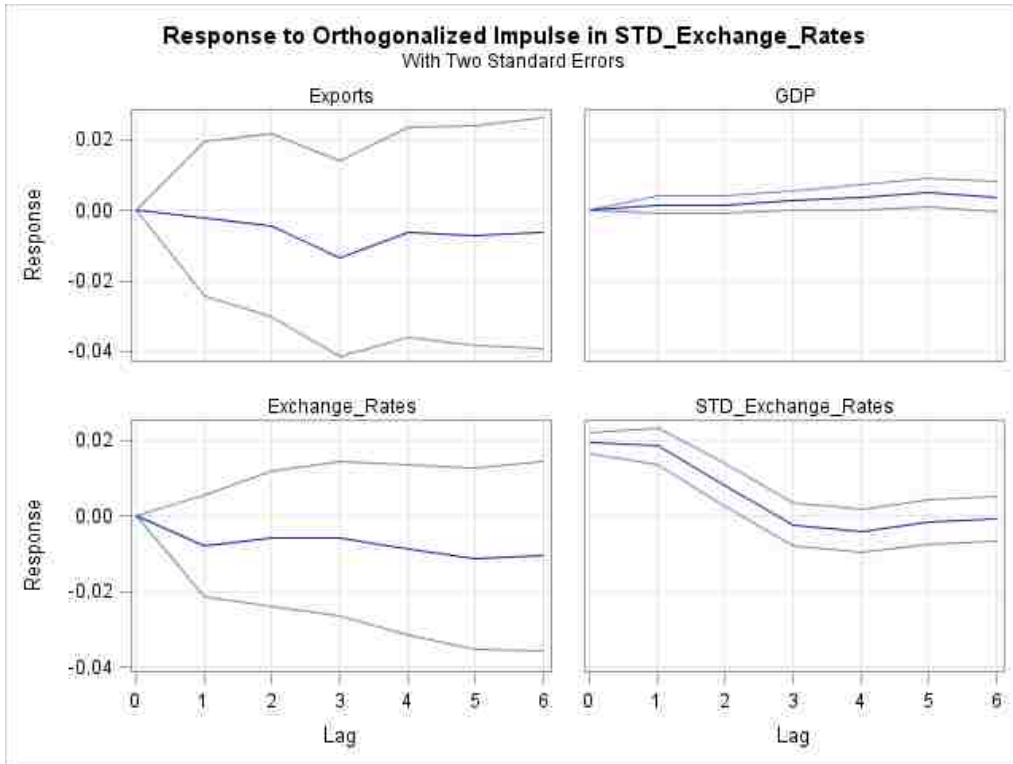
Figure 4-5. IRF: ZAR/USD Volatility → South Africa, Real Series, Ag Exports.
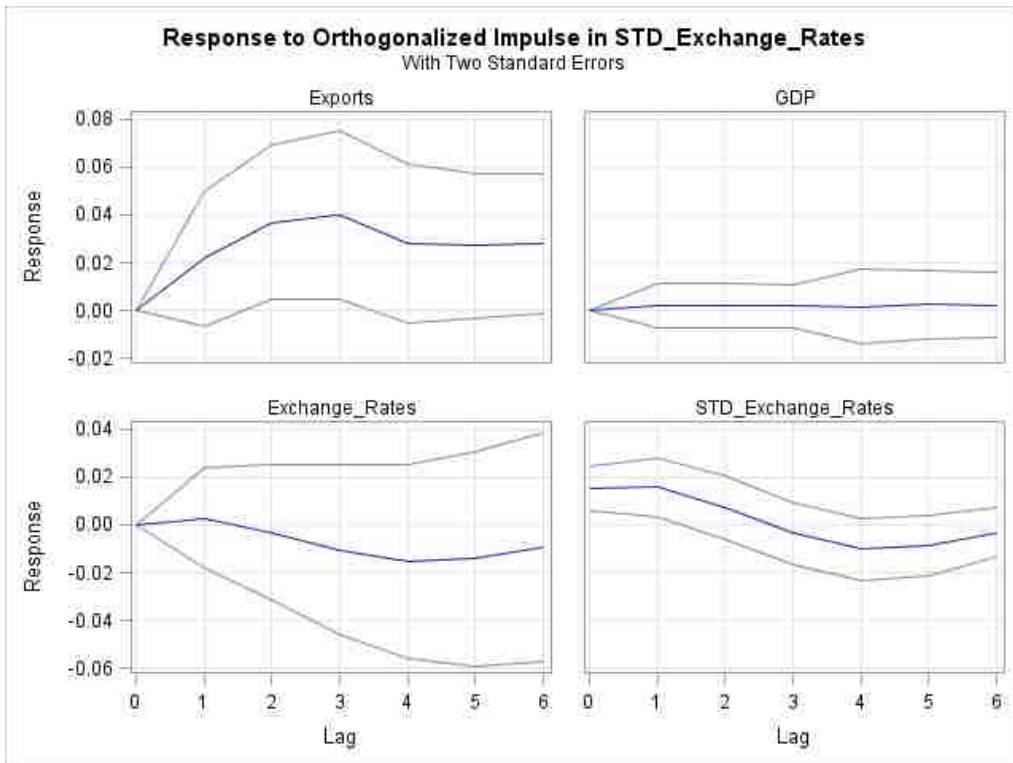
Figure 4-6. IRF: TRY/USD Volatility → Turkey, Nominal Series, Ag Exports.

4.1.3.2   Case 2: Third Country Currency Volatility

In the third country case, the CV was included as an alternative unconditional volatility measure. That is why there are 58 models in Tables 4-8 and 4-9 in lieu of 28 in 4-6. There are three null hypotheses ($H_{0,i}$) per model tested: the first, $H_{0,1}$, unconditional volatility of EUR/USD does not granger cause ($\nrightarrow$) exports; second, $H_{0,2}$, JPY/USD volatility $\nrightarrow$ exports, and third, $H_{0,3}$, a joint test of EUR/USD and JPY/USD volatility $\nrightarrow$ exports. In Table 4-8, the first column represents countries, the second to third columns show the type of hypothesis. For example, from the eight estimated models for Brazil, the non-causality $H_{0,1}$ is rejected four times, and $H_{0,2}$ and $H_{0,3}$ two times each. In the case of China, the $H_{0,1}$ was rejected thrice, $H_{0,2}$ twice, and $H_{0,3}$ never. Models for Honduran exports rejected both $H_{0,1}$ and $H_{0,2}$ four times, and none $H_{0,3}$. For Indian exports, both $H_{0,1}$ and $H_{0,2}$ were rejected once, and $H_{0,3}$ never. In the case of Russia, the test rejected $H_{0,1}$ thrice, $H_{0,2}$ once, and $H_{0,3}$ thrice.

Table 4-8. Summary Granger non Causality Test for G3 Exchange Rates Volatility.

Country	Number of times H_0 is rejected			Models	Sign
	EURUSD $\nrightarrow$ Exp	JPYUSD $\nrightarrow$ Exp	EURUSD & JPYUSD $\nrightarrow$ Exp		
Brazil	4	2	2	8	*
China	3	2	2	8	*
Honduras	4	4		8	*
India	1	1		8	*
Russia	3	1	3	8	*

*Significance level ($\alpha=0.1$), ** is $\alpha=0.5$, and *** is $\alpha=0.01$.

Table 4-9 includes each test carried along with its p value from an F statistic (Table 4-8 is a summary of Table 4-9). The first column specifies the model, the second the volatility tests, and the third the significance level. These columns are repeated in the other half of the Table 4-9 to save space. H_0 was rejected 31 times.

Table 4-9. Granger Non-Causality Tests, Case: G3 Exchange Rate Volatility Models.

Models	Volatility	PF	Sig	Model (Cont.)	Volatility	PF	Sig
BR N AG CV	EUR_USD	.638		IN R AG CV	EUR_USD	.798	
BR N AG CV	JPY_USD	.001	***	IN R AG CV	JPY_USD	.568	
BR N AG CV	Joint Test	.007	***	IN R AG CV	Joint Test	.693	
BR N AG STD	Joint Test	.609		IN R AG STD	Joint Test	.243	
BR N AG STD	EUR_USD	.530		IN R AG STD	EUR_USD	.630	
BR N AG STD	JPY_USD	.434		IN R AG STD	JPY_USD	.244	
BR N TE CV	EUR_USD	.568		IN R TE CV	EUR_USD	.928	
BR N TE CV	JPY_USD	.022	**	IN R TE CV	JPY_USD	.442	
BR N TE CV	Joint Test	.088	*	IN R TE CV	Joint Test	.767	
BR N TE STD	Joint Test	.571		IN R TE STD	Joint Test	.494	
BR N TE STD	EUR_USD	.199		IN R TE STD	EUR_USD	.334	
BR N TE STD	JPY_USD	.712		IN R TE STD	JPY_USD	.556	
BR R AG CV	EUR_USD	.332		RU N AG CV	EUR_USD	.006	***
BR R AG CV	JPY_USD	.242		RU N AG CV	JPY_USD	.053	*
BR R AG CV	Joint Test	.328		RU N AG CV	Joint Test	.005	***
BR R AG STD	Joint Test	.031	**	RU N AG STD	Joint Test	.430	
BR R AG STD	EUR_USD	.002	***	RU N AG STD	EUR_USD	.983	
BR R AG STD	JPY_USD	.592		RU N AG STD	JPY_USD	.229	
BR R TE CV	EUR_USD	.474		RU N TE CV	EUR_USD	.131	
BR R TE CV	JPY_USD	.280		RU N TE CV	JPY_USD	.798	
BR R TE CV	Joint Test	.449		RU N TE CV	Joint Test	.412	
BR R TE STD	Joint Test	.012	**	RU N TE STD	Joint Test	.649	
BR R TE STD	EUR_USD	.001	***	RU N TE STD	EUR_USD	.599	
BR R TE STD	JPY_USD	.378		RU N TE STD	JPY_USD	.652	
CN N AG CV	EUR_USD	.826		RU R AG CV	EUR_USD	.016	**
CN N AG CV	JPY_USD	.854		RU R AG CV	JPY_USD	.163	
CN N AG CV	Joint Test	.932		RU R AG CV	Joint Test	.018	**
CN N AG STD	Joint Test	.221		RU R AG STD	Joint Test	.704	
CN N AG STD	EUR_USD	.128		RU R AG STD	EUR_USD	.765	
CN N AG STD	JPY_USD	.758		RU R AG STD	JPY_USD	.779	
CN N TE CV	EUR_USD	.564		RU R TE CV	EUR_USD	.012	**
CN N TE CV	JPY_USD	.153		RU R TE CV	JPY_USD	.497	
CN N TE CV	Joint Test	.334		RU R TE CV	Joint Test	.037	**
CN N TE STD	Joint Test	.156		RU R TE STD	Joint Test	.835	
CN N TE STD	EUR_USD	.129		RU R TE STD	EUR_USD	.396	
CN N TE STD	JPY_USD	.718		RU R TE STD	JPY_USD	.889	
CN R AG CV	EUR_USD	.114		SA N AG CV	EUR_USD	.139	
CN R AG CV	JPY_USD	.051	*	SA N AG CV	JPY_USD	.454	
CN R AG CV	Joint Test	.043	**	SA N AG CV	Joint Test	.254	
CN R AG STD	Joint Test	.088	*	SA N AG STD	Joint Test	.984	
CN R AG STD	EUR_USD	.033	**	SA N AG STD	EUR_USD	.808	
CN R AG STD	JPY_USD	.156		SA N AG STD	JPY_USD	.931	
CN R TE CV	EUR_USD	.656		SA N TE CV	EUR_USD	.144	

*Significance level (α=0.1), ** is α=0.5, and *** is α=0.01.

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Table 4-9. Continued.

Models	Volatility	PF	Sig	Model (Cont.)	Volatility	PF	Sig
CN R TE CV	JPY_USD	.011	**	SA N TE CV	JPY_USD	.639	
CN R TE CV	Joint Test	.033	**	SA N TE CV	Joint Test	.412	
CN R TE STD	Joint Test	.141		SA N TE STD	Joint Test	.711	
CN R TE STD	EUR_USD	.032	**	SA N TE STD	EUR_USD	.392	
CN R TE STD	JPY_USD	.519		SA N TE STD	JPY_USD	.721	
HN N AG CV	EUR_USD	.490		SA R AG CV	EUR_USD	.160	
HN N AG CV	JPY_USD	.005	***	SA R AG CV	JPY_USD	.334	
HN N AG CV	Joint Test	.012	**	SA R AG CV	Joint Test	.134	
HN N AG STD	Joint Test	.004	***	SA R AG STD	Joint Test	.954	
HN N AG STD	EUR_USD	.425		SA R AG STD	EUR_USD	.733	
HN N AG STD	JPY_USD	.001	***	SA R AG STD	JPY_USD	.901	
HN N TE CV	EUR_USD	.763		SA R TE CV	EUR_USD	.101	
HN N TE CV	JPY_USD	.242		SA R TE CV	JPY_USD	.184	
HN N TE CV	Joint Test	.320		SA R TE CV	Joint Test	.212	
HN N TE STD	Joint Test	.260		SA R TE STD	Joint Test	.849	
HN N TE STD	EUR_USD	.153		SA R TE STD	EUR_USD	.696	
HN N TE STD	JPY_USD	.500		SA R TE STD	JPY_USD	.752	
HN R AG CV	EUR_USD	.105		TR N AG CV	EUR_USD	.205	
HN R AG CV	JPY_USD	.070	*	TR N AG CV	JPY_USD	.674	
HN R AG CV	Joint Test	.012	**	TR N AG CV	Joint Test	.439	
HN R AG STD	Joint Test	.007	***	TR N AG STD	Joint Test	.483	
HN R AG STD	EUR_USD	.182		TR N AG STD	EUR_USD	.343	
HN R AG STD	JPY_USD	.017	**	TR N AG STD	JPY_USD	.545	
HN R TE CV	EUR_USD	.825		TR N TE CV	EUR_USD	.653	
HN R TE CV	JPY_USD	.931		TR N TE CV	JPY_USD	.735	
HN R TE CV	Joint Test	.898		TR N TE CV	Joint Test	.853	
HN R TE STD	Joint Test	.782		TR N TE STD	Joint Test	.240	
HN R TE STD	EUR_USD	.716		TR N TE STD	EUR_USD	.143	
HN R TE STD	JPY_USD	.876		TR N TE STD	JPY_USD	.355	
IN N AG CV	EUR_USD	.888		TR R AG CV	EUR_USD	.130	
IN N AG CV	JPY_USD	.146		TR R AG CV	JPY_USD	.536	
IN N AG CV	Joint Test	.413		TR R AG CV	Joint Test	.329	
IN N AG STD	Joint Test	.236		TR R AG STD	Joint Test	.564	
IN N AG STD	EUR_USD	.302		TR R AG STD	EUR_USD	.680	
IN N AG STD	JPY_USD	.235		TR R AG STD	JPY_USD	.375	
IN N TE CV	EUR_USD	.237		TR R TE CV	EUR_USD	.247	
IN N TE CV	JPY_USD	.049	**	TR R TE CV	JPY_USD	.421	
IN N TE CV	Joint Test	.067	*	TR R TE CV	Joint Test	.456	
IN N TE STD	Joint Test	.328		TR R TE STD	Joint Test	.408	
IN N TE STD	EUR_USD	.152		TR R TE STD	EUR_USD	.545	
IN N TE STD	JPY_USD	.466		TR R TE STD	JPY_USD	.203	

*Significance level (α=0.1), ** is α=0.5, and *** is α=0.01.

Parameter estimates are presented in Table 4-10 only for models in which the H_0 is rejected (see Table 4-9). Table 4-10 can be read in the same manner as Table 4-7, with the exception of an additional volatility measure, CV. Attention is particularly paid to "SumEst" signs, for instance, EUR/USD and JPY/USD volatilities as measured by the CV, negatively affect Brazilian real and nominal agricultural and total exports. The EUR/USD volatility, as measured by CV, has a positive impact on Chinese nominal total exports, but a negative one in all other country exports. EUR /USD volatility (STD) positively impacts Honduran real agricultural exports, but negatively all country exports. The JPY/USD volatility (CV) impacts positively Brazilian nominal total exports, Chinese real agricultural, and total exports, Honduran real agricultural exports, and Russian real total exports, whereas all others are negatively impacted. Lastly, JPY/USD volatility (STD) presents a negative impact on Brazil real agricultural exports, Honduran real agricultural exports, and all others positively. Although, parameter estimates are difficult to interpret, own currency volatility magnitudes tend to be greater than their third country counterparts.

Selected cases of IRFs for the third country currency volatility are also presented in Figures 4-7 to 4-13. The effects for Brazilian exports are for one time shock on exchange rates volatilities (JPY/USD) and (EUR/USD) are negative, and traced in Figures 4-7 and 4-8. In the case of China, exports presents both positive and negative responses to impulses in exchange rates from both EUR/USD and JPY/USD (Figure 4-9 and 4-10). Similar oscillating pattern in observed for responses of Honduran exports to one shock change in exchange rate JPY/USD (Figure 4-11).

Table 4-10. Parameter Estimates G3 (Third) Exchange Rates Volatility.

Models	Estimate	EUR USD t-1	EUR USD t-2	EUR USD t-3	EUR USD t-4	EUR USD t-5	JPY USD t-1	JPY USD t-2	JPY USD t-3	JPY USD t-4	JPY USD t-5	Sum Est EurUsd	Sum Est JpyUsd
BR N AG CV	Est	-.002	.003	-.008	.012	-.018	-.013	.008	-.016	.000	.022	**-.018**	**-.008**
BR N AG CV	SE	.006	.008	.009	.009	.009	.005	.007	.008	.008	.008		
BR N AG CV	Pt	.733	.712	.384	.190	.044	.010	.262	.044	.995	.008		
BR N AG CV	Sig					**	**		**		***		
BR N TE CV	Est	-.002	.007	-.014	.017	-.017	-.008	.002	-.007	-.003	.016	**-.014**	**.008**
BR N TE CV	SE	.005	.007	.008	.008	.008	.005	.007	.007	.007	.007		
BR N TE CV	Pt	.669	.334	.087	.044	.043	.070	.736	.311	.646	.026		
BR N TE CV	Sig			*	**	**	*				**		
BR R AG STD	Est	-.048	.019	.002	-.038	.008	.017	-.025	.011	.013	-.016	**-.048**	**-.009**
BR R AG STD	SE	.012	.016	.016	.016	.016	.010	.013	.015	.015	.015		
BR R AG STD	Pt	.000	.235	.885	.020	.630	.097	.058	.449	.383	.277		
BR R AG STD	Sig	***			**		*	*					
BR R TE STD	Est	-.045	.020	-.001	-.037	.006	.020	-.028	.011	.016	-.008	**-.082**	**-.007**
BR R TE STD	SE	.011	.014	.015	.015	.015	.009	.012	.014	.014	.014		
BR R TE STD	Pt	.000	.169	.935	.014	.693	.032	.029	.441	.258	.578		
BR R TE STD	Sig	***			**		**	**					
CN R AG CV	Est	.000	-.012	.017	-.003	-.009	-.003	.010	-.004	.019	-.005	**-.005**	**.029**
CN R AG CV	SE	.005	.006	.006	.006	.005	.004	.005	.005	.006	.006		
CN R AG CV	Pt	.986	.059	.007	.593	.092	.451	.039	.390	.002	.417		
CN R AG CV	Sig		*	***		*		**		***			
CN R AG STD	Est	-.003	-.007	.017	.005	.002	.005	.009	-.007	.001	-.003	**.017**	**.009**
CN R AG STD	SE	.005	.007	.007	.007	.008	.004	.005	.006	.005	.005		
CN R AG STD	Pt	.518	.315	.020	.538	.834	.286	.090	.233	.820	.563		
CN R AG STD	Sig			**				*					

Table 4-10. Continued.

Models	Estimate	EUR USD t-1	EUR USD t-2	EUR USD t-3	EUR USD t-4	EUR USD t-5	JPY USD t-1	JPY USD t-2	JPY USD t-3	JPY USD t-4	JPY USD t-5	Sum Est EurUsd	Sum Est JpyUsd
CN R AG STD	Sig			**				*					
CN R TE CV	Est	.000	-.003	.005	.002	-.008	-.006	.011	-.010	.018	-.006	**-.008**	**.012**
CN R TE CV	SE	.004	.005	.005	.005	.004	.003	.004	.004	.005	.005		
CN R TE CV	Pt	.940	.575	.333	.616	.061	.048	.005	.018	.000	.206		
CN R TE CV	Sig					*	**	***	**	***			
CN R TE STD	Est	-.001	-.007	.016	-.001	-.006	-.004	.009	-.006	-.001	.005	**.016**	**.009**
CN R TE STD	SE	.004	.005	.005	.005	.005	.003	.004	.004	.004	.004		
CN R TE STD	Pt	.777	.131	.001	.898	.278	.229	.019	.170	.807	.255		
CN R TE STD	Sig			***				**					
HN N AG CV	Est	-.020	.017	.011	.006	.008	.027	-.050	.017	.002	.023	**-.032**	**-.023**
HN N AG CV	SE	.013	.014	.014	.014	.014	.010	.012	.014	.014	.014		
HN N AG CV	Pt	.118	.240	.432	.667	.581	.010	.000	.218	.871	.107		
HN N AG CV	Sig						***	***					
HN N AG STD	Est	-.013	.022	.025	-.017	.002	-.032	.030	-.018	-.006	.056	**.000**	**.053**
HN N AG STD	SE	.012	.015	.016	.015	.017	.012	.016	.015	.014	.014		
HN N AG STD	Pt	.291	.139	.122	.277	.928	.011	.066	.242	.670	.000		
HN N AG STD	Sig						**	*			***		
HN R AG CV	Est	-.028	.023	.002	.022	.022	.020	-.039	.016	-.013	.033	**-.028**	**.015**
HN R AG CV	SE	.014	.016	.016	.015	.016	.011	.013	.014	.014	.014		
HN R AG CV	Pt	.048	.154	.922	.159	.172	.065	.004	.283	.361	.025		
HN R AG CV	Sig	**					*	***			**		
HN R AG STD	Est	.005	.010	.039	-.011	.020	-.034	.024	-.023	-.007	.049	**.039**	**.014**
HN R AG STD	SE	.014	.017	.017	.018	.018	.011	.014	.014	.014	.014		
HN R AG STD	Pt	.745	.547	.030	.537	.276	.003	.106	.120	.600	.002		

Table 4-10. Continued.

Models	Estimate	EUR USD t-1	EUR USD t-2	EUR USD t-3	EUR USD t-4	EUR USD t-5	JPY USD t-1	JPY USD t-2	JPY USD t-3	JPY USD t-4	JPY USD t-5	Sum Est EurUsd	Sum Est JpyUsd
HN R AG STD	Sig			**			***				***		
IN N TE CV	Est	-.001	.002	.007	.001	-.003	-.010	.011	-.016	.013	-.010	**.000**	**-.012**
IN N TE CV	SE	.004	.006	.007	.007	.006	.004	.005	.006	.006	.006		
IN N TE CV	Pt	.796	.690	.291	.910	.655	.006	.034	.005	.021	.098		
IN N TE CV	Sig						***	**	***	**	*		
RU N AG CV	Est	.011	.018	-.017	-.060	.013	-.030	-.002	-.012	-.029	.006	**-.060**	**-.059**
RU N AG CV	SE	.013	.016	.016	.015	.015	.010	.013	.014	.013	.013		
RU N AG CV	Pt	.390	.258	.291	.000	.366	.005	.896	.431	.039	.660		
RU N AG CV	Sig				***		***			**			
RU R AG CV	Est	-.009	.019	-.024	-.048	-.006	-.031	.002	.001	-.002	.020	**-.048**	**-.031**
RU R AG CV	SE	.014	.016	.016	.016	.018	.010	.012	.013	.013	.012		
RU R AG CV	Pt	.507	.252	.139	.006	.766	.004	.892	.946	.876	.120		
RU R AG CV	Sig				***		***						
RU R TE CV	Est	.014	.024	-.022	.018	-.039	-.009	.008	.005	-.001	.014	**-.038**	**.014**
RU R TE CV	SE	.010	.012	.012	.013	.012	.006	.007	.007	.008	.008		
RU R TE CV	Pt	.163	.056	.068	.173	.002	.173	.267	.498	.906	.100		
RU R TE CV	Sig		*	*		***					*		

Figure 4-12 depicts the responses of Indian Agricultural exports to JPY/USD volatility (CV) exchange rate impulse. At all lag orders responses are below zero, and hence, their overall impact is negative. Same pattern is shown in Figure 4-13 for the response of Russian total exports to JPY/USD volatility (CV) exchange rate impulses.

Comparing the parameter estimates from Table 4-10 to their model counterparts from IRF, it can be seen that similar patterns are found. That is, the positive and negative signs (or non-significant coefficients) associated to the parameter estimates for the different lags for each model and country, coincide with the direction, above or below zero (or zero) of the IRFs from Figures 4-7 to 4-13. For example, for Brazil, the first model in Table 4-10, all significant parameters estimates are negative. Likewise the IRF in Figure 4-7 present negative responses for all lags.
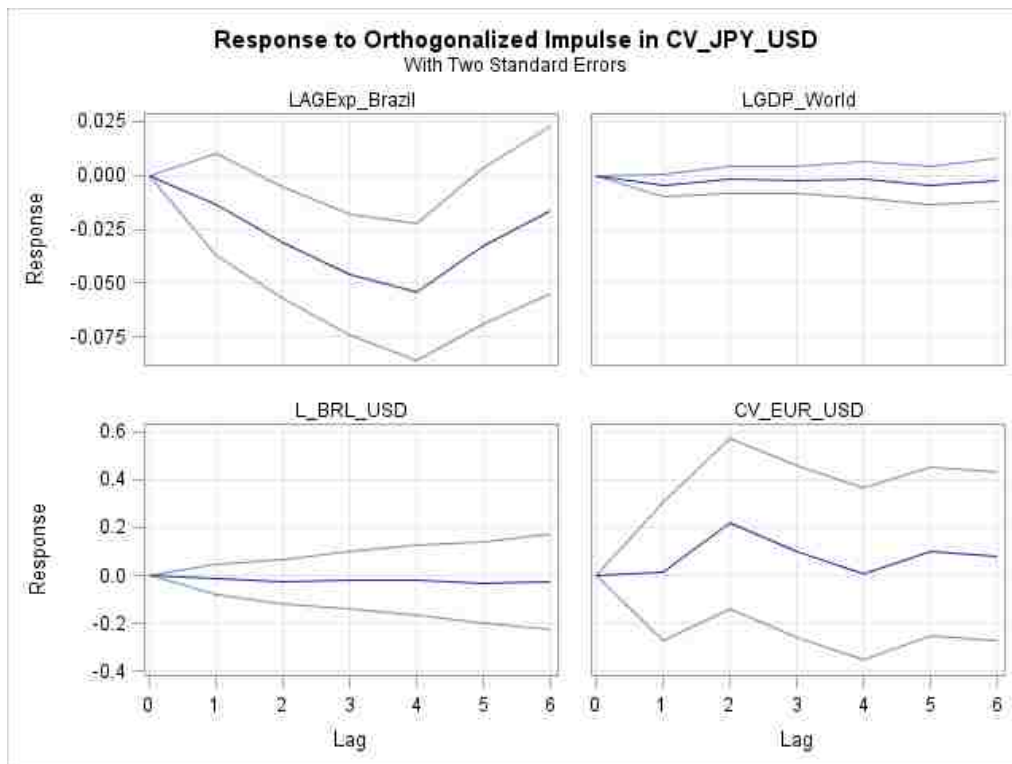
Figure 4-7. IRF: JPY/USD Volatility → Brazil, Nominal Series, Ag Exports, CV.
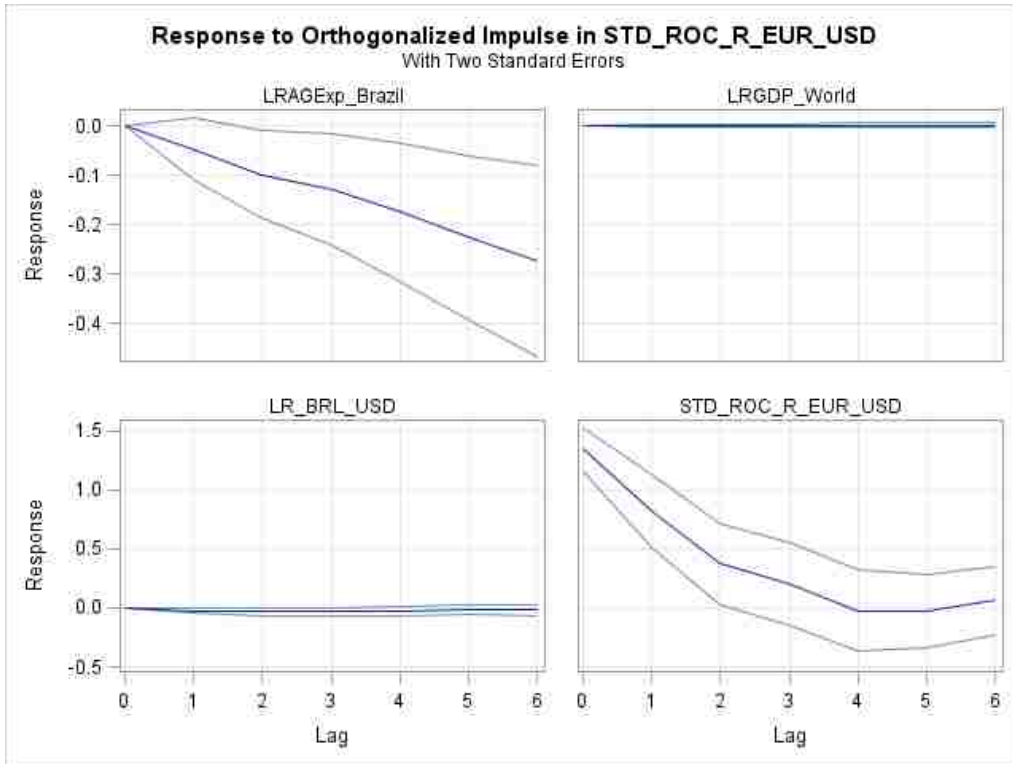
Figure 4-8. IRF: EUR/USD Volatility → Brazil, Real Series, Ag Exports, STD.
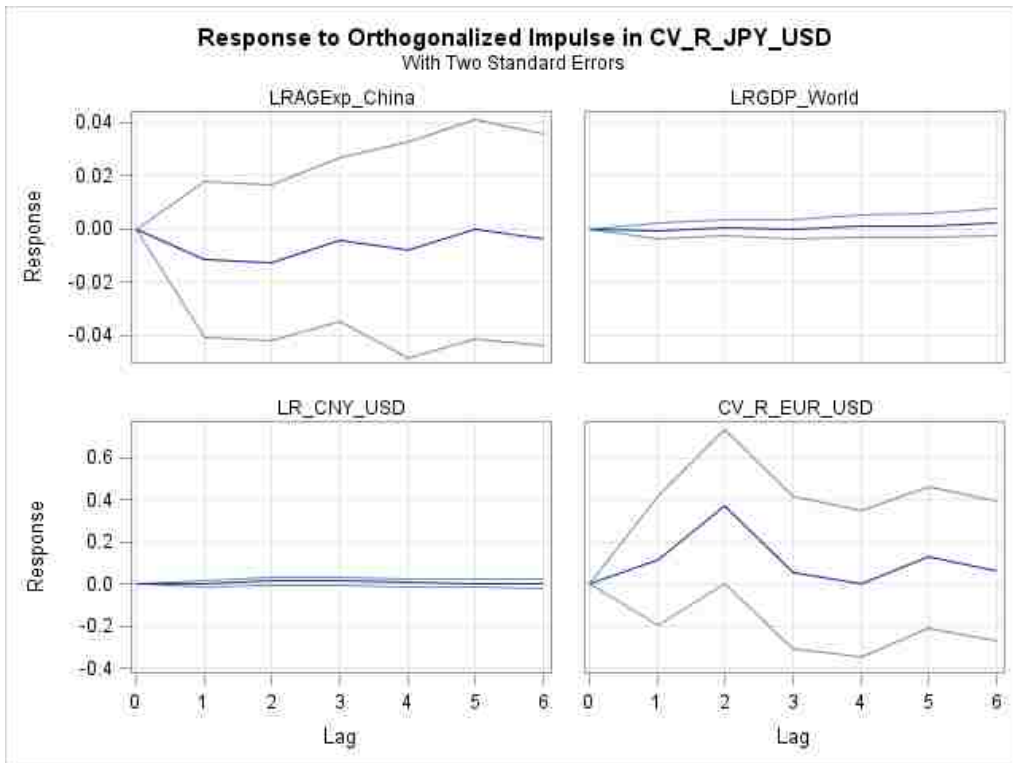
Figure 4-9. IRF: JPY/USD Volatility → China, Real Series, Ag Exports, CV.
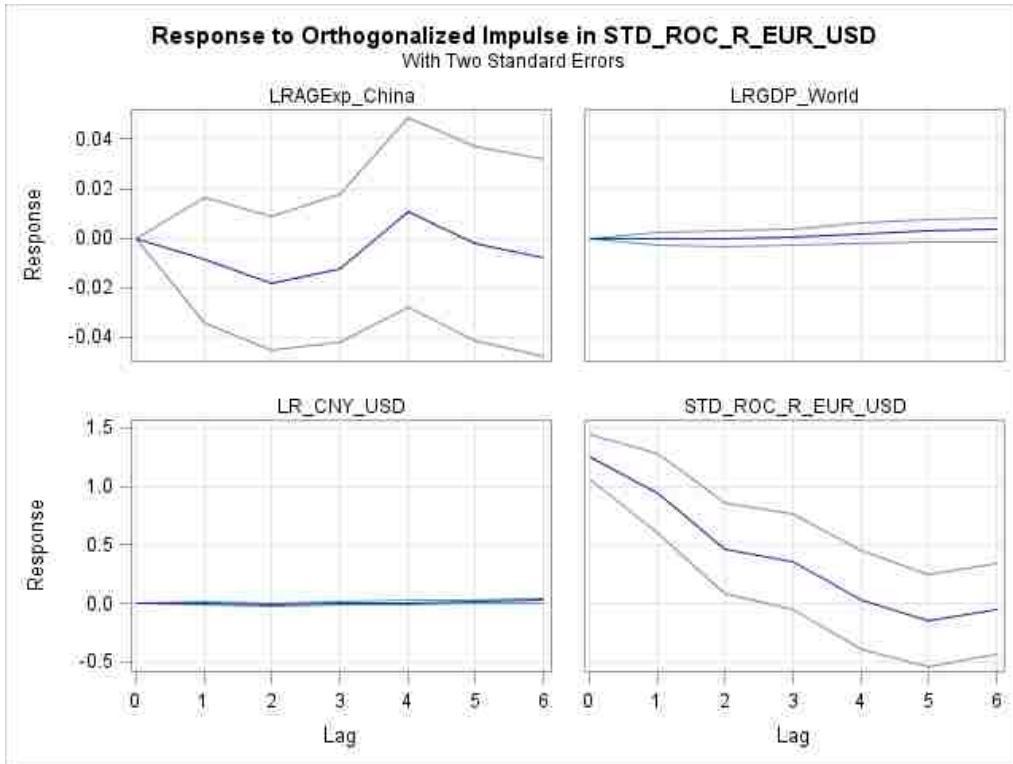
Figure 4-10. IRF: EUR/USD Volatility → China, Real Series, Ag Exports, STD.
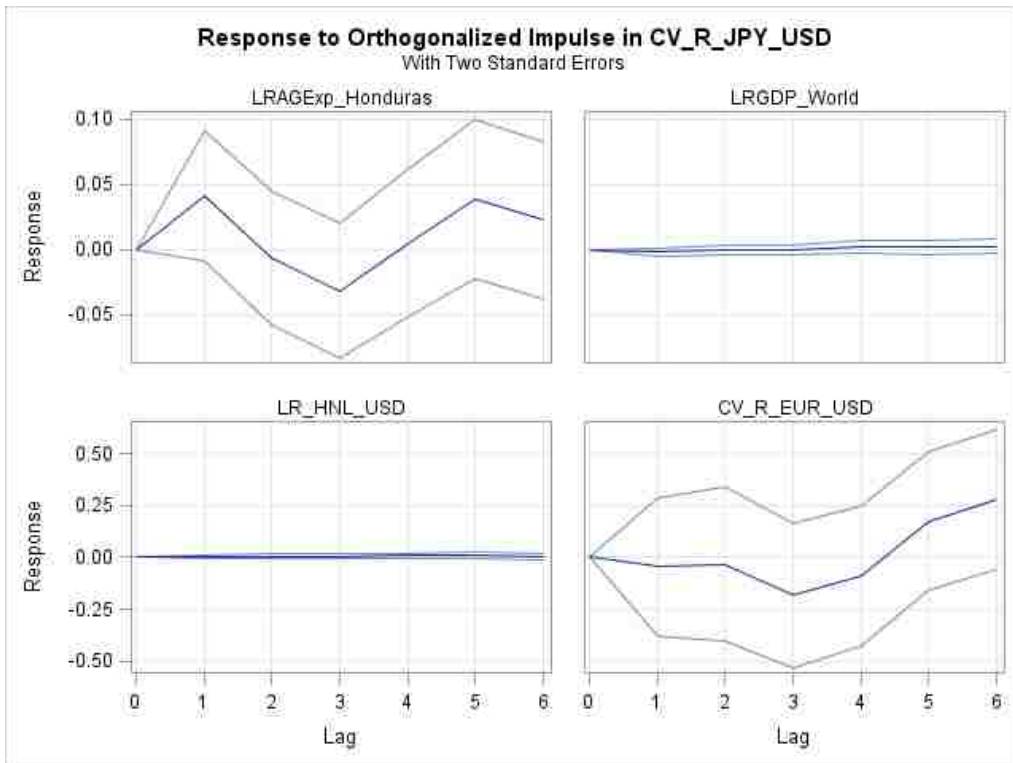
Figure 4-11. IRF: JPY/USD Volatility → Honduras, Real Series, Ag Exports, CV.
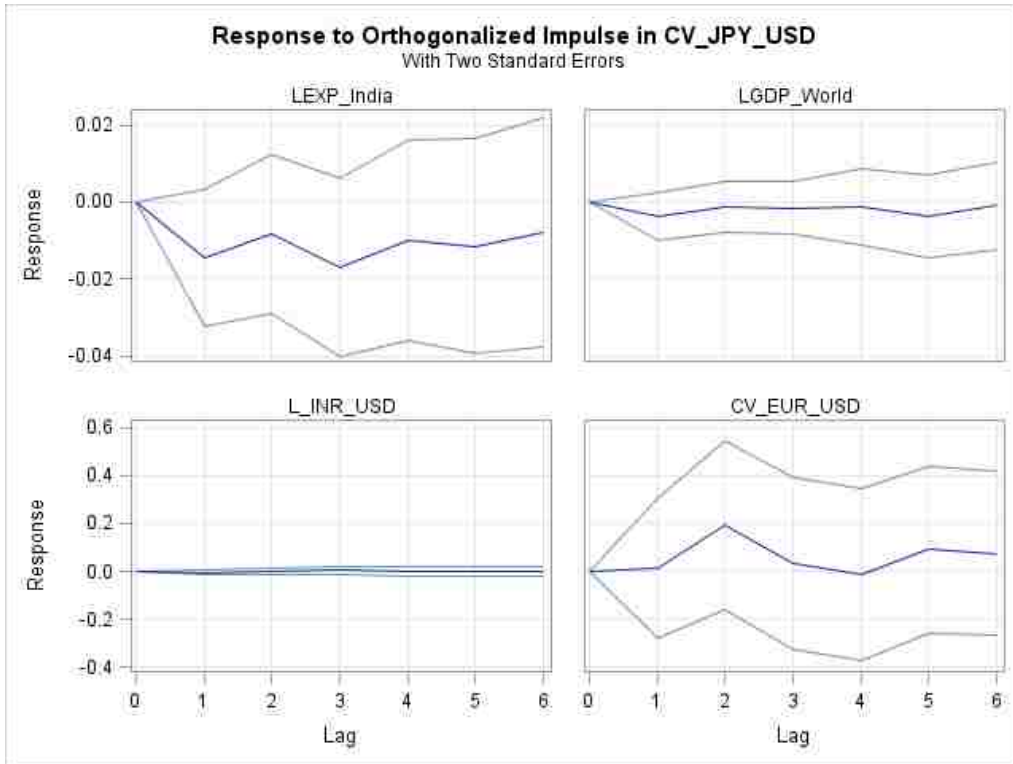
Figure 4-12. IRF: JPY/USD Volatility → India, Nominal Series, Total Exports, CV.
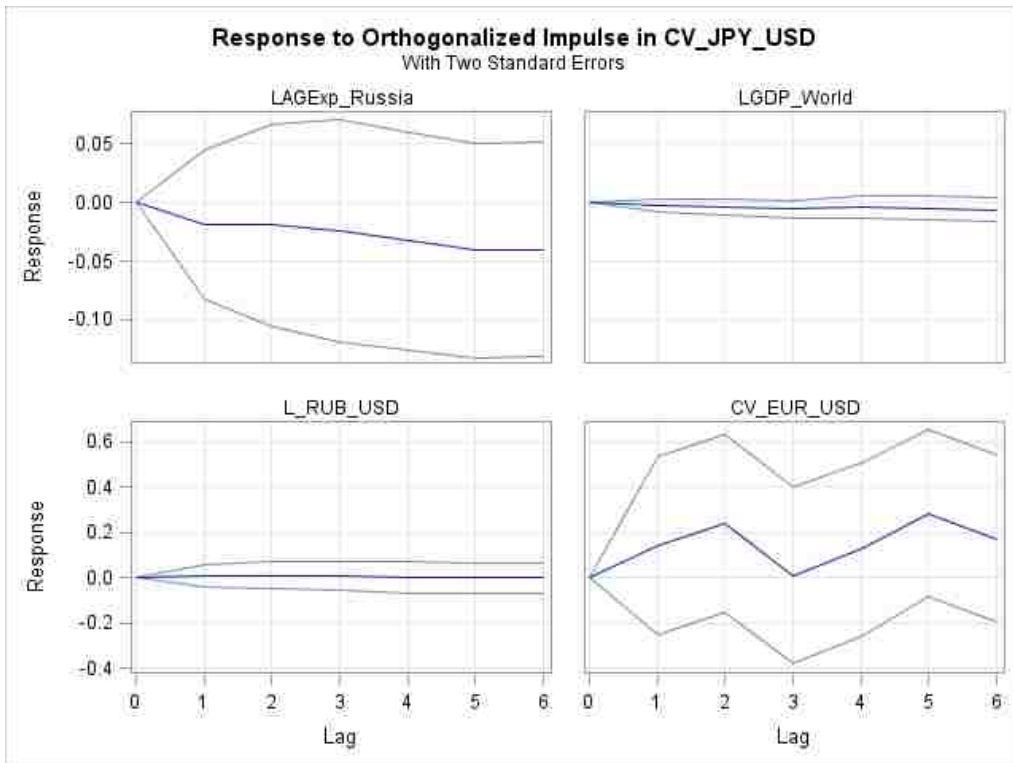
Figure 4-13. IRF: JPY/USD Volatility → Russia, Nominal Series, Ag Exports, CV.

4.2   Hypothesis 2

This section presents the effects of conditional volatility on exports using

Bivariate-GARCH-in-mean models. There were two steps prior GARCH estimation.

First, unit root tests in monthly log levels variables indicated I(1) processes for all

exports and exchange rates variables. Hence, variables were transformed to log first

differences. Second, to determine the lag order of the subsequent mean equations in

the GARCH models (equation 3.36), VAR (k) models were estimated and lag order

specification selected according to statistical criteria: AICc, SBC, prediction residual

diagnostics (Auto-Correlation Functions (ACF), Partial ACF), and normality tests.

Figures 4.14 and 4.15 illustrate the prediction error diagnostics for a Bivariate

VAR(k) model for Monthly Brazilian exports and EUR/USD volatility.
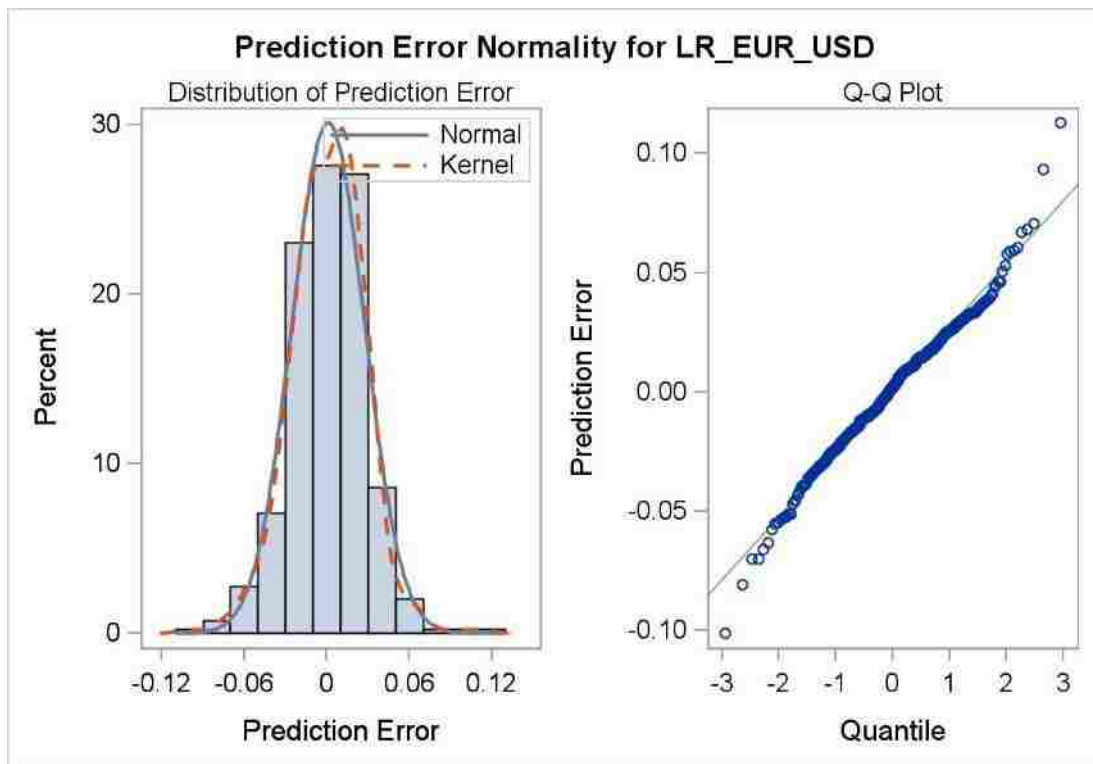
Figure 4-14. Normality Diagnostics.
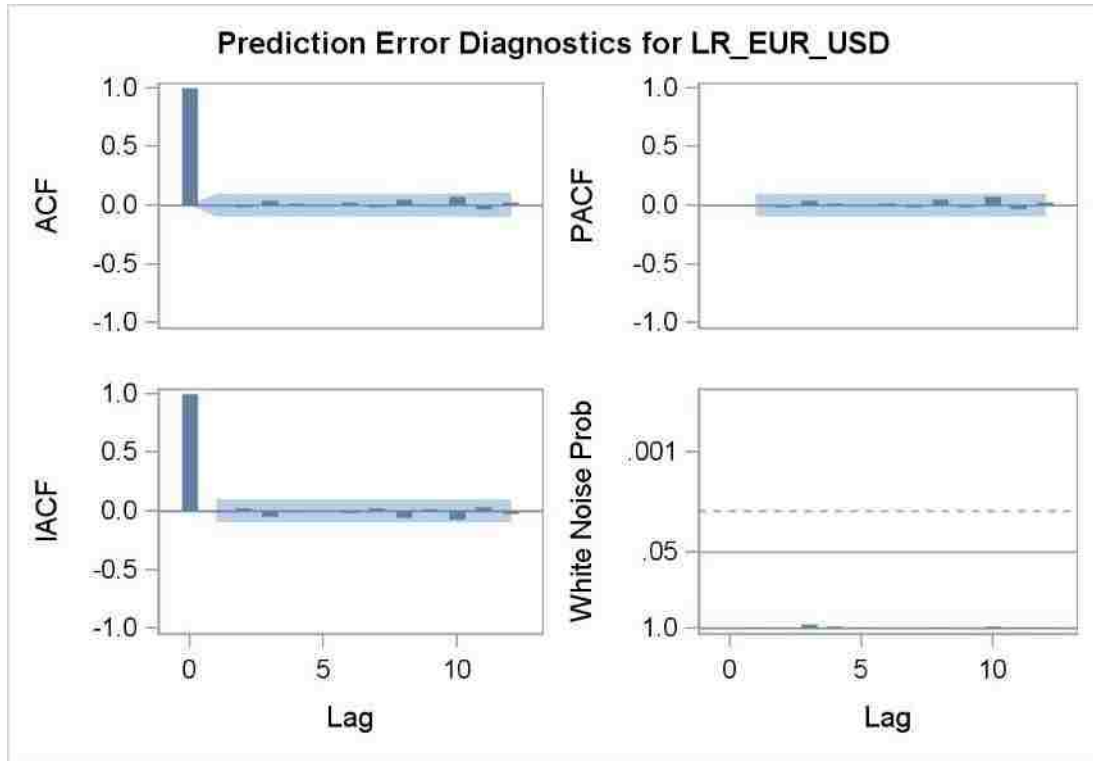
Figure 4-15. Prediction Error Diagnostics, ACF, PACF, IACF and White Noise.

From these two Figures above it is evident that errors are normally distributed, white noise, no auto-correlated, and also the absence of significant spikes in the ACF and PACF lead us to conclude that the VAR model has captured the system dynamics and is well specified. We did the same for all 42 estimated models and selected lag-orders ranged from one to four. A summary of lag order selection is shown in Table 4-11, half of the Table is dedicated to total export models and the other half to their agricultural exports counterparts. For example, the first row in the left hand side of the Table tells that the optimal model for Brazilian exports and EUR/USD exchange rate is a VAR with two lags, the associated AICc, and the number of observations, and dates ranges used are shown in the next columns.

Table 4-11. Mean (VAR (k)) Equations Optimal Lag Lengths Models.

| | **Total Export Models** | | | | | | **Agricultural Export Models** | | | | | |
Bivariate Model	**VAR**	**AICc**	**Obs**	**Date (Starting-End)**		**MLE Conv.**	**VAR**	**AICc**	**Obs**	**Date (Starting-End)**		**MLE Conv.**
BR OWN	3	-9.02	397	80-1	13-1	Yes	3	-8.94	384	80-1	11-12	Yes
BR EUR	2	-10.95	397	80-1	13-1	Yes	2	-10.87	384	80-1	11-12	Yes
BR JPY	3	-10.98	397	80-1	13-1	Yes	3	-10.91	384	80-1	11-12	Yes
RU OWN	1	-9.85	249	92-2	13-1	Yes	1	-9.51	236	92-2	11-12	No
RU EUR	1	-11.28	249	92-2	13-1	No	3	-10.83	236	92-2	11-12	Yes
RU JPY	1	-11.23	249	92-2	13-1	No	1	-10.82	236	92-2	11-12	No
IN OWN	2	-12.04	477	73-2	13-1	Yes	2	-11.98	464	73-2	11-12	Yes
IN EUR	2	-11.56	477	73-2	13-1	Yes	2	-11.47	464	73-2	11-12	Yes
IN JPY	3	-11.48	477	73-2	13-1	Yes	4	-11.39	464	73-2	11-12	Yes
CN OWN	2	-10.89	259	91-4	13-1	No	2	-10.49	296	87-2	11-12	No
CN EUR	2	-10.80	259	91-4	13-1	Yes†	2	-10.44	296	87-2	11-12	Yes†
CN JPY	2	-10.78	259	91-4	13-1	No	2	-10.41	296	87-2	11-12	Yes†
SA OWN	2	-11.17	477	73-2	13-1	Yes	2	-10.96	464	73-2	11-12	Yes†
SA EUR	2	-11.73	477	73-2	13-1	Yes	3	-11.54	464	73-2	11-12	Yes
SA JPY	2	-11.62	477	73-2	13-1	Yes	2	-11.44	464	73-2	11-12	Yes†
HN OWN	2	-13.80	206	95-9	13-1	Yes	2	-13.60	193	95-9	11-12	Yes†
HN EUR	1	-11.12	206	95-9	13-1	Yes	2	-10.92	193	95-9	11-12	Yes
HN JPY	1	-11.22	206	95-9	13-1	No	2	-11.06	193	95-9	11-12	No
TR OWN	4	-9.64	477	73-2	13-1	Yes	1	-9.48	464	73-2	11-12	No
TR EUR	1	-10.93	477	73-2	13-1	Yes	4	-10.70	464	73-2	11-12	Yes
TR JPY	1	-10.84	477	73-2	13-1	Yes	4	-10.61	464	73-2	11-12	Yes
Percentage of Convergence						76%	Percentage of Convergence					76%

† Convergence reached with one lag less than suggested by AICc. Because they might not be able to capture all system dynamics, these models may not be reliable because of omitted variable bias.

The parameter estimates from the first set of VAR(k) models served as starting values for the Maximum Likelihood estimation of the VAR(k)-GARCH(1,1)-in-mean models (equations 3.36-3.37). Estimation results for GARCH models are presented in Tables 4-12 to 4-19. Every Table contains six bivariate models which main variations are the exports and exchange rate type. For example, the first model refers to total exports and own country exchange rate volatility, the second to total exports and EUR/USD volatility, the third to total exports and JPY/USD volatility, and in the same fashion from model fourth to sixth, with the exception that the first

variables are agricultural exports. These Tables include parameter estimates

(coefficients) along with their associated standard errors (SE), and significance (sig)

from p-values. The mathematical notation used is as in equations 3.36 and 3.37. The

nomenclature of the parameter estimates is as follows. The constants for the export

and exchange rates mean equations are γ_{10}, and γ_{20}, respectively. The next parameters

$\gamma_{11,t-1}$, through $\gamma_{22,t-3}$ are lagged autoregressive terms from export mean equation,

where the first and second subscripts represent equation and variable, respectively.

For example, $\gamma_{12,t-3}$ represents the third lag of exchange rates (variable 2) on exports

(equation 1). Parameters γ_{13} through γ_{24}, first and second subscripts represent equation

and estimated volatility variable, respectively. For instance, γ_{14} measures the effect of

estimated conditional exchange rate volatility (variable 2) on exports (equation 1).

Pertaining to the volatility or variance equations 3.37, the next set of parameters, $\alpha_{11,}$

$\alpha_{22,}$ and $\beta_{11,}$ β_{22}, represent ARCH and GARCH estimates, respectively. And finally ρ_{12}

is the parameter representing Bollerslev (1990) time invariant or constant conditional

correlation ($\rho_{21,t}= \rho_{21}$) between $e_{1,t}$ and $e_{2,t}$. Model adequacy and specification was

validated through residuals diagnostics: Ljung-Box statistics, Jarque-Bera normality

test, Pormanteau test for cross correlations of errors, ACF and PACF to check auto-

correlation patterns, and Durbin Watson test for univariate model white noise

diagnostics. The log-likelihood function was maximized in 32 out of 42 models. [21]

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[21] Notice that after trying different numbers of iterations (500, and1000) and numerical optimization algorithms (BFGS, and BHHH), the MLE did not converge for some models. Also there were cases, †, in which conversion was attained by specifying one less lag from optimal lag-lengths, so caution is used in drawing conclusions in those cases.

Of special interest in these models is the effect of exchange rates conditional volatility on exports, represented by the estimates of γ_{14} in Tables 4-12 to 4-19. We therefore proceed to test the second research hypothesis: Conditional currency exchange rate volatility (own and G-3) does not impact exports.

4.2.1 Brazil

In the case of Brazilian exports, the GARCH volatility estimates in the export mean equation, γ_{14}, and their associated standard errors lead us to reject the null hypotheses of no-effect of own currency (BRL/USD) and third country currency (EUR/USD) exchange rate volatility on Brazilian total and agricultural exports at the 0.05 significance level (Table 4-12). In addition, the impact is negative as suggested by the sign associated to the volatility coefficients, meaning that as exchange rate volatility increases, export growth decreases.

This relationship was expected, according to decision theory, the greater the uncertainty in export revenues, the less likely are merchants to continue engaging in international trade, especially those that are risk averse or neutral. However, we fail to reject the null hypothesis of the effect of JPY/USD volatility on Brazilian total and agricultural exports. The magnitudes of the effects are stronger in the case of EUR/USD volatility models, followed by JPY/USD and own volatility models.

Another important relationship is the one that measures the effects of export volatility on the growth of total amount of exports, γ_{13}. In line with decision theory, export uncertainty is statistically significant (at 0.01 significance level) and negatively related to Brazilian total export growth in the EUR/USD volatility model.

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However, there is no effect of third currency (EUR/USD) exchange rate volatility on agricultural exports. In the case of own currency (BRL/USD) and third currency (JPY/USD) volatility models, export uncertainty is statistically significant and positively related to the Brazilian export growth. Though, the sign of these coefficients across models were not consistent, at least same direction is expected in this particular case.

In analyzing autoregressive parameter estimates from the export mean equation, in general, is evident that past export growth, $\gamma_{11, t-1}$, $\gamma_{11, t-2}$, and $\gamma_{11, t-3}$ has a significant and positive effect over current total and agricultural export growth from Brazil. The magnitude of these parameters tend to increase over time, which means that past third-month export growth has relatively stronger effect on current export growth than past second and first month export growth. Perhaps Brazilian merchants take export decisions in quarterly basis, and thus the last month of a quarter is relatively more important than first and second months.

The situation is different in the exchange rate mean equation, past changes in exchange rates $\gamma_{22, t-1}$, $\gamma_{22, t-2}$, and $\gamma_{22, t-3}$ are in general non-significant after lag one, and thus only one month past exchange rate growth positively influences current exchange rate growth. Greater than one lag coefficients do not help to explain actual values of exchange rates. For the six Brazilian export models in general parameters describing ARCH processes (α_{11} and α_{22}) and GARCH processes (β_{11} and β_{22}) in the variance equations are significant which means that exports and exchange rates are well modeled by a GARCH process. Finally, the log likelihood estimation was maximized for all six Brazilian models.

Table 4-12. Brazil Bivariate-GARCH-in-mean Estimates.

| Nomenclature | Parameters | Total Exports | | | | | | | | | Agricultural Exports | | | | | | | | |
| | | OWN/USD Vol | | | EUR/USD Vol | | | JPY/USD Vol | | | OWN/USD Vol | | | EUR/USD Vol | | | JPY/USD Vol | | |
		Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig
$B_{(1)}$	γ_{10}	-0.154	0.057	***	7.798	0.509	***	-0.581	1.095		-0.180	0.071	**	3.536	0.108	***	-0.685	1.280	
$B_{(2)}$	γ_{20}	0.002	0.013		-4.371	0.305	***	0.112	0.292		-0.005	0.014		-5.760	0.174	***	0.077	0.171	
$AR1_{(1,1)}$	$\gamma_{11,t-1}$	0.059	0.045		0.036	0.052		0.070	0.045		0.076	0.044	*	0.146	0.053	***	0.087	0.050	*
$AR1_{(2,1)}$	$\gamma_{21,t-1}$	0.007	0.009		-0.001	0.007		-0.007	0.007		0.008	0.009		0.001	0.007		-0.009	0.007	
$AR1_{(1,2)}$	$\gamma_{12,t-1}$	0.108	0.104		0.313	0.268		0.712	0.263	***	0.104	0.103		0.213	0.275		0.775	0.241	***
$AR1_{(2,2)}$	$\gamma_{22,t-1}$	0.068	0.057		0.242	0.054	***	0.303	0.051	***	0.064	0.059		0.250	0.053	***	0.297	0.050	***
$AR2_{(1,1)}$	$\gamma_{11,t-2}$	0.202	0.035	***	0.139	0.050	***	0.226	0.041	***	0.206	0.039	***	0.220	0.048	***	0.230	0.043	***
$AR2_{(2,1)}$	$\gamma_{21,t-2}$	-0.006	0.012		0.007	0.008		-0.006	0.008		-0.004	0.010		0.009	0.008		0.000	0.008	
$AR2_{(1,2)}$	$\gamma_{12,t-2}$	-0.175	0.098	*	-0.199	0.261		-0.346	0.244		-0.162	0.099		-0.081	0.276		-0.395	0.244	
$AR2_{(2,2)}$	$\gamma_{22,t-2}$	0.002	0.050		-0.018	0.046		-0.065	0.049		-0.001	0.044		-0.017	0.046		-0.061	0.049	
$AR3_{(1,1)}$	$\gamma_{11,t-3}$	0.334	0.044	***				0.346	0.045	***	0.317	0.043	***				0.328	0.047	***
$AR3_{(2,1)}$	$\gamma_{21,t-3}$	-0.005	0.013					0.015	0.009	*	-0.010	0.013					0.014	0.009	
$AR3_{(1,2)}$	$\gamma_{12,t-3}$	0.019	0.090					0.336	0.230		0.047	0.095					0.462	0.232	**
$AR3_{(2,2)}$	$\gamma_{22,t-3}$	-0.027	0.043					0.026	0.047		-0.026	0.040					0.020	0.047	
$GM_{(1,1)}$	γ_{13}	1.068	0.409	***	-2.491	0.859	***	1.028	0.431	**	1.210	0.502	**	0.054	0.477		0.980	0.423	**
$GM_{(2,1)}$	γ_{23}	0.016	0.091		-0.024	0.045		-0.016	0.064		0.063	0.087		0.081	0.023	***	0.019	0.059	
$GM_{(1,2)}$	**γ_{14}**	**-0.308**	**0.134**	**	**-294.575**	**19.426**	***	**15.395**	**40.508**		**-0.342**	**0.139**	**	**-139.820**	**5.072**	***	**19.164**	**46.352**	
$GM_{(2,2)}$	γ_{24}	-0.189	0.103	*	172.563	12.040	***	-4.035	10.603		-0.194	0.105	*	224.553	6.817	***	-2.943	6.258	
$VCV_{(1)}$	ω_1	0.009	0.002	***	0.000	0.000	**	0.010	0.003	***	0.011	0.003	***	0.012	0.004	***	0.011	0.003	***
$VCV_{(2)}$	ω_2	0.001	0.000	***	0.000	0.000	***	0.001	0.000	***	0.001	0.000	***	0.001	0.000	***	0.001	0.000	***
$VBV_{(1)}$	α_{11}	0.169	0.058	***	0.024	0.009	**	0.178	0.066	***	0.164	0.068	**	0.121	0.057	**	0.215	0.082	***
$VBV_{(2)}$	α_{22}	0.759	0.129	***	0.002	0.000	***	0.021	0.050		0.795	0.128	***	0.001	0.000	***	0.023	0.051	
$VAV_{(1)}$	β_{11}	0.378	0.134	***	0.959	0.013	***	0.361	0.153	**	0.326	0.133	**	0.402	0.191	**	0.287	0.142	**
$VAV_{(2)}$	β_{22}	0.230	0.067	***	0.254	0.103	**	-0.135	0.398		0.218	0.066	***	0.234	0.077	***	-0.143	0.402	
$QC_{(1,1)}$	ρ_{12}	0.018	0.043		-0.039	0.054		-0.014	0.050		0.013	0.042		-0.017	0.058		-0.011	0.050	

4.2.2 Russia

In the case of Russian bivariate export models, the estimation of the log

likelihood function was possible only for "total exports and own exchange rate", and

"agricultural exports and EUR/USD exchange rate" models. Consequently we focus

our attention to the results of these converged models.

The GARCH volatility estimates in the export mean equation, γ_{14}, and their

associated standard errors lead us to reject the null hypothesis of no-effect of own

currency (RUB/USD) exchange rate volatility on Russian total exports at the 0.01

significance level (Table 4-13). In addition, the impact is negative as suggested by the

sign associated to the volatility coefficient, meaning that as own exchange rate

volatility increases, export growth decreases. This relationship was expected,

according to decision theory, the greater the uncertainty in exchange rates or relative

prices which affect export revenues, the less likely are merchants to continue

engaging in international trade, especially those that are risk averse or neutral. The

magnitudes of the effect is stronger for Russian exports than for Brazilian ones.

However, we fail to reject the null hypothesis of "no effect" in the case of

third country exchange rate (EUR/USD) volatility in agricultural exports. In other

words, the model discards any impact, negative or positive, of third country exchange

rates on Russian agricultural exports.

Another important relationship to analyze is the one that measures the effects

of export volatility on export growth, γ_{13}. In line with decision theory, export

uncertainty is statistically significant and negatively related to Russian total export

growth in the own country currency (RUB/USD) exchange rate volatility model. But this coefficient is positive and significant at the 0.01 significance level in the case of "agricultural exports and third currency (EUR/USD) exchange rates." This result is very surprising as we were not expecting inconsistencies in the direction of the effects for this coefficient across Russian models, yet, same contradiction was found in the case of Brazilian exports.

In analyzing autoregressive export terms, only in the model "Agricultural Exports and EUR/USD Exchange rates" past changes of exports or, $\gamma_{11, t-1}$, had a significant and negative effect on current agricultural export growth from Russia. Perhaps, Russian merchants take export decisions on a monthly basis, and thus one month is enough to base future export expectations.

In this particular case due to the short time series available for Russia and knowing that GARCH need long series to be consistent and reliable, we are careful in drawing inferences. As a general interpretation of this last coefficient, the negative sign and small magnitude of the coefficient means that an increase in prior month export growth leads to a decrease of current month exports growth. The situation is different in the exchange rate mean equation, past growth in exchange rates $\gamma_{22, t-1}$, are positive and significant for the two models (at 0.01 significance level). Hence past exchange rate growth are positively related to actual values of exchange rate growth. For the two converged Russian export models, in general parameters describing ARCH processes α_{11} and α_{22} and GARCH processes β_{11} and β_{22} in the variance equations are significant which means that exports and exchange rates are well modeled by a GARCH process.

Table 4-13. Russia Bivariate-GARCH-in-mean Estimates.

Nomenclature	Parameters	OWN/USD Vol Coeff	SE	Sig	EUR/USD Vol Coeff	SE	Sig	JPY/USD Vol Coeff	SE	Sig	OWN/USD Vol Coeff	SE	Sig	EUR/USD Vol Coeff	SE	Sig	JPY/USD Vol Coeff	SE	Sig
		Total Exports									**Agricultural Exports**								
$B_{(1)}$	γ_{10}	0.025	0.008	***	-0.006	0.053		0.058	0.001	***	0.148	0.004	***	0.446	0.061	***	-0.088	0.000	***
$B_{(2)}$	γ_{20}	-0.009	0.001	***	-0.021	0.008	***	-0.071	0.003	***	-0.006	0.001	***	-0.051	0.026	**	-0.059	0.000	***
$AR_{1(1,1)}$	$\gamma_{11,t-1}$	-0.099	0.064		-0.263	0.067	***	-0.208	0.014	***	-0.267	0.009	***	-0.099	0.037	***	-0.069	0.001	***
$AR_{1(2,1)}$	$\gamma_{21,t-1}$	0.011	0.001	***	0.004	0.006		0.005	0.009		0.002	0.004		-0.012	0.009		0.002	0.000	***
$AR_{1(1,2)}$	$\gamma_{12,t-1}$	0.572	0.304	*	0.152	0.157		-0.052	0.050		0.259	0.025	***	-0.256	0.281		0.615	0.013	***
$AR_{1(2,2)}$	$\gamma_{22,t-1}$	0.262	0.013	***	0.458	0.063	***	0.187	0.058	***	0.516	0.052	***	0.226	0.062	***	0.364	0.002	***
$GM_{(1,1)}$	γ_{13}	0.310	0.058	***	0.213	0.432		2.214	0.048	***				-0.062	0.034	*			
$GM_{(2,1)}$	γ_{23}	-0.077	0.010	***	0.140	0.062	**	-0.387	0.021	***				-0.002	0.009				
$GM_{(1,2)}$	**γ_{14}**	**-3.508**	**0.373**	***	**-1.121**	**0.162**	***	**-15.533**	**0.209**	***				**-0.350**	**0.314**				
$GM_{(2,2)}$	γ_{24}	0.775	0.026	***	-0.249	0.064	***	4.979	0.234	***				-0.124	0.056	**			
$VCV_{(1)}$	ω_1	0.019	0.001	***	0.008	0.002	***	0.026	0.001	***				0.061	0.034	*			
$VCV_{(2)}$	ω_2	0.001	0.000	***	0.000	0.000	*	0.000	0.000	***				0.008	0.010				
$VBV_{(1)}$	α_{11}	0.000	0.026		0.206	0.097	**	-0.031	0.001	***				0.399	0.222	*			
$VBV_{(2)}$	α_{22}	0.187	0.003	***	1.611	0.228	***	0.057	0.008	***				-0.014	0.057				
$VAV_{(1)}$	β_{11}	-0.015	0.059		0.352	0.096	***	-0.390	0.008	***	-0.912	0.004	***	-2.737	0.255	***	0.636	0.006	***
$VAV_{(2)}$	β_{22}	-0.652	0.090	***	0.325	0.045	***	0.286	0.095	***	0.028	0.004	***	-0.017	0.085		0.337	0.001	***
$QC_{(1,1)}$	ρ_{12}	-0.046	0.063		-0.064	0.064		-0.123	0.067	*	-1.295	0.105	***	-5.058	1.199	***	-1.755	0.005	***

4.2.3 India

In the case of Indian bivariate export models, the estimation of the log

likelihood function was possible for all six models. We start by testing the hypothesis:

Conditional currency exchange rate volatility (own and G-3) does not impact Indian

exports (total and agricultural). In general for the six models, the GARCH volatility

estimates in the export mean equation, γ_{14}, and their associated standard errors lead us

to reject the null hypotheses of no-effect of own currency (INR/USD) and third

country currency (EUR/USD and JPY/USD) exchange rates volatilities on total and

agricultural exports from India at the 0.10 significance level (Table 4-14). In addition,

the impact is mixed. A negative effect, as suggested by the sign associated to the

coefficients, is found in the models "agricultural exports and own currency exchange

rates" and "agricultural exports and third country currency (JPY/USD) exchange

rates," meaning that as exchange rate volatility increases, agricultural export growth

decreases. This relationship was expected, according to decision theory, the greater

the uncertainty in exchange rates or relative prices which affect export revenues, the

less likely are merchants to continue engaging in international trade, especially those

that are risk averse or neutral.

On the other hand, for the remaining four models, the sign associated to the

exchange rate volatility coefficient is positive. Although without considering the

currency exchange regimes prevailing in India, and solely basing our analysis on

decision theory, that effect direction would be surprising and not expected. [22] Notice

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[22] Perhaps the "de-facto controlled market exchange rate" prevailing in India could explain this situation, and we come back to this point in the following chapter entitled "Discussion."

that the magnitudes of those positive coefficients are very small (close to zero) compared to their negative counterparts, meaning that volatility slightly impacts exports when the predicted direction is positive.

Another important relationship to analyze is the one that measures the effects export volatility or export uncertainty on the growth of total amount of exports, γ_{13}. In line with decision theory, export uncertainty is statistically significant and negatively related to Indian agricultural export growth in its three models.

Although not as expected, in the total exports models with own INR/USD and third (JPY/USD) currency volatility, export uncertainty is statistically significant and positively related to the Indian total export growth. This result is very surprising as we would expect signs of the coefficients to be consistent across models for the same country. Though, same contradiction in the direction effects were revealed in the case of Brazilian, and Russian exports. In analyzing the autoregressive term in all six models, past changes of exports or autoregressive export terms, $\gamma_{11,\,t\text{-}1}$, $\gamma_{11,\,t\text{-}2}$, $\gamma_{11,\,t\text{-}3}$, $\gamma_{11,\,t\text{-}4}$ had a significant and negative effect over current agricultural and total export growth in India. Perhaps, Indian merchants create export market expectations and take export decisions in quarterly basis for the American and European markets, and every four months for Japanese market. These lagged autoregressive terms could also be due to the model's need to account for the system dynamics. As a general interpretation, the negative sign and small magnitude means that an increase in past export growth rates leads to a decrease of current month exports growth. The decreasing of absolute value of the coefficients means that recent past changes in exports are more determinant in explaining current export volumes.

Table 4-14. India Bivariate-GARCH-in-mean Estimates.

| Nomenclature | Parameters | Total Exports | | | | | | | | | Agricultural Exports | | | | | | | | |
| | | OWN/USD Vol | | | EUR/USD Vol | | | JPY/USD Vol | | | OWN/USD Vol | | | EUR/USD Vol | | | JPY/USD Vol | | |
		Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig
B$_{(1)}$	γ_{10}	0.147	0.010	***	7.689	0.283	***	0.440	0.305		7.724	0.166	***	0.123	0.098		0.336	0.142	**
B$_{(2)}$	γ_{20}	0.011	0.000	***	2.888	0.104	***	0.063	0.065		2.361	0.048	***	-0.015	0.014		0.061	0.026	**
AR$_{1(1,1)}$	$\gamma_{11,t-1}$	-0.531	0.041	***	-0.518	0.041	***	-0.464	0.048	***	-0.471	0.048	***	-0.499	0.044	***	-0.467	0.048	***
AR$_{1(2,1)}$	$\gamma_{21,t-1}$	-0.011	0.004	***	0.003	0.007		-0.001	0.010		0.003	0.006		0.010	0.009		-0.006	0.010	
AR$_{1(1,2)}$	$\gamma_{12,t-1}$	0.405	0.183	**	0.492	0.247	**	0.390	0.176	**	0.613	0.273	**	-0.087	0.195		0.385	0.184	**
AR$_{1(2,2)}$	$\gamma_{22,t-1}$	0.293	0.016	***	0.292	0.047	***	0.294	0.047	***	0.302	0.048	***	0.258	0.050	***	0.287	0.046	***
AR$_{2(1,1)}$	$\gamma_{11,t-2}$	-0.217	0.039	***	-0.195	0.040	***	-0.212	0.047	***	-0.182	0.045	***	-0.199	0.041	***	-0.250	0.052	***
AR$_{2(2,1)}$	$\gamma_{21,t-2}$	-0.012	0.007	*	0.004	0.007		-0.001	0.010		0.005	0.007		0.004	0.009		-0.002	0.012	
AR$_{2(1,2)}$	$\gamma_{12,t-2}$	-0.244	0.147	*	-0.249	0.243		-0.279	0.194		-0.256	0.263		-0.511	0.192	***	-0.217	0.190	
AR$_{2(2,2)}$	$\gamma_{22,t-2}$	-0.020	0.017		0.015	0.040		-0.045	0.043		0.031	0.044		-0.033	0.043		-0.042	0.043	
AR$_{3(1,1)}$	$\gamma_{11,t-3}$							-0.081	0.039	**							-0.128	0.048	***
AR$_{3(2,1)}$	$\gamma_{21,t-3}$							0.012	0.009								0.011	0.011	
AR$_{3(1,2)}$	$\gamma_{12,t-3}$							-0.083	0.191								-0.048	0.195	
AR$_{3(2,2)}$	$\gamma_{22,t-3}$							0.026	0.041								0.029	0.045	
AR$_{4(1,1)}$	$\gamma_{11,t-4}$	-0.798	0.194	***	-0.343	0.289		-2.074	1.218	*							-0.080	0.042	*
AR$_{4(2,1)}$	$\gamma_{21,t-4}$	-0.034	0.001	***	0.037	0.035		-0.188	0.137								-0.004	0.010	
AR$_{4(1,2)}$	$\gamma_{12,t-4}$	-2.061	0.686	***	-386.638	14.319	***	-7.593	9.656								0.056	0.200	
AR$_{4(2,2)}$	$\gamma_{22,t-4}$	-0.282	0.002	***	-146.178	5.256	***	-1.602	2.279								-0.027	0.041	
GM$_{(1,1)}$	γ_{13}	0.001	0.001	*	0.000	0.000		0.012	0.002	***	-1.397	0.621	**	-1.423	0.617	**	-1.066	0.326	***
GM$_{(2,1)}$	γ_{23}	0.001	0.000	***	0.000	0.000	***	0.001	0.000	***	-0.054	0.058		-0.183	0.026	***	-0.102	0.119	
GM$_{(1,2)}$	**γ_{14}**	**0.081**	**0.044**	*	**0.053**	**0.021**	**	**0.118**	**0.058**	**	**-392.112**	**7.793**	***	**1.847**	**0.976**	*	**-7.854**	**4.106**	*
GM$_{(2,2)}$	γ_{24}	0.156	0.001	***	0.000	0.000	***	0.054	0.057		-122.140	2.287	***	1.451	0.632	**	-1.851	0.883	**
VCV$_{(1)}$	ω_1	0.844	0.066	***	0.915	0.033	***	-0.044	0.134		0.014	0.005	***	0.012	0.003	***	0.013	0.003	***
VCV$_{(2)}$	ω_2	-0.373	0.008	***	0.512	0.029	***	-0.246	0.178		0.000	0.000	***	0.000	0.000	***	0.001	0.000	***
VBV$_{(1)}$	α_{11}	-0.071	0.045		-0.016	0.046		-0.072	0.046		0.112	0.042	***	0.112	0.048	**	0.147	0.053	***
VBV$_{(2)}$	α_{22}	0.147	0.010	***	7.689	0.283	***	0.440	0.305		0.000	0.000	***	0.123	0.048	***	0.047	0.027	*
VAV$_{(1)}$	β_{11}	0.011	0.000	***	2.888	0.104	***	0.063	0.065		-0.059	0.297		0.089	0.196		-0.055	0.218	
VAV$_{(2)}$	β_{22}	-0.531	0.041	***	-0.518	0.041	***	-0.464	0.048	***	0.458	0.054	***	0.446	0.133	***	-0.235	0.199	
QC$_{(1,1)}$	ρ_{12}	-0.011	0.004	***	0.003	0.007		-0.001	0.010		-0.022	0.047		-0.046	0.050		-0.063	0.048	

The situation is different in the exchange rate mean equation, past changes in exchange rates at lag one, $\gamma_{22, t-1}$, are statistically significant for all models (at 0.01 significance level) and positive. Hence past growth rates in exchange rates are positively related to actual values of exchange rate growth. All Indian export models in general present statistically significant ARCH α_{11} and α_{22} and or GARCH β_{11} and β_{22} coefficients in the variance equations meaning that exports and exchange rates are well modeled by a GARCH process.

4.2.4 China

In the case of Chinese bivariate models, the estimation of the log likelihood function was possible for only three models, "Total exports and Own Currency exchange rate," "Agricultural Exports and Third country (EUR/USD) currency exchange rate," and "Agricultural Exports and Third country (JPY/USD) currency exchange rate." [23] We start the analysis of these three models by testing the null hypothesis: Conditional currency exchange rate volatility (own and G-3) does not impact Chinese exports (total and agricultural).

In general for the three models, the GARCH volatility estimates in the export mean equation, γ_{14}, and their associated standard errors lead us to reject the null hypotheses of no-effect of own currency (CNY/USD) and third country currency (EUR/USD and JPY/USD) exchange rates volatilities on total and agricultural exports from China at the 0.01 significance level (Table 4-15). In addition, the impact is positive as suggested by the sign associated to this coefficient, meaning that as

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[23] Convergence was reached with one less lag than the optimal lag length.

exchange rate volatility increases, agricultural and total export growth increases. Although without considering the currency exchange regimes prevailing in China, and solely basing our analysis on decision theory, that effect direction would be surprising and not expected. [24] Notice that the magnitudes of those coefficients are small, though bigger compared to the coefficients found in the models for India.

Another important relationship to analyze is the one that measures the effects export volatility or export uncertainty on the growth of total amount of exports, γ_{13}. The coefficients for export uncertainty are strongly significant (at 0.01 significance level) and positively related to Chinese agricultural and total export growth in all three models. Yet the sign of this coefficient is consistent across Chinese models, the direction of the effect was not as expected based on decision theory. Compared to the previous countries, this is the first time in which all of these estimates are consistent across model types for the same country.

In analyzing the autoregressive terms in the three converged models, past changes of exports, $\gamma_{11, t-1}$, had a significant and negative effect over current agricultural and total export growth in China. It could be the case that Chinese merchants create export market expectations and take export decisions in monthly basis. The negative sign and small magnitude of the coefficient means that an increase in past export-growth leads to a slight decrease of current month exports-growth.

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[24] Perhaps the "de-facto controlled market exchange rate" prevailing in China could explain this situation, and we come back to this point in the following chapter entitled "Discussion."

Table 4-15. China Bivariate-GARCH-in-mean Estimates.

Nomenclature	Parameters	Total Exports OWN/USD Vol Coeff	SE	Sig	EUR/USD Vol Coeff	SE	Sig	JPY/USD Vol Coeff	SE	Sig	Agricultural Exports OWN/USD Vol Coeff	SE	Sig	EUR/USD Vol Coeff	SE	Sig	JPY/USD Vol Coeff	SE	Sig
$B_{(1)}$	γ_{10}	0.059	0.003	***	0.119	0.075		0.041	0.000	***	0.090	0.004	***	0.043	0.079		0.002	0.110	
$B_{(2)}$	γ_{20}	-0.005	0.001	***	-0.054	0.046		0.001	0.001		0.000	0.002		-0.070	0.050		-0.017	0.024	
$AR_{1(1,1)}$	$\gamma_{11,t-1}$	-0.362	0.001	***	-0.215	0.059	***	-0.346	0.000	***	-0.367	0.005	***	-0.237	0.067	***	-0.222	0.060	***
$AR_{1(2,1)}$	$\gamma_{21,t-1}$	0.025	0.003	***	-0.005	0.009		0.001	0.006		0.007	0.007		0.000	0.008		0.009	0.009	
$AR_{1(1,2)}$	$\gamma_{12,t-1}$	0.279	0.004	***	0.179	0.235		0.313	0.001	***	-0.335	0.229		0.000	0.262		-0.454	0.240	*
$AR_{1(2,2)}$	$\gamma_{22,t-1}$	-0.839	0.057	***	0.213	0.058	***	0.287	0.051	***	0.278	0.055	***	0.226	0.057	***	0.273	0.062	***
$AR_{2(1,1)}$	$\gamma_{11,t-2}$	-0.233	0.005	***				-0.246	0.001	***	-0.298	0.011	***						
$AR_{2(2,1)}$	$\gamma_{21,t-2}$	-0.015	0.005	***				-0.013	0.005	**	-0.012	0.005	**						
$AR_{2(1,2)}$	$\gamma_{12,t-2}$	0.763	0.032	***				-0.015	0.001	***	0.317	0.212							
$AR_{2(2,2)}$	$\gamma_{22,t-2}$	0.266	0.058	***				0.004	0.059		-0.050	0.054							
$AR_{3(1,1)}$	$\gamma_{11,t-3}$	-0.086	0.003	***				-0.026	0.000	***									
$AR_{3(2,1)}$	$\gamma_{21,t-3}$	0.056	0.006	***				0.001	0.006										
$AR_{3(1,2)}$	$\gamma_{12,t-3}$	0.084	0.001	***				0.195	0.007	***									
$AR_{3(2,2)}$	$\gamma_{22,t-3}$	-0.067	0.031	**				-0.009	0.056										
$GM_{(1,1)}$	γ_{13}	0.012	0.001	***	0.068	0.067		0.012	0.000	***	-0.246	0.001	***	0.115	0.110		0.093	0.072	
$GM_{(2,1)}$	γ_{23}	0.000	0.000	***	0.001	0.009		0.001	0.000	***	0.007	0.012		0.013	0.012		0.004	0.010	
$GM_{(1,2)}$	**γ_{14}**	**0.850**	**0.013**	***	**-3.859**	**3.178**		**0.941**	**0.008**	***	**-0.695**	**0.016**	***	**-1.839**	**3.030**		**0.210**	**4.237**	
$GM_{(2,2)}$	γ_{24}	1.922	0.021	***	2.212	1.944		0.134	0.006	***	-0.073	0.063		2.726	2.065		0.598	0.930	
$VCV_{(1)}$	ω_1	-0.027	0.001	***	0.008	0.001	***	-0.029	0.000	***	0.013	0.001	***	0.017	0.002	***	0.012	0.001	***
$VCV_{(2)}$	ω_2	-0.162	0.009	***	0.000	0.000	***	0.057	0.006	***	0.001	0.000	***	0.000	0.000	***	0.001	0.000	***
$VBV_{(1)}$	α_{11}	-0.120	0.040	***	1.511	0.280	***	-0.074	0.074		1.058	0.004	***	1.066	0.195	***	1.347	0.227	***
$VBV_{(2)}$	α_{22}	0.059	0.003	***	0.120	0.082		0.041	0.000	***	0.093	0.037	**	0.119	0.080		0.101	0.064	
$VAV_{(1)}$	β_{11}	-0.005	0.001	***	0.003	0.011		0.001	0.001		-0.013	0.001	***	0.007	0.015		0.002	0.012	
$VAV_{(2)}$	β_{22}	-0.362	0.001	***	0.329	0.145	**	-0.346	0.000	***	-0.741	0.070	***	0.309	0.127	**	-0.671	0.428	
$QC_{(1,1)}$	ρ_{12}	0.025	0.003	***	-0.042	0.068		0.001	0.006		-0.066	0.054		-0.034	0.056		-0.033	0.058	

The situation is different in the exchange rate mean equation, past changes in exchange rates at lag one, $\gamma_{22, t-1}$, are statistically significant for all models (at 0.01 significance level). They are negative in the "total exports and own currency model," and positive in the "agricultural exports and third country currency (EUR/USD and JPY/USD) models. However, mixed coefficient signs across models were not expected. In general, Chinese export models present statistically significant ARCH α_{11} and α_{22} and or GARCH β_{11} and β_{22} coefficients in the variance equations, meaning that exports and exchange rates are well modeled by a GARCH process.

4.2.5   South Africa

In the case of South African bivariate models, the estimation of the log likelihood function was possible for all six models.[25] We start the analysis by testing the null hypothesis: Conditional currency exchange rate volatility (own and G-3) does not impact South African exports (total and agricultural).

In four out the six models, the GARCH volatility estimates in the export mean equation, γ_{14}, and their associated standard errors lead us to reject the null hypothesis of no-effect of own currency (ZAR/USD) and third country currency (EUR/USD and JPY/USD) exchange rate volatilities on total and agricultural exports from South Africa at the 0.05 significance level (Table 4-16). In addition, the direction of the impact is surprisingly mixed; positive in the case of total exports, meaning that as exchange rate volatility increases, total export growth increases; and negative in the case of "agricultural exports and EUR/USD exchange rate" implying that as exchange

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[25] Agricultural exports and Own, and JPY/USD exchange rate models converged with one lag.

rate volatility increases, agricultural export decreases. Contrary to what decision theory would predict, a positive effects of exchange rate volatility on exports are also found in empirical works. Notice that the magnitudes of those positive coefficients are smaller compared to negative ones.

Another important relationship to analyze is the one that measures the effects export uncertainty on the growth of total amount of exports, γ_{13}. Coefficients for export uncertainty are significant (at 0.01 significance level) and positively related to South African total export growth. This coefficient is not significant in the case of agricultural exports. Yet the positive sign of this coefficient is consistent across South African models, the direction of the effect was not as expected according to decision theory.

In analyzing the autoregressive terms, past changes of exports, $\gamma_{11, t-1}$, had a significant and negative effect over current agricultural and total export growth in South Africa. It could be the case that South African merchants create export market expectations and take export decisions in a quarterly basis. The negative sign of the coefficient means that an increase in past export-growth leads to a decrease of current month exports-growth. However, in the model "total exports and own currency exchange rate" the sum of autoregressive terms is positive. In the exchange rate mean equation, past changes in exchange rates at lag one, $\gamma_{22, t-1}$, are positive and statistically significant for all models (at 0.01 significance level). Hence past changes in exchange rates lead to greater actual exchange rate growth..

Table 4-16. South Africa Bivariate-GARCH-in-mean Estimates.

Nomenclature Parameters		Total Exports OWN/USD Vol			EUR/USD Vol			JPY/USD Vol			Agricultural Exports OWN/USD Vol			EUR/USD Vol			JPY/USD Vol		
		Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig
$B_{(1)}$	γ_{10}	-0.116	0.069	*	-0.043	0.085		-0.119	0.093		-0.169	0.152		0.386	0.629		-0.267	0.304	
$B_{(2)}$	γ_{20}	0.021	0.013		-0.025	0.023		-0.010	0.033		0.007	0.017		0.009	0.067		-0.003	0.055	
$AR_{1(1,1)}$	$\gamma_{11,t-1}$	-0.608	0.049	***	-0.572	0.048	***	-0.560	0.048	***	-0.382	0.046	***	-0.542	0.051	***	-0.378	0.046	***
$AR_{1(2,1)}$	$\gamma_{21,t-1}$	-0.016	0.010		-0.005	0.010		-0.005	0.010		-0.025	0.009	***	-0.007	0.010		-0.001	0.009	
$AR_{1(1,2)}$	$\gamma_{12,t-1}$	-0.446	0.141	***	-0.209	0.185		-0.026	0.174		-0.128	0.159		0.024	0.202		0.157	0.196	
$AR_{1(2,2)}$	$\gamma_{22,t-1}$	0.273	0.060	***	0.253	0.055	***	0.284	0.047	***	0.242	0.051	***	0.252	0.052	***	0.282	0.046	***
$AR_{2(1,1)}$	$\gamma_{11,t-2}$	-0.375	0.044	***	-0.352	0.043	***	-0.341	0.042	***				-0.363	0.046	***			
$AR_{2(2,1)}$	$\gamma_{21,t-2}$	0.022	0.010	**	0.004	0.010		-0.006	0.010					-0.003	0.011				
$AR_{2(1,2)}$	$\gamma_{12,t-2}$	0.212	0.135		-0.295	0.187		-0.246	0.170					-0.633	0.199	***			
$AR_{2(2,2)}$	$\gamma_{22,t-2}$	-0.050	0.041		-0.040	0.048		-0.036	0.043					-0.045	0.048				
$AR_{3(1,1)}$	$\gamma_{11,t-3}$	1.118	0.645	*	0.799	0.612		0.733	0.487					-0.061	0.044				
$AR_{3(2,1)}$	$\gamma_{21,t-3}$	-0.159	0.116		-0.089	0.112		0.227	0.123	*				-0.003	0.010				
$AR_{3(1,2)}$	$\gamma_{12,t-3}$	-0.158	0.247		-1.782	1.905		1.407	2.838					0.368	0.201	*			
$AR_{3(2,2)}$	$\gamma_{22,t-3}$	-0.126	0.098		1.378	0.871		-0.564	1.126					0.018	0.043				
$GM_{(1,1)}$	γ_{13}	0.004	0.002	**	0.006	0.002	**	0.004	0.002	***	1.391	1.214		-2.699	5.265		1.907	2.188	
$GM_{(2,1)}$	γ_{23}	0.001	0.000	***	0.000	0.000	***	0.001	0.000	***	-0.036	0.132		-0.287	0.533		0.197	0.285	
$GM_{(1,2)}$	**γ_{14}**	**0.114**	**0.053**	****	**0.117**	**0.050**	****	**0.112**	**0.046**	****	**-0.191**	**0.271**		**-3.059**	**1.776**	*****	**0.953**	**4.535**	
$GM_{(2,2)}$	γ_{24}	0.854	0.168	***	0.119	0.051	**	0.077	0.060		-0.108	0.088		0.986	0.713		-0.827	1.546	
$VCV_{(1)}$	ω_1	0.529	0.185	***	0.417	0.206	**	0.531	0.141	***	0.007	0.003	**	0.017	0.006	***	0.006	0.003	*
$VCV_{(2)}$	ω_2	0.001	0.026		0.451	0.144	***	-0.318	0.210		0.001	0.000	***	0.000	0.000	**	0.001	0.000	***
$VBV_{(1)}$	α_{11}	-0.204	0.047	***	-0.149	0.045	***	-0.091	0.046	**	0.070	0.068		0.034	0.051		0.051	0.075	
$VBV_{(2)}$	α_{22}	-0.116	0.069	*	-0.043	0.085		-0.119	0.093		0.863	0.171	***	0.133	0.051	***	0.062	0.053	
$VAV_{(1)}$	β_{11}	0.021	0.013		-0.025	0.023		-0.010	0.033		0.484	0.207	**	-0.289	0.445		0.562	0.266	**
$VAV_{(2)}$	β_{22}	-0.608	0.049	***	-0.572	0.048	***	-0.560	0.048	***	-0.007	0.030		0.517	0.146	***	-0.324	0.246	
$QC_{(1,1)}$	ρ_{12}	-0.016	0.010		-0.005	0.010		-0.005	0.010		-0.172	0.046	***	-0.159	0.045	***	-0.082	0.049	*

In general, South African export models present statistically significant ARCH α_{11} and α_{22} and or GARCH β_{11} and β_{22} coefficients in the variance equations, meaning that exports and exchange rates are well modeled by a GARCH process.

4.2.6 Honduras

In the case of the Honduran bivariate models, the estimation of the log likelihood function was not possible for third country currency (JPY/USD) models. Consequently the analysis is based only on the other four models which estimation was accomplished. We start the analysis by testing the null hypothesis: Conditional currency exchange rate volatility (own and G-3) does not impact Honduran exports (total and agricultural).

In two out of four models, the GARCH volatility estimates in the export mean equation, γ_{14}, and their associated standard errors lead us to reject the null hypothesis of no-effect of own currency (HNL/USD) exchange rate volatility on total exports at 0.01 significance level; and third country exchange rates (EUR/USD) volatility on agricultural exports at the 0.10 significance level (Table 4-17). In addition, the direction of the impact is surprisingly positive, meaning that as exchange rate volatility increases, total export growth increases. Positive effects of exchange rate uncertainty on exports are also found in empirical works. This positive effect could be due to the long periods of fixed exchange regime prevailed in Honduras for several decades.

Another important relationship to analyze is the one that measures the effects of export uncertainty on the growth of total exports, γ_{13}. Coefficients for export

uncertainty are significant, at 0.05 significance level, and positively related to Honduran total and agricultural export growth. Yet the positive sign of this coefficient is consistent across Honduran models, the direction of the effect was not as expected according to decision theory.

In analyzing the autoregressive terms, past export growth, $\gamma_{11, t-1}$, had a significant and negative effect over current total export growth in Honduras. The negative sign of the coefficient means that an increase in past export-growth leads to a decrease of current month exports-growth. The same coefficients were not significant in the case of agricultural exports.

The situation is different in the exchange rate mean equation, past changes in exchange rates at lag one, $\gamma_{22, t-1}$, are positive and statistically significant for all models. Hence past exchange rate growth lead to greater actual exchange rate growth. Except for "agricultural exports and own HNL/USD exchange rates" model, Honduran models present statistically significant ARCH α_{11} and α_{22} and or GARCH β_{11} and β_{22} coefficients in the variance equations, meaning that exports and exchange rates are well modeled by a GARCH process. In the particular case in which ARCH and/or GARCH effects are not significant, the TYDL methodology for the first hypothesis is an alternative to unveil the potential effects of exchange rates on exports.

Table 4-17. Honduras Bivariate-GARCH-in-mean Estimates.

Nomenclature	Parameters	Total Exports OWN/USD Vol			EUR/USD Vol			JPY/USD Vol			Agricultural Exports OWN/USD Vol			EUR/USD Vol			JPY/USD Vol		
		Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig	Coeff	SE	Sig
B$_{(1)}$	γ_{10}	-0.052	0.006	***	2.063	0.499	***	-0.025	0.008	***	-0.319	0.243		-0.112	0.013	***	-8.761	0.535	***
B$_{(2)}$	γ_{20}	-0.004	0.001	***	-1.432	0.267	***	0.019	0.001	***	0.006	0.006		0.001	0.001		-0.914	0.040	***
AR$_{1(1,1)}$	$\gamma_{11,t-1}$	-0.083	0.016	***	-0.138	0.070	**	-0.183	0.005	***	-0.023	0.070		-0.116	0.076		-0.146	0.076	*
AR$_{1(2,1)}$	$\gamma_{21,t-1}$	0.001	0.002		0.005	0.010		0.019	0.001	***	-0.003	0.002		0.025	0.010	***	0.000	0.011	
AR$_{1(1,2)}$	$\gamma_{12,t-1}$	-2.019	0.080	***	0.325	0.375		0.556	0.273	**	-1.540	1.648		0.506	0.460		0.529	0.455	
AR$_{1(2,2)}$	$\gamma_{22,t-1}$	0.162	0.056	***	0.186	0.070	***	0.276	0.002	***	0.145	0.086	*	0.195	0.010	***	0.204	0.073	***
AR$_{2(1,1)}$	$\gamma_{11,t-2}$	0.075	0.001	***										0.063	0.061		0.099	0.062	
AR$_{2(2,1)}$	$\gamma_{21,t-2}$	-0.003	0.002	**										0.018	0.007	**	0.000	0.009	
AR$_{2(1,2)}$	$\gamma_{12,t-2}$	-0.717	0.028	***										-0.047	0.420		-0.557	0.409	
AR$_{2(2,2)}$	$\gamma_{22,t-2}$	0.031	0.033											0.058	0.013	***	-0.079	0.063	
AR$_{3(1,1)}$	$\gamma_{11,t-3}$	0.529	0.042	***	1.296	1.722		0.290	0.058	***	2.160	1.549		1.205	0.120	***	54.603	2.318	***
AR$_{3(2,1)}$	$\gamma_{21,t-3}$	0.027	0.006	***	-0.176	0.081	**	-0.269	0.009	***	-0.026	0.034		-0.087	0.003	***	-3.847	0.153	***
AR$_{3(1,2)}$	$\gamma_{12,t-3}$	-6.056	0.449	***	-91.652	18.529	***	-0.603	0.322	*	-2.765	5.202		-3.188	0.484	***	22.448	8.550	***
AR$_{3(2,2)}$	$\gamma_{22,t-3}$	-0.320	0.105	***	59.330	10.769	***	0.878	0.008	***	-0.562	0.285	**	0.563	0.031	***	59.454	2.669	***
GM$_{(1,1)}$	γ_{13}	0.045	0.000	***	0.022	0.009	**	0.029	0.001	***	0.025	0.006	***	0.020	0.002	***	0.012	0.004	***
GM$_{(2,1)}$	γ_{23}	0.000	0.000		0.000	0.000	***	0.001	0.000	***	0.000	0.000		0.001	0.000	***	0.000	0.000	***
GM$_{(1,2)}$	**γ_{14}**	**0.078**	**0.003**	***	**0.119**	**0.076**		**0.065**	**0.001**	***	**0.135**	**0.117**		**0.099**	**0.059**	*	**0.004**	**0.001**	***
GM$_{(2,2)}$	γ_{24}	0.150	0.014	***	0.006	0.002	***	0.184	0.002	***	0.149	0.058	***	0.173	0.004	***	0.006	0.001	***
VCV$_{(1)}$	ω_1	-1.041	0.001	***	-0.142	0.449		-0.487	0.035	***	-0.180	0.188		0.066	0.078		0.448	0.186	**
VCV$_{(2)}$	ω_2	0.838	0.022	***	0.210	0.153		-0.411	0.009	***	0.810	0.064	***	-0.545	0.026	***	0.210	0.141	
VBV$_{(1)}$	α_{11}	0.091	0.070		0.075	0.067		0.058	0.069		0.054	0.072		0.016	0.063		0.071	0.072	
VBV$_{(2)}$	α_{22}	-0.052	0.006	***	2.063	0.499	***	-0.025	0.008	***	-0.319	0.243		-0.112	0.013	***	-8.761	0.535	***
VAV$_{(1)}$	β_{11}	-0.004	0.001	***	-1.432	0.267	***	0.019	0.001	***	0.006	0.006		0.001	0.001		-0.914	0.040	***
VAV$_{(2)}$	β_{22}	-0.083	0.016	***	-0.138	0.070	**	-0.183	0.005	***	-0.023	0.070		-0.116	0.076		-0.146	0.076	*
QC$_{(1,1)}$	ρ_{12}	0.001	0.002		0.005	0.010		0.019	0.001	***	-0.003	0.002		0.025	0.010	***	0.000	0.011	

4.2.7 Turkey

In the case of Turkish bivariate models, the estimation of the log likelihood function was not possible for agricultural exports and own country currency (TRY/USD) model. Therefore, this model is excluded from the following analysis. We start the analysis by testing the null hypothesis: Conditional currency exchange rate volatility (own and G-3) does not impact Turkish exports (total and agricultural).

The GARCH volatility estimates in the export mean equation, γ_{14}, and their associated standard errors lead us to reject the null hypothesis of no-effect of exchange rate volatility only in "total exports and third country currency (EUR/USD) exchange rate" model at 0.01 significance level (Table 4-18). In line with decision theory, the direction of the impact is negative, meaning that as exchange rate volatility increases, total export growth decreases. This null hypothesis could not be rejected in the other four estimated models, meaning that there is no effect from own exchange rate volatility on Turkish total exports, and no effect of third country (EUR/USD and JPY/USD) currency volatility on Turkish agricultural total exports.

Another important parameter to analyze is the one that measures the effects export uncertainty on the growth of total amount of exports, γ_{13}. Coefficients for export uncertainty are significant, at 0.05 significance level, and negatively related to Turkish total and agricultural export growth. The negative sign of this coefficient is as expected based on decision theory, and this direction is consistent across Turkish models. In analyzing the autoregressive terms, past export growth, $\gamma_{11,\,t-1}$, had a significant and negative effect over current total and agricultural export growth in Turkey.

Table 4-18. Turkey Bivariate-GARCH-in-mean Estimates.

Nomenclature	Parameters	Total Exports OWN/USD Vol Coeff	SE	Sig	EUR/USD Vol Coeff	SE	Sig	JPY/USD Vol Coeff	SE	Sig	Agricultural Exports OWN/USD Vol Coeff	SE	Sig	EUR/USD Vol Coeff	SE	Sig	JPY/USD Vol Coeff	SE	Sig
B(1)	γ_{10}	0.040	0.024	*	0.026	0.006	***	-0.018	0.047		0.045	0.000	***	-0.020	0.050		0.119	0.140	
B(2)	γ_{20}	-0.026	0.006	***	0.000	0.000	***	-0.030	0.017	*	-0.001	0.001	**	-0.025	0.011	**	0.028	0.058	
AR1(1,1)	$\gamma_{11,t-1}$	-0.386	0.047	***	-0.340	0.008	***	-0.321	0.048	***	-0.225	0.017	***	-0.313	0.062	***	-0.285	0.075	***
AR1(2,1)	$\gamma_{21,t-1}$	-0.043	0.007	***	-0.032	0.002	***	-0.005	0.007		-0.029	0.006	***	-0.012	0.006	*	-0.004	0.007	
AR1(1,2)	$\gamma_{12,t-1}$	0.008	0.155		0.114	0.134		0.166	0.237		0.154	0.022	***	0.238	0.265		0.180	0.255	
AR1(2,2)	$\gamma_{22,t-1}$	0.065	0.052		0.091	0.002	***	0.245	0.047	***	0.250	0.034	***	0.240	0.052	***	0.279	0.050	***
AR2(1,1)	$\gamma_{11,t-2}$	-0.112	0.045	**										-0.072	0.043	*	-0.061	0.047	
AR2(2,1)	$\gamma_{21,t-2}$	-0.031	0.007	***										-0.014	0.006	**	-0.005	0.007	
AR2(1,2)	$\gamma_{12,t-2}$	-0.052	0.130											-0.369	0.265		0.120	0.264	
AR2(2,2)	$\gamma_{22,t-2}$	0.041	0.031											-0.058	0.049		-0.052	0.045	
AR3(1,1)	$\gamma_{11,t-3}$	0.022	0.045											-0.038	0.038		-0.037	0.036	
AR3(2,1)	$\gamma_{21,t-3}$	-0.025	0.008	***										-0.005	0.006		0.004	0.007	
AR3(1,2)	$\gamma_{12,t-3}$	-0.078	0.138											0.018	0.287		-0.070	0.273	
AR3(2,2)	$\gamma_{22,t-3}$	-0.039	0.028											0.024	0.041		0.046	0.047	
AR4(1,1)	$\gamma_{11,t-4}$	-0.066	0.041											-0.023	0.037		-0.029	0.035	
AR4(2,1)	$\gamma_{21,t-4}$	-0.001	0.008											-0.007	0.006		-0.002	0.007	
AR4(1,2)	$\gamma_{12,t-4}$	0.112	0.139											-0.010	0.250		0.098	0.249	
AR4(2,2)	$\gamma_{22,t-4}$	0.032	0.023											-0.034	0.041		-0.017	0.045	
GM(1,1)	γ_{13}	-0.393	0.162	**	-0.299	0.040	***	-0.376	0.164	**	-0.428	0.023	***	-0.475	0.199	**	-0.441	0.165	***
GM(2,1)	γ_{23}	0.147	0.032	***	0.010	0.000	***	0.030	0.020		-0.040	0.004	***	0.029	0.018		0.046	0.023	**
GM(1,2)	$\boldsymbol{\gamma_{14}}$	-0.275	0.185		-0.330	0.109	***	1.655	1.594		-0.263	0.111	**	2.180	1.488		-3.258	5.121	
GM(2,2)	γ_{24}	0.081	0.089		-0.016	0.001	***	1.018	0.652		0.254	0.015	***	0.769	0.404	*	-1.356	2.155	
VCV(1)	ω_1	0.000	0.000		0.005	0.000	***	0.006	0.002	***	0.020	0.001	***	0.015	0.003	***	0.018	0.004	***
VCV(2)	ω_2	0.000	0.000	***	0.001	0.000	***	0.000	0.000	***	0.001	0.000	***	0.000	0.000	***	0.001	0.000	***
VBV(1)	α_{11}	0.023	0.009	***	0.373	0.003	***	0.382	0.085	***	0.532	0.002	***	0.556	0.101	***	0.514	0.111	***

Table 4-18. Continued.

Nomenclature		OWN/USD Vol			EUR/USD Vol			JPY/USD Vol			OWN/USD Vol			EUR/USD Vol			JPY/USD Vol		
		Total Exports									**Agricultural Exports**								
Parameters		**Coeff**	**SE**	**Sig**	**Coeff**	**SE**	**Sig**	**Coeff**	**SE**	**Sig**	**Coeff**	**SE**	**Sig**	**Coeff**	**SE**	**Sig**	**Coeff**	**SE**	**Sig**
VBV$_{(2)}$	α_{22}	1.341	0.166	***	1.388	0.012	***	0.144	0.052	***	1.514	0.055	***	0.192	0.062	***	0.051	0.051	
VAV$_{(1)}$	β_{11}	0.975	0.009	***	0.437	0.010	***	0.417	0.117	***	-0.067	0.004	***	0.040	0.077		-0.014	0.105	
VAV$_{(2)}$	β_{22}	0.007	0.016		-0.029	0.000	***	0.474	0.140	***	0.004	0.012		0.449	0.118	***	-0.295	0.214	
QC$_{(1,1)}$	ρ_{12}	0.007	0.047		-0.023	0.041		-0.177	0.044	***	0.024	0.048		-0.175	0.045	***	-0.110	0.046	**

The negative sign of the coefficient means that an increase in past export-growth leads to a decrease of current month exports-growth in both total and agricultural exports.

The situation is different in the exchange rate mean equation, past changes in exchange rates at lag one, $\gamma_{22,\,t-1}$, are positive and statistically significant for all models with the exception of "total exports and own country currency exchange rates." Hence past exchange rate growth lead to greater actual exchange rate growth. There is enough evidence to support GARCH models in the case of Turkish exports and exchange rates as Turkish models present statistically significant ARCH α_{11} and α_{22} and or GARCH β_{11} and β_{22} coefficients in the variance equations.

4.3 Comparison of Estimated Exchange Rates Volatility

Figures 4-16 to 4-24 summarize the estimated exchange rates unconditional (M-STD) and conditional (GARCH) volatilities. It is evident that EUR/USD, JPY/USD, BRL/USD and ZAR/USD exchange rates are the more volatile with fluctuations ranging from -0.5 to 0.5. The rest of the currencies seem to be passive with oscillations between -0.2 to 0.2. These Figures show that the estimated GARCH residuals outperformed the moving standard deviation in predicting actual volatility. Notice that in every Figure the blue line representing the GARCH follows very closely the actual volatility as measured by the rates of change. Hence the GARCH assumption seems to be appropriate as most of the exchange rates show periods of high volatility followed by period of tranquility.
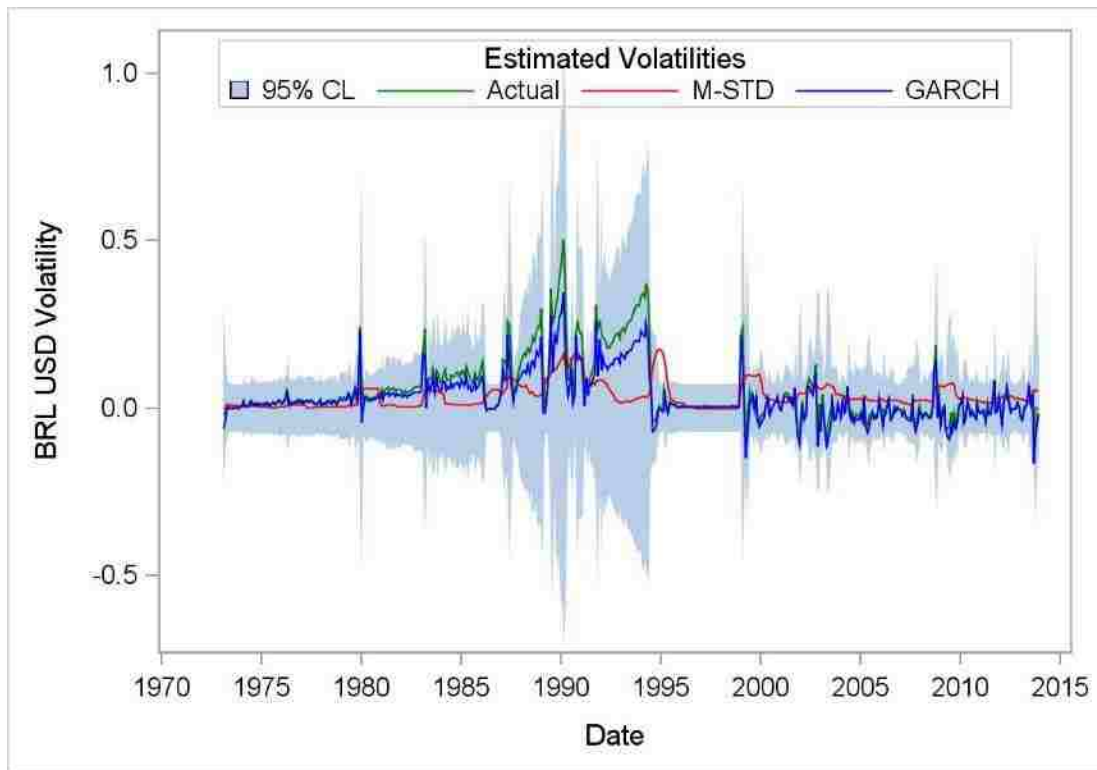
Figure 4-16. Brazilian Real (BRL/USD) Estimated Volatilities.
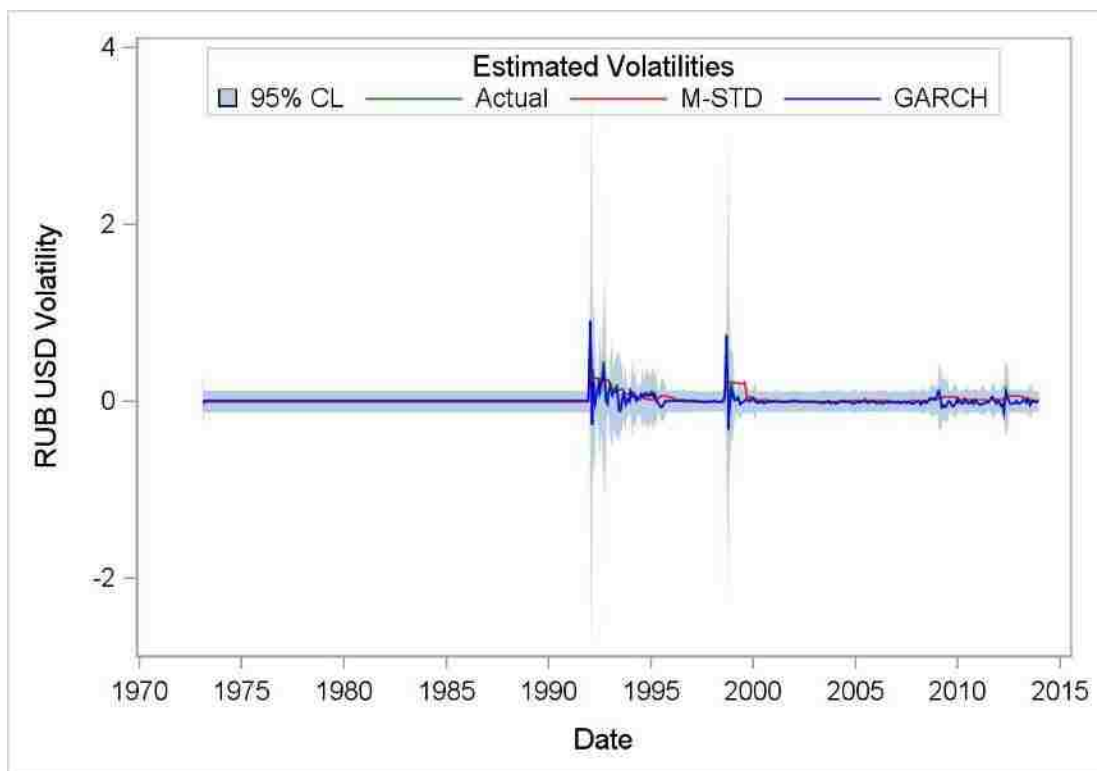
Figure 4-17. Russian Rouble (RUB/USD) Estimated Volatilities.

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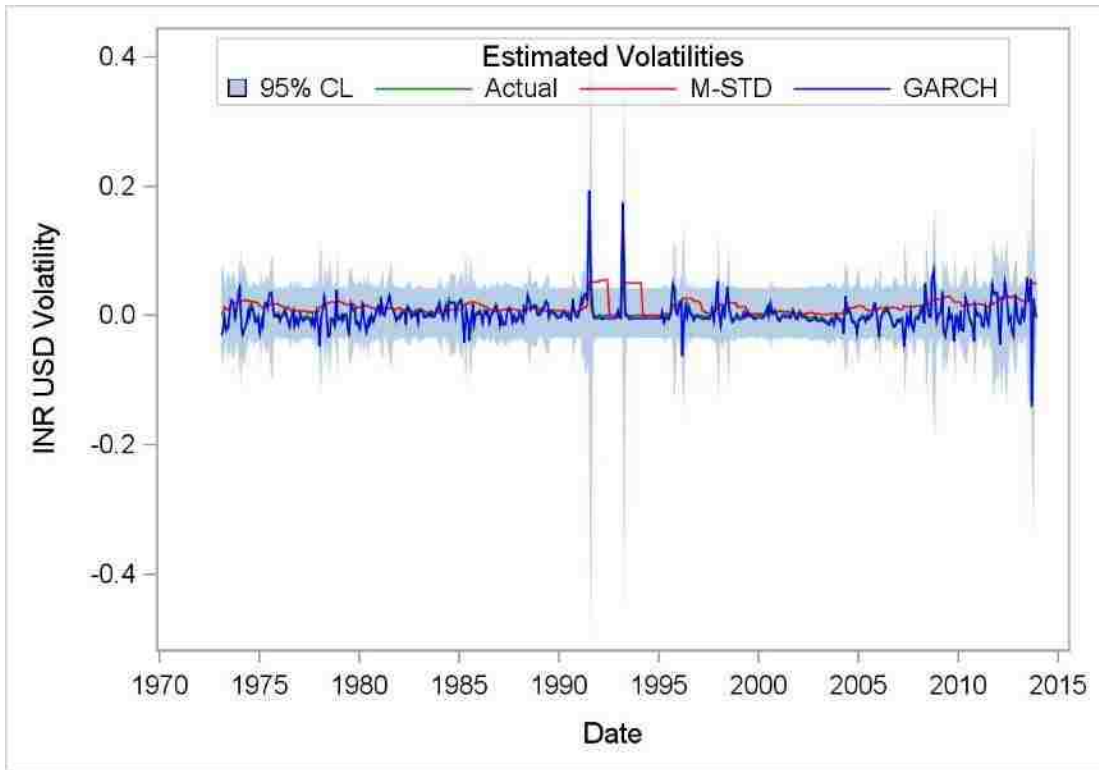
Figure 4-18. Indian Rupee (INR/USD) Estimated Volatilities.
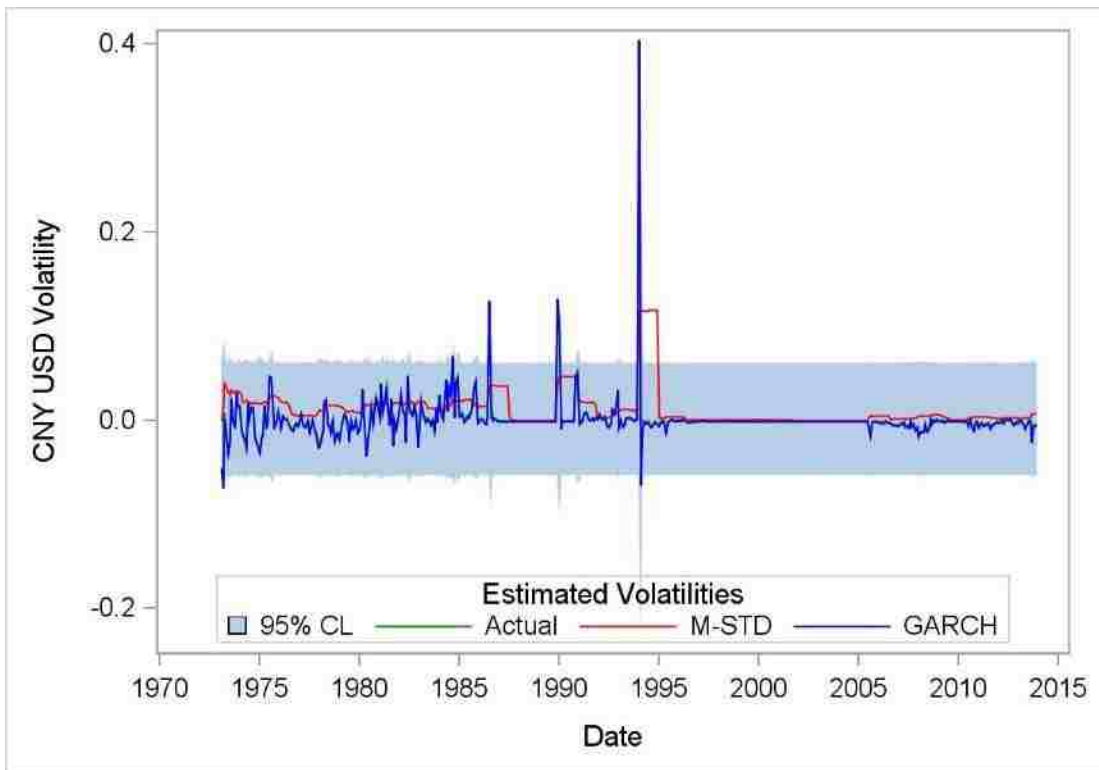
Figure 4-19. Chinese Yuan or Renminbi (CNY/USD) Estimated Volatilities.

113
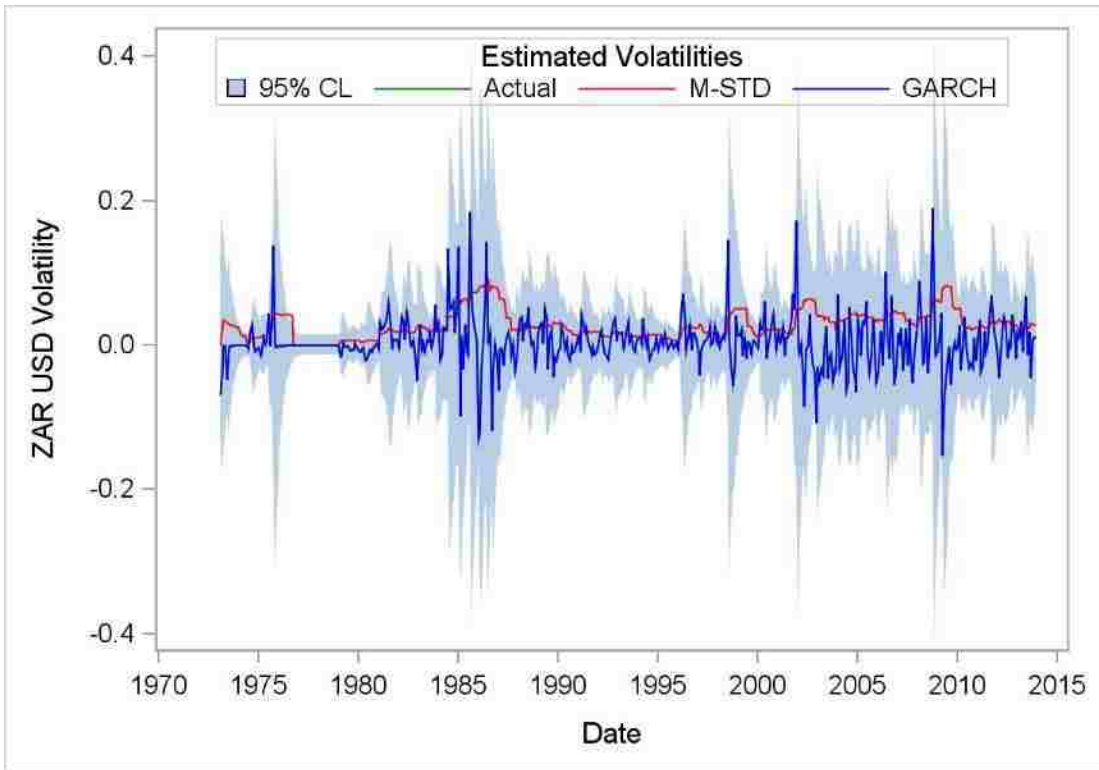
Figure 4-20. South Africa Rand (ZAR/USD) Estimated Volatilities.
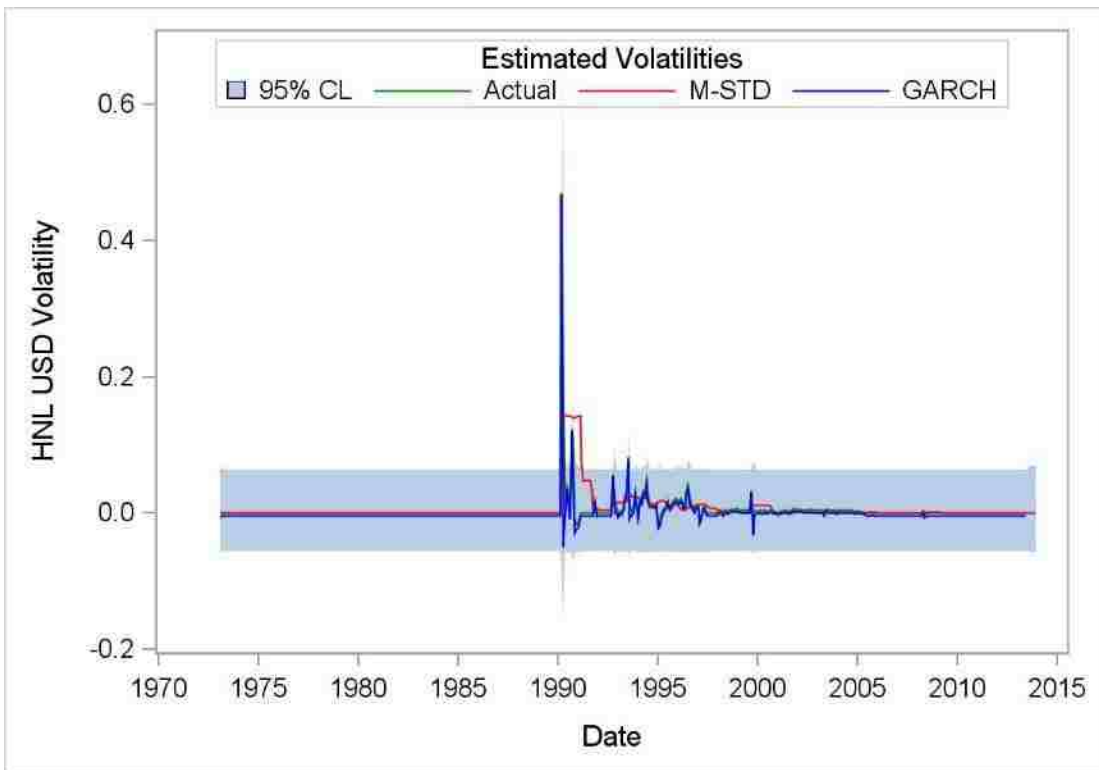
Figure 4-21. Honduran Lempira (HNL/USD) Estimated Volatilities.
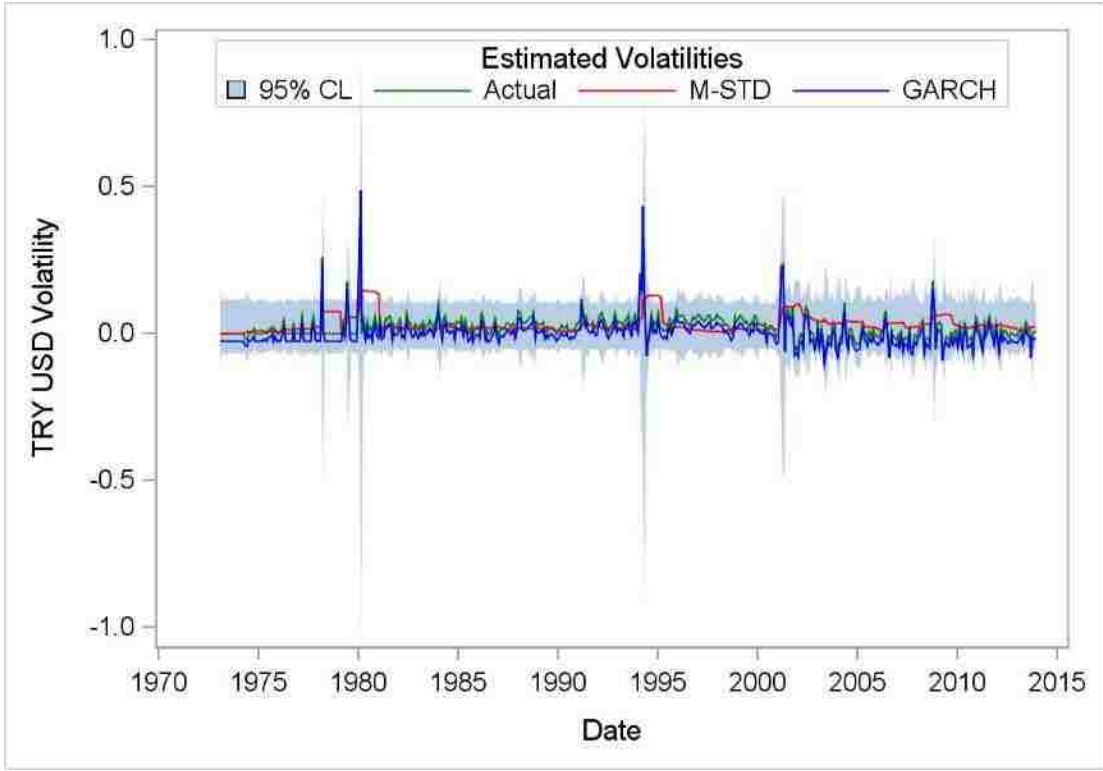
Figure 4-22. Turkish Lira (TYR/USD) Estimated Volatilities.
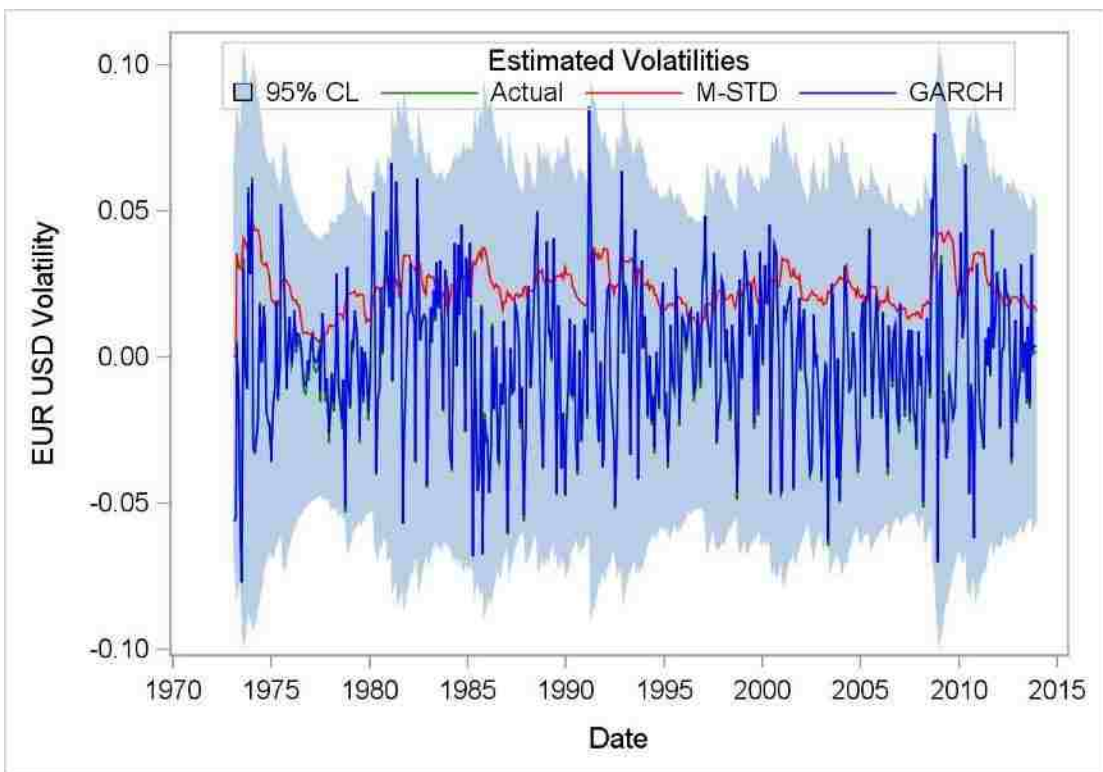
Figure 4-23. Euro-Zone Euro (EUR/USD) Estimated Volatilities.
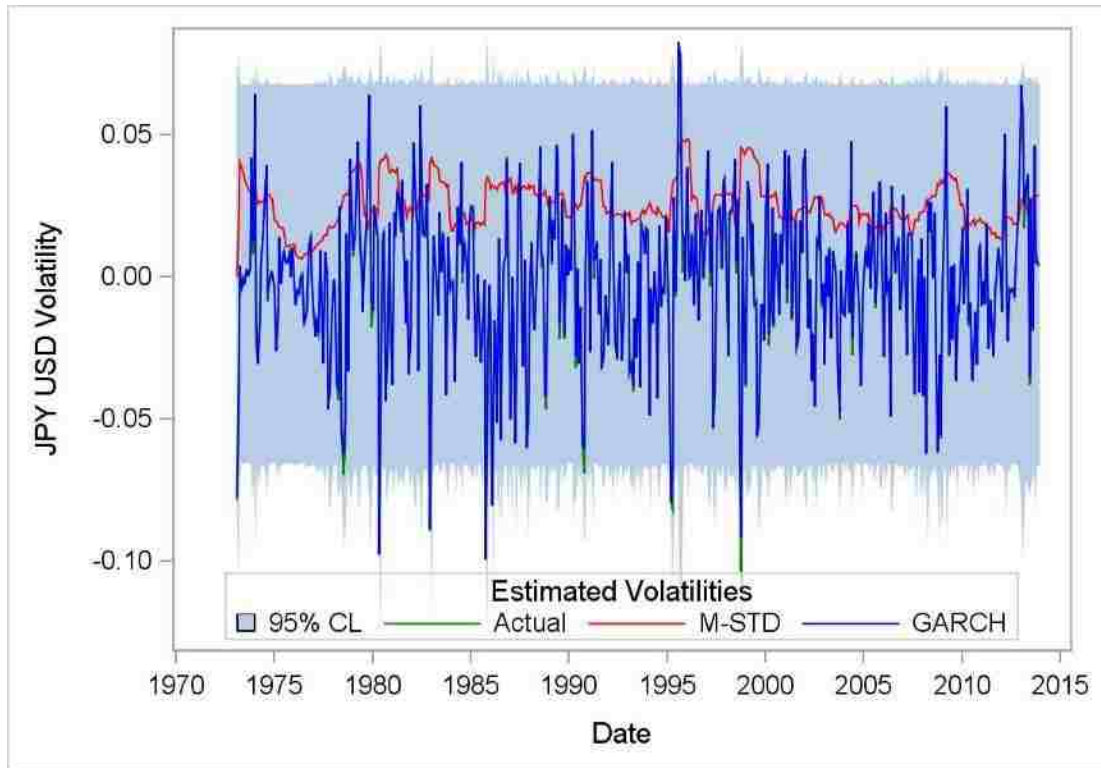
Figure 4-24. Japanese Yen (JPY/USD) Estimated Volatilities.

To conclude on the effects of exchange rate volatility on exports (no-effect, and significant positive and negative effects), we compare the results between TYDL and GARCH models (Table 4-19), and total and agricultural exports. In general TYDL and GARCH procedures were consistent in 13 tests, while they diverged in 19. The agreement rates between models/tests are: Turkey (4/5), Brazil (4/6), Honduras (3/4), India (1/6), South Africa (1/6), Russia (0/2), and China (0/2).

The direction of the effects on agricultural and total exports from TYDL and GARCH procedures came to an agreement in 21 tests, and diverged in 14. The agreement rates were: Brazil (6/6), China (4/4), Turkey (4/5), India (3/6), Russia (1/3), South Africa (3/6), and Honduras (1/5).

In Table 4-20, we compare real and nominal series models (TYDL models and total exports only). Model results came to agreement in nine and disagree in 13. Volatility measure CV detected 10 significant effects of exchange rate volatility on exports and M-STD six.

Table 4-19. ER Volatility Comparison of Real Total and Agricultural Exports.

Country	Exports	TDYL			GARCH			Exchange Rate Regime
		OWN	EUR/USD	JPY/USD	OWN	EUR/USD	JPY/USD	
Brazil	Total	-	-	-	-	-	0	Independently Floating
	AG	-	-	-	-	-	0	
China	Total	0	+	+	n/a	0	n/a	Crawling Peg
	AG	0	+	+	n/a	0	0	
India	Total	+	0	0	+	+	+	Managed Floating With No Predetermined Path for Exchange Rate
	AG	0	0	0	-	+	-	
Russia	Total	0	-	+	-	n/a	n/a	Other conventional fixed peg arrangement
	AG	-	-	-	n/a	0	n/a	
South Africa	Total	-	0	0	+	+	+	Independently Floating
	AG	-	0	0	0	-	0	
Turkey	Total	0	0	0	0	-	0	Independently Floating
	AG	0	0	0	n/a	0	0	
Honduras	Total	0	0	0	+	0	n/a	Other conventional fixed peg arrangement
	AG	0	+	+	0	+	n/a	

Table 4-20. ER Volatility Effect Comparison of Real and Nominal Total Exports.

Country	Exports	OWN	TDYL EUR / USD	JPY / USD	Exchange Rate Regime
Brazil	Real	-	-	-	Independently Floating
	Nominal	0	-	0	
China	Real	0	+	+	Crawling Peg
	Nominal	+	0	0	
India	Real	+	+	-	Managed Floating With No Predetermined Path for Exchange Rate
	Nominal	0	0	0	
Russia	Real	0	-	+	Other conventional fixed peg arrangement
	Nominal	0	0	0	
South Africa	Real	-	0	0	Independently Floating
	Nominal	0	0	0	
Turkey	Real	0	0	0	Independently Floating
	Nominal	+	0	0	
Honduras	Real	0	0	0	Other conventional fixed peg arrangement
	Nominal	0	0	0	

5   SUMMARY AND CONCLUSIONS

5.1   Summary

At the fourth BRICS summit in New Delhi, India, the leaders of the five leading emerging economies claimed that G-3 currency exchange rate volatility negatively impacts their exports and expressed their desire for less trade dependence on these currencies. The motivation of this study was to empirically test this claim and provide evidence of its validity or nullity. Hence, the general research question addressed in this work was: "Have own and/or third country exchange rate volatilities impacted exports from Brazil, Russia, India, China, South Africa (BRICS countries), Turkey, and Honduras; and, if that is the case, what is the direction of this impact?" To this end two general null hypotheses (objectives) were tested: 1) Unconditional (constant) currency exchange rate volatility does not Granger cause ($\nrightarrow$) exports. 2) Conditional (stochastic) currency exchange rate volatility does not impact exports. Unconditional volatility's main assumption is constant variance (homoskedasticity) and is estimated through moving standard deviation (M-STD), and coefficient of variation (CV); conditional volatility assumes heteroskedasticity and is estimated using ARCH models. The null hypotheses were tested separately for the national (own) vis-à-vis USD currency exchange rate volatility, and for third country currency exchange rate volatility (G-3: EUR/USD and/or JPY/USD).

In order to achieve the first objective, it was opted to implement the modified Wald test as in the procedure proposed by Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) –TYDL- to test for Granger non-causality in the context of a Vector Autoregressive (VAR) dynamic system (the economic model) of exports,

foreign income (GDP), relative prices (Exchange rates vis-à-vis the USD), and own and third country currency exchange rate volatilities. The mix of orders of integration found in the variables as suggested by a battery of unit root tests (ADF, PP, ERS, NgP (DFGLS, MPT MSB, MZ, MZa, and PT), and KPSS) was the main justification to carry out Granger non-causality tests using the TYDL procedure over a strong contender like Johansen's (1991) methodology (the later involves testing for co-integration and building a Vector Error Correction Model (VECM)). In total, 84 models were estimated using quarterly data from 1973 to 2013; they differ according to country, series type (real or nominal), type of volatility (M-STD and CV), exchange rates (own and third country), and exports (agricultural and total)[26].

The second objective was accomplished by estimating six sets of bivariate GARCH(1,1)-M models for each of the seven countries and test for the significance of the volatility parameter estimate via t-tests. The models used monthly data in log first differences as unit root test suggested I(1) process in all variables. The mean equations were bivariate VAR(k) which k lags were selected according to statistical selection criteria AICc and SBC, and ACFs and PACFs. The variance or volatility equations were time-invariant or constant-correlation models following Bollerslev (1990) procedure. The maximum likelihood estimation was possible for 32 out of 42 bivariate GARCH-M models formulated.

The contributions to the empirical literature in agricultural economics are: an assessment of the risk faced by BRICS quarterly agricultural exports due to exchange

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[26] There are different types of series used in previous studies, thus our models and test results allow for a broader comparison.

rate volatility compared to non-agricultural exports (total exports minus agricultural);

an extensive comparison between sources of potential mixed results in past works:

different types of series, real and nominal, types of volatility measures (CV, M-STD

and GARCH); the very long series covering since the end of Breton Woods in 1973

to the first quarter of 2013, the use of EUR/USD exchange rates since 1973 to

determine whether there is third currency volatility impact on BRICS agricultural and

total exports not used in other studies[27]; a modest update of the literature review since

the last review article of Bahmani-Oskooee and Hegerty (2007) is provided; the

identification of the time series properties is based on new unit root test developments

with more statistical power than the ones used in the typical procedures in this issue;

the implementation of the TYDL procedure to test for Granger non-causality of

exchange rates on quarterly agricultural and total exports compared to a bivariate-

GARCH(1,1)-M method that uses monthly data; and the use of actual World GDP

quarterly series as a measure of foreign economic activity generated from GDP

growth rates published by the IMF.

5.2   Findings and Discussion

One contribution of this work to the literature is in studying the differences

between the risk faced by agricultural exports and total exports due to exchange rate

volatility in relative prices, and third country exchange rate volatility for BRICS,

Turkey and Honduras. The results of this work support the general assumption that

the degree of the impact of exchange rate volatility, and sometimes its direction, on

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[27] a GDP weighted average of the currencies which were merged into the Euro were used for the years prior the Euro coins and banknotes entered circulation,1973-2001.

exports differs across sectors. For Brazil own and third country RER volatility present

negative impact on agricultural and total exports (although for the 1957-1974 period

of fixed exchange rates, Coes (1981) found positive and zero effect of relative price

volatility on agricultural exports). The sign of the impact is associated to the risk

attitudes of the firms selling products overseas, negative sign is associated with risk

averse firms while positive sign with risk lovers (Broda and Romalis, 2011). Hence,

we gain more confidence on the results as Brazilian investors are categorized as risk

averse (Fonseca, 2013; and Park, 2012). In spite of vast efforts, Brazil capital markets

are still underdeveloped and thus risk management instruments are incomplete

(currency forward market and agricultural insurance markets) which are propitious

conditions for risk aversion. Some researchers argue that when exporters are risk

averse, there is a tendency to sell proportionally more differentiated goods to markets

with lower volatility vis-à-vis home currency (Broda and Romalis, 2011). Brazil's

two most important single currency markets by value have traditionally been the

Euro-Zone and the U.S. The BRL's highest volatility registered between 2002 and

2012 were with respect to EUR and USD (Figure 5-1). Yet the share of exports to

these markets suffered significant contractions (from 21.87% and 25.7% in 2002 to

17.35% and 11.07% in 2012), at the expense of an increasing export share to BRICS

which (from 8.12% in 2002 to 21.85% in 2012 mainly driven by China (Figures 5-2

and 5-3)). To be certain about whether export flows of more differentiated products

from BRICS are directed to less volatile currency markets, a study with disaggregated

data will be necessary. Moreover, the test results also indicate that Brazilian exports

are not sensitive to JPY/USD volatility, which is convincing since the share of

Brazilian exports to Japan changed only slightly from 3.48% in 2002 to 3.28% in 2012 (Figure 5-2). This small decrease is possibly not linked to exchange rate volatility. Finally, the absence of an effect of JPY/USD on Brazilian exports is analogous to the findings of Esquivel and Larrain (2002). The magnitude of the effect is another important element. The parameter estimates indicate that the degree of the effect of relative price (BRL/USD) volatility in Brazilian agricultural exports is less than that for total exports, and since total exports include agricultural exports, this result means that non-agricultural Brazilian exports are more vulnerable to exchange rate volatility than its agricultural counterparts. This sensitivity differential is explained by the high share of agricultural commodities in Brazilian agricultural exports (oil-cake, soybeans, sugar, poultry, coffee, and chemical wood pulp), and commodities that are known to have less (or no) response to exchange rate volatility than differentiated products (Broda and Romalis 2011). While the opposite is true for the magnitudes of the third country exchange rate impacts (EUR/USD) which volatility parameter estimates are larger for agricultural exports than they are for total exports. Additionally GARCH models explain that export volatility has a positive effect on export growth. Possibly Brazilian exporters manage business cycles successfully, or they switch export markets by redirecting export to economies in expansion like China whose share of Brazilian export market increased from 4.7% in 2002 to 17% in 2012. China's hunger for Brazil's mineral wealth (iron-ore, alumina, nickel, bauxite and copper) may explain why, yet sensitive to business cycles, basic materials and energy sectors weights are the second largest (after consumers) in Bovespa (Brazilian major equity index). As a concluding remark, the results were as

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expected because the problems that Brazil experienced during great part of the studied period, especially with the mismanagement of inflation and failed stabilization plans by the Central Bank of Brazil (Banco Central do Brasil, BCB), increased the exchange rate volatility which had negative consequences in Brazil's current account. At the present time, the IMF *de facto* classification for Brazil exchange rate arrangement is "independently floating" which is compatible with an "inflation targeting" monetary policy framework.

All tests indicate either that there is a positive or no-effect on Chinese exports. This result was expected Chinese exports have been booming, catapulted by an undervalued CNY and its very low volatility vis-à-vis the USD owed to the Chinese monetary policy framework that uses the USD as an anchor currency in a "*de facto* exchange rate regime - crawling peg.*" The share of Chinese exports to the EURO-Zone has remained stable during the last decade, a slight decrease of 4.21% to USA and 7.4% to Japan is registered, while the BRICS and ROW markets have absorbed these differences, and again the pricing of the bulk of the trade in these two markets is still dominated by the USD or any other G-3 currency. The magnitude of the coefficients between TYDL models that use agricultural exports from those that use total exports is similar. Hence no difference between the sensitivity for agricultural and non-agricultural exports exists. The bottom line is that the test results are in line with the assumption that artificially low CNY/USD exchange rate and its volatility, maintained by the People's Bank of China (PBOC), stimulates export growth. These results are consistent with other studies that found positive effects of pegged exchange rate regimes on trade (e.g., Ghosh et al., (1997); and Frankel and Rose,

(2002)). Overall the results are comparable to Chen's (2011) findings: positive effect of CNY/JPY volatility on Chinese agricultural exports, and depreciation of CNY is an export promoter, while appreciation detriments Chinese exports.

Exchange rate volatility effects on Honduran exports are also positive or non-significant, a result that is not surprising as the HNL had a "*de facto* fixed pegged exchange rate regime" using the USD as an anchor currency (from Jan 1973 to March 1990 and from November 2005 to February 2012), similar to that of China (Figure 5-1). Honduras main trading partner has traditionally been the U.S. who buys approximately 47% of Honduran exports, a share that has remained stable during the 2002-2012 period. A major change in markets is an increase of the share of Honduran exports to EURO-Zone by about eight percent from 2002 to 2012, same proportion of the decrease to ROW. In addition, the bulk of Honduran exports are non-differentiated products which tend to be non-sensitive to exchange rate volatility (with agriculture representing 32.4% and coffee alone accounting for 17% of total exports). Although not covering the same time periods, other studies found negative effects of exchange rate volatility on Honduran exports for the 1973–2004 period (Arize et al., (2008)). As for models using nominal and real data, no differences in the results were found in the case of Honduras.

In the case of Turkey, there is no effect of exchange rate volatility on agricultural exports. This is a good result given that at least the 11% that agriculture represents from total Turkish exports are not being negatively affected by exchange rate volatility. Total exports are, in general, not sensitive to exchange rate volatility (the same conclusion was reached in Esquivel and Larrain, (2002)). However in the

EUR/USD case, the TYDL model predicts a negative effect, while GARCH suggests

no-effect. Although more evidence is needed to establish a concrete conclusion, there

are some facts that may support the negative impact of EUR/USD. The share of

Turkish exports to the EURO-Zone dropped from 42.2% in 2002 to 26.77% in 2012,

coupled with a relatively high TRY/EUR exchange rate volatility amongst the other

currencies. The TRY experienced one of the highest volatilities from 2002 to 2012,

similar to the one faced by BRL and ZAR (Figure 5-1). The fragility of the TRY has

recently increased due to the confidence of investors in the Central Bank of the

Republic of Turkey (*Türkiye Cumhuriyet Merkez Bankası*-CBRT-) which is perceived

as non-proactive in taking actions against Lira's value losses.

South Africa's TYDL and GARCH model results agree only in no-effect from

JPY/USD volatility on agricultural exports. This is a logical result as the proportion

of trade flows from South Africa to Japan has not changed in a decade (2002-2012),

and the proportion of agricultural to total exports has remained almost constant at

about seven percent during the last 28 years. As for the other currency volatilities

ZAR/USD and EUR/USD, since there is disagreement between TYDL and GARCH

model results in regards to the direction of the effect, it is difficult to interpret and

infer. Nevertheless, there are no disagreements between the results of TYDL models

for agricultural and total exports, negative for ZAR/USD, while no-effect for third

country currency exchange rate volatility. Comparing results from TYDL models

using nominal and real data, there is only one case of disagreement in the ZAR/USD

volatility, negative (real) and no-effect (nominal). An important remark is that South

Africa has gradually been decreasing exports flows to traditional powerhouses like

the U.S. and the EURO-Zone to take a position in the BRICS market (13% increase from 2002 to 2012, Figure 5-1). In addition, the ZAR registered the highest volatility amongst the BRICS currencies with respect to G-3 currencies (Figure 5-1).

Models for India came to an agreement only for a positive effect of INR/USD on total exports. The share of Indian exports to USA decreased eight percent, but exports to ROW increased almost 10% possibly propelled by the INR/USD exchange rate stability as the majority of ROW countries use the USD (Figures 5-1 and 5-2).

Results from TYDL and GARCH models for Russia completely diverged in the direction of the effects. When comparing the results of agricultural and total export models, mixed effects directions are also found. Real and nominal data models solely agreed in the no-effect of RUB/USD exchange rate on total exports. The evidence of the no-effect *versus* a potential negative effect gains more weight as the RUB has a pegged exchange rate regime, and as seen in the Chinese and Honduras cases, two countries which have had "*de facto* fixed pegged exchange rate regimes," exchange rate volatility tend to either have a positive effect or no-effect on exports. In addition, exports flows have been very stable during the past decade, being the EURO-Zone Russia's major trading partner, and the RUB shows a low volatility comparable to the ones from CNY, HNL and INR (Figures 5-1 to 5-3).

A comparison of the "*de facto* exchange rates regimes" with the direction of the volatility effect on exports gives some signals of association. For example, Brazil and Turkey, two countries with independently floating exchange rate regimes have either negative or no-effect in third country exchange rate volatility. On the other

hand positive or no-effect on exports are found in China and Honduras, countries with pegged regimes (USD anchor currency). Although Russia has *de facto* pegged exchange rate regime, we are careful in making a conclusion due to the lack of convergence in four out of six GARCH models using monthly data, and the small sample size of quarterly data used in the TYDL models (1992-2013)

One of the purposes of the study was to explore on the mixed effects commonly found in the literature when using real and nominal data by using lower frequency data, quarterly and monthly, as opposed to annual as in the majority of studies. However, the number of disagreements found between real and nominal data models are still significant to reject a hypothesis of no difference.
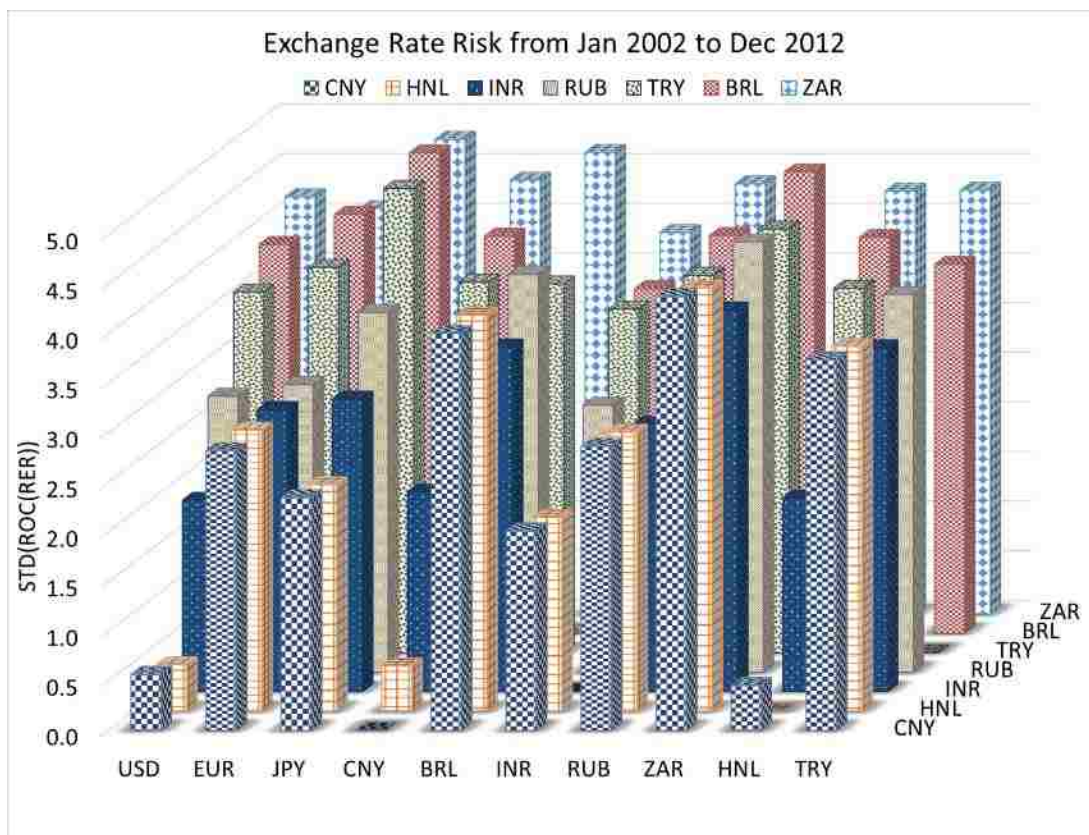
Figure 5-1. Exchange Rate Risk from 2002 to 2012.
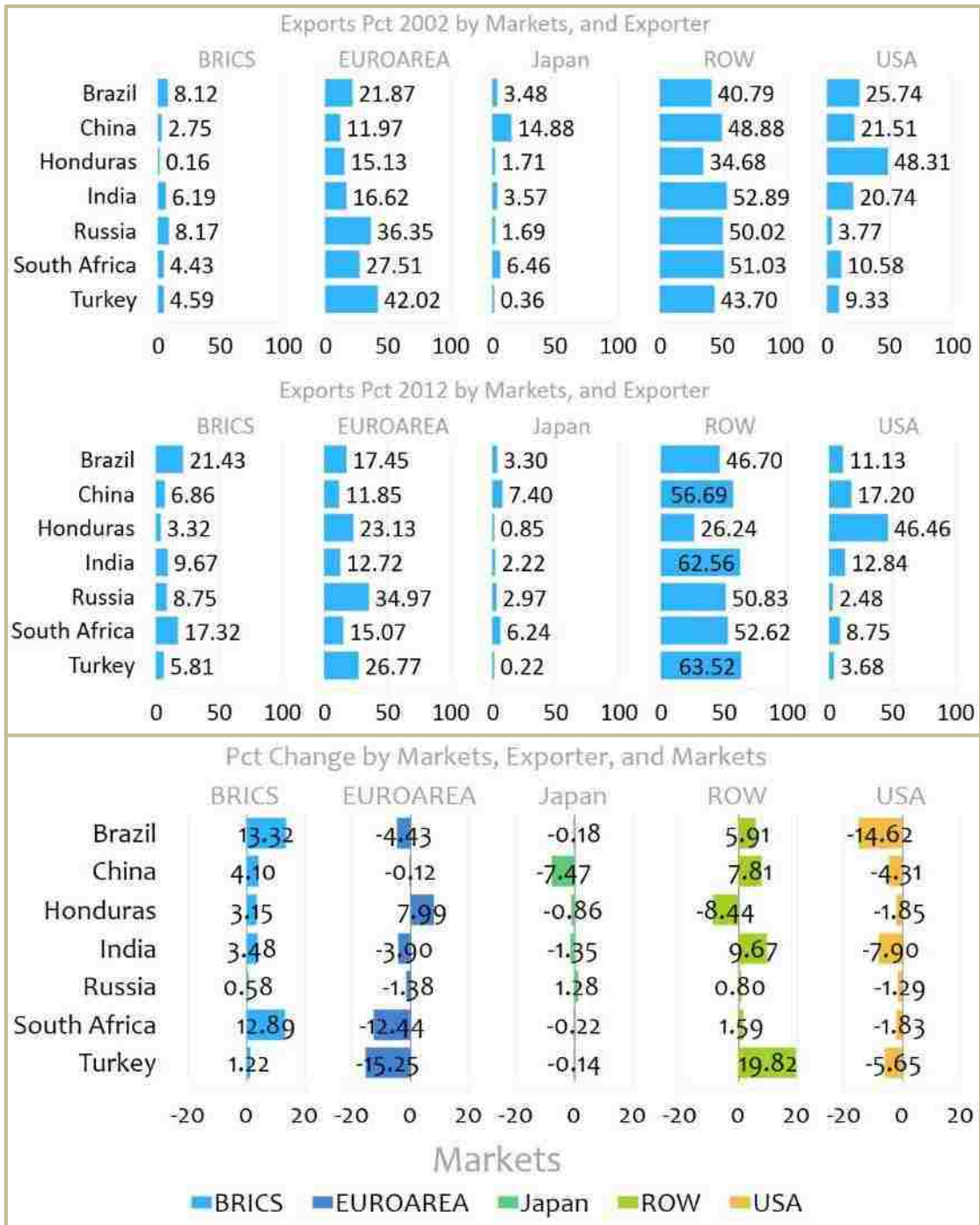
Figure 5-2. Country Trade Flows as Proportions to Total Exports to the World.
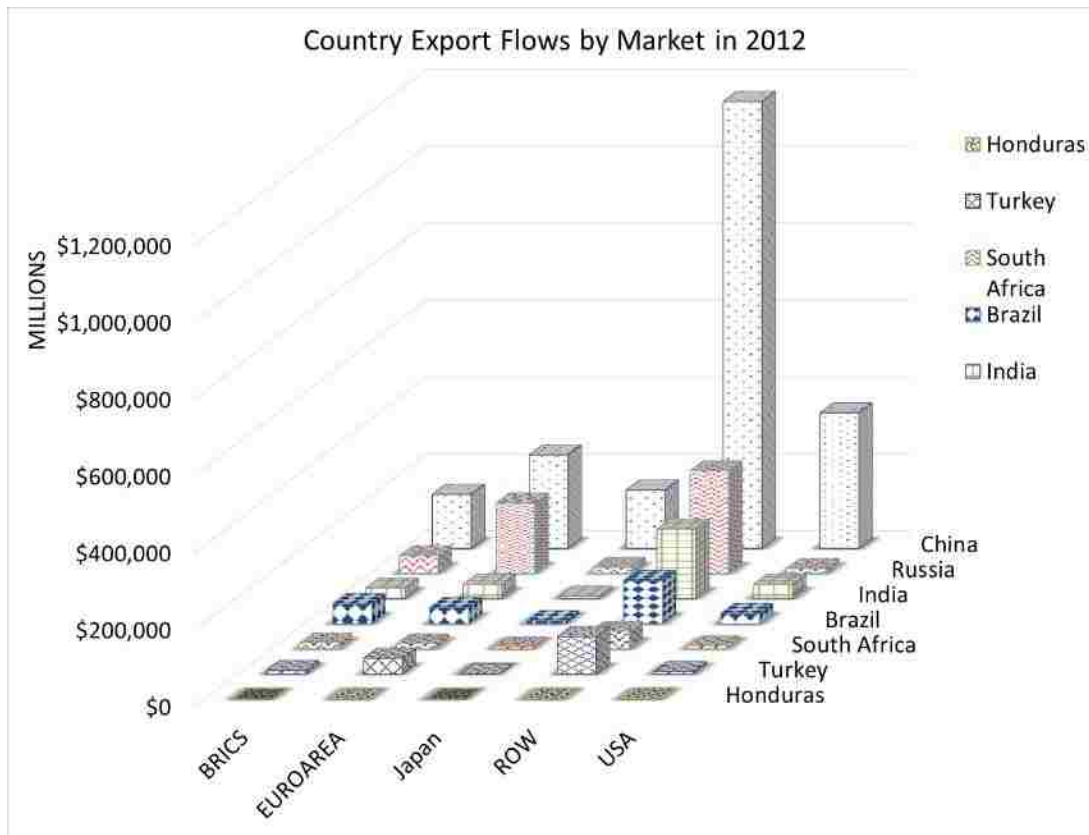
Figure 5-3. Country Export Flows in Levels by Markets.

5.3   Implications

There is empirical evidence of negative impact of exchange rate volatility on Brazilian agricultural and total exports. Since agriculture represents about 31% of Brazilian total exports, negative impacts on this sector's exports come with high degradation of the country current account. This is a result that may receive the attention of Brazilian leaders in designing the most appropriate policies to decrease the vulnerability of the agricultural sector to abrupt changes in exchange rate volatility. On the other hand there is evidence of no-effect and even positive effect of exchange rate volatility on Chinese and Honduran agricultural and total exports. Exports from Russia, India, South Africa and Turkey present mixed results. Taking into consideration that China, the largest economy and contributor to BRICS trade,

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have instead benefitted from its current exchange rate regime vis-à-vis the USD, whether the move away from the USD and the launching of a BRICS currency for intra-trade is aimed to reduce export revenue uncertainty in these countries is still dubious. Another reason is that the BRICS do not fulfil the requirements of an Optimum Currency Area (OCA) due to a low intra-trade (registered at 8.81% in 2012), and geographical dispersion. In spite of this initial idea, it appears that there is more inclination towards selecting a particular currency amongst the BRICS. And because of the dominance of China in the current trade flows, the Yuan is positioned as a stronger contender. As a matter of fact, there is an increasing number of bilateral swap agreements between the PBOC and partners' central banks that speeds up the internationalization of the Yuan for trade and investment. As for Brazil, the second largest BRICS economy, the Real is not a viable selection due to its obscure past of currency fluctuations, hyperinflation problems and loss of currency value that could easily increase currency risk well-beyond existing patterns in G3 countries, which may not be good for the BRICS.

The re-structuring of the Chinese economic growth model motivated by concerns over pollution, credit and real state bubbles, and a desire for less dependence on external demand and more on internal demand, led the Chinese government, on March 8, 2014, to sacrifice short term economic growth by targeting it at 7.5% for 2014. This implies that the current BRICS export growth boosted by Chinese demand of commodities is going to be heavily impacted, particularly in Brazil, whose biggest customer for metals and soybeans is China. A hope is still in

the hands of the advanced economies which industrial production indices have been giving good signals of improvement.

A general implication of the findings is the average time lag for adjustment of exports to changes in relative prices, income, and volatility ranges from four to six quarters, depending on the country and the modeled series; most of these adjustments are visible in the IRF functions, while others can be seen via parameter estimates of the VAR models. This could be an essential element to consider in deciding on future policy actions.

5.4   Policy Recommendations

At the pinnacle of the 2008 financial crisis, increased money supply in the U.S. helped emerging economies by providing liquidity. In March 2013, at the Durban BRICS Summit in South Africa, the leaders of these emerging economies expressed their concern with the unintended spillover effects such as capital outflows and currency depreciation that the tapering of the U.S. Fed monetary stimulus may create in these emerging economies. The leaders of the BRICS' and some other emerging countries in the G-20 call for an "effective, carefully calibrated and clearly communicated" normalization of the monetary policy in the advanced economies. While the central banks of the emerging economies considered the potential harm that hot money will create by maintaining artificially high interest rates, as experienced in the East Asian financial crisis of 1997, they opted for lower interest rates as a mean to control excessive capital inflows that could lead to bubbles. A fact is that after Bern Bernanke implied that the Fed would begin a gradual the reduction of assets purchases through Quantitative Easing "or tapering" on June 19, 2013 (which actually

started on December 18, 2013), investors started to move money from emerging markets back to the U.S. This has been generating losses in emerging country's currency values and increased volatility in the markets. Some economists believe that the problem is not the fall in currency values, but, on the contrary they fear that the timing and magnitude of the emerging economies central banks reactions may not be appropriate. In early 2014, their strategy has been to increase interest rates to reacquire currency values. However, this needs to be carefully done as BRICS economies are experiencing a slowdown, and the rise in interest rates could discourage BRICS economies even further. Brazil could be very affected as it has one of the largest ratio of FDI amongst BRICS nations, yet the country has been proactive in addressing currency depreciations to rebuilt investors' confidence. More fragile nations are Turkey, and South Africa as they have high deficits in their current accounts, and their Central Banks have not been proactive regarding to currency depreciations, which is a main concern to investors who in early 2014 have been punishing the value of these currencies by staying away from them as they do not inspire enough confidence. India has lately carried out a series of reforms to cut deficits and increase investor's confidence. Although current account deficits are not the problem of Russia due to the high surpluses ran by its oil and gas exports, the main concern is political turmoil. In the recent political crisis between the West and Russia over Ukraine, on March 3, 2014, the RUB plunged to a record low level against the EUR (50 RUB=1 EUR) and USD (36.4 RUB=1 USD). Also Russia's principal Stock Exchange, the MICEX, registered a 10% loss. This shows the vulnerability of RUB to geopolitical instability. As a measure intended to prevent

further loss of currency value, the Central Bank of Russia (CBR) has raised interest rates from 5.5% to 7%.

Emerging markets' central banks and other governmental institutions have a bad reputation for not being reliable due to their mismanagement of and/or inability to anticipate economic shocks. Therefore more efforts to rebuild confidence in investors is needed through the implementation of sound economic policies. More efforts to develop capital markets, investment in the development of more risk management tools, more reforms to ease inflows and retention of capital, monetary policies designed to stabilize currency exchange rate are needed.

Given the risk faced by agricultural exports, its high importance as percentage of total exports, and its vulnerability to exchange rate volatility, especially in Brazil, more efforts are needed to invert negative impacts which, besides reducing trade, affects food security (Figure 1-2). In particular, incentives that aims to develop agriculture technology, boost agricultural productivity and agricultural production are expected to have an influence on exports. In addition, a continued commitment is needed to develop financial risk management tools to aid producers, aid exporters to diminish their risk and, in turn become less risk averse (although Brazil is a pioneer in Latin America in crop insurance and some other risk management tools to help producers, a lot more needs to be done). There is also a need to increase the access to affordable food to avoid political unrest (a problem in neighboring Venezuelan clashes in 2014). Brazil has taken leadership in enhancing cooperation and share their advances in agricultural technology. State owned Brazilian Enterprise for Agricultural Research, EMBRAPA, has opened offices in several African and Latin American

countries. Also, BRICS need to commit to the continuation and development of the WTO, especially in the negotiations of the reforms to the trade system in agriculture during the Doha Round of trade negotiations.

5.5   Limitations of the Study and Future Research

One of the limitations of using TYDL and the Bivariate GARCH models in this work is that it is difficult to provide elasticity estimates of variables such as income, relative prices, and long run adjustment to volatility.

World GDP as a measure of foreign economic activity was not included in the specification of the bivariate GARCH models because the number of parameters and equations to estimate explode with the number of variables in the context of a VAR-GARCH-M. Thus the original export demand equation was collapsed to only two variables, exports and exchange rates, while the exchange rate volatility is determined within the model. Nevertheless, it is unclear whether the models are impacted by not having the foreign income variable. As more work is done in this area, more time series data points will be available and thus greater sample sizes that will ease the estimation of models with larger number of equations, and thus the estimation of VAR-GARCH-M models for BRICS including the full export demand equation (e.g., GDP) is a matter of future research.

Given the dominant exporting role that Brazil and China play in world trade, exchange rate volatility in some trading partners (the U.S., the Euro-Zone, and Japan) raises the possibility that excessive volatility (such as that experienced during the recent financial crises and that resulting from the Fed's tapering) 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 could be a subject of much future research.

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APPENDICES

A. Unit Root Tests in Log Levels

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
ADF	CV_EUR_USD	0.003	0.000	0.132	ST	ST	ST
ADF	CV_JPY_USD	0.001	0.000	0.104	ST	ST	ST
ADF	CV_R_EUR_USD	0.002	0.000	0.104	ST	ST	ST
ADF	CV_R_JPY_USD	0.001	0.000	0.148	ST	ST	ST
ADF	LAGExp_Brazil	0.697	0.906	0.997	UR	UR	UR
ADF	LAGExp_China	0.713	0.963	0.999	UR	UR	UR
ADF	LAGExp_Honduras	0.093	0.647	0.850	ST	UR	UR
ADF	LAGExp_India	0.822	0.969	0.997	UR	UR	UR
ADF	LAGExp_Russia	0.762	0.871	0.980	UR	UR	UR
ADF	LAGExp_South_Africa	0.700	0.934	0.954	UR	UR	UR
ADF	LAGExp_Turkey	0.165	0.802	0.995	UR	UR	UR
ADF	LEXP_Brazil	0.028	0.501	0.997	ST	ST	UR
ADF	LEXP_China	0.019	0.968	0.999	ST	ST	UR
ADF	LEXP_Honduras	0.696	0.975	0.995	UR	UR	UR
ADF	LEXP_India	0.732	0.973	1.000	UR	UR	UR
ADF	LEXP_Russia	0.143	0.657	0.986	UR	UR	UR
ADF	LEXP_South_Africa	0.036	0.244	0.978	ST	ST	UR
ADF	LEXP_Turkey	0.120	0.731	1.000	UR	UR	UR
ADF	LGDP_World	0.999	0.063	0.980	ST	UR	UR
ADF	LRAGExp_Brazil	0.773	0.146	0.033	ST	ST	UR
ADF	LRAGExp_China	0.878	0.887	0.824	UR	UR	UR
ADF	LRAGExp_Honduras	0.534	0.108	0.178	UR	UR	UR
ADF	LRAGExp_India	0.907	0.542	0.789	UR	UR	UR
ADF	LRAGExp_Russia	0.159	0.014	0.203	ST	ST	UR
ADF	LRAGExp_South_Africa	0.966	0.314	0.053	ST	UR	UR
ADF	LRAGExp_Turkey	0.973	0.770	0.002	ST	ST	ST
ADF	LREXP_Brazil	0.760	0.146	0.041	ST	ST	UR
ADF	LREXP_China	0.309	0.959	0.988	UR	UR	UR
ADF	LREXP_Honduras	0.957	0.183	0.270	UR	UR	UR
ADF	LREXP_India	0.726	0.885	0.953	UR	UR	UR
ADF	LREXP_Russia	0.056	0.008	0.371	ST	ST	ST
ADF	LREXP_South_Africa	0.412	0.669	0.444	UR	UR	UR
ADF	LREXP_Turkey	0.960	0.780	0.004	ST	ST	ST
ADF	LRGDP_World	0.000	0.869	0.999	ST	ST	ST
ADF	LR_BRL_USD	0.810	0.473	0.420	UR	UR	UR
ADF	LR_CNY_USD	0.973	0.533	0.795	UR	UR	UR
ADF	LR_EUR_USD	0.487	0.254	0.118	UR	UR	UR
ADF	LR_HNL_USD	0.917	0.567	0.600	UR	UR	UR
ADF	LR_INR_USD	0.983	0.545	0.849	UR	UR	UR
ADF	LR_JPY_USD	0.252	0.053	0.564	ST	UR	UR
ADF	LR_RUB_USD	0.607	0.723	0.589	UR	UR	UR
ADF	LR_TRY_USD	0.859	0.603	0.311	UR	UR	UR
ADF	LR_ZAR_USD	0.044	0.233	0.718	ST	ST	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
ADF	L_BRL_USD	0.864	0.611	0.057	ST	UR	UR
ADF	L_CNY_USD	0.966	0.750	0.860	UR	UR	UR
ADF	L_EUR_USD	0.221	0.086	0.093	ST	UR	UR
ADF	L_HNL_USD	0.759	0.925	0.976	UR	UR	UR
ADF	L_INR_USD	0.929	0.856	0.999	UR	UR	UR
ADF	L_JPY_USD	0.240	0.510	0.215	UR	UR	UR
ADF	L_RUB_USD	0.808	0.832	0.201	UR	UR	UR
ADF	L_TRY_USD	0.984	0.730	0.009	ST	ST	ST
ADF	L_ZAR_USD	0.354	0.842	0.917	UR	UR	UR
ADF	REER_BRL_USD	0.439	0.211	0.582	UR	UR	UR
ADF	REER_CNY_USD	0.629	0.042	0.044	ST	ST	UR
ADF	REER_EUR_USD	0.123	0.033	0.591	ST	ST	UR
ADF	REER_JPY_USD	0.547	0.186	0.507	UR	UR	UR
ADF	REER_RUB_USD	0.375	0.620	0.893	UR	UR	UR
ADF	REER_ZAR_USD	0.040	0.384	0.407	ST	ST	UR
ADF	STD_ROC_EUR_USD	0.006	0.001	0.176	ST	ST	ST
ADF	STD_ROC_JPY_USD	0.001	0.000	0.218	ST	ST	ST
ADF	STD_ROC_R_EUR_USD	0.009	0.002	0.195	ST	ST	ST
ADF	STD_ROC_R_JPY_USD	0.001	0.000	0.247	ST	ST	ST
ERS	CV_EUR_USD	1.000	0.004		ST	ST	ST
ERS	CV_JPY_USD	0.999	0.003		ST	ST	ST
ERS	CV_R_EUR_USD	1.000	0.001		ST	ST	ST
ERS	CV_R_JPY_USD	0.997	0.001		ST	ST	ST
ERS	LAGExp_Brazil	1.000	0.997		UR	UR	UR
ERS	LAGExp_China	1.000	1.000		UR	UR	UR
ERS	LAGExp_Honduras	1.000	0.243		UR	UR	UR
ERS	LAGExp_India	1.000	0.983		UR	UR	UR
ERS	LAGExp_Russia	1.000	0.867		UR	UR	UR
ERS	LAGExp_South_Africa	1.000	0.849		UR	UR	UR
ERS	LAGExp_Turkey	1.000	0.987		UR	UR	UR
ERS	LEXP_Brazil	1.000	1.000		UR	UR	UR
ERS	LEXP_China	1.000	1.000		UR	UR	UR
ERS	LEXP_Honduras	1.000	0.985		UR	UR	UR
ERS	LEXP_India	1.000	1.000		UR	UR	UR
ERS	LEXP_Russia	1.000	1.000		UR	UR	UR
ERS	LEXP_South_Africa	1.000	0.998		UR	UR	UR
ERS	LEXP_Turkey	1.000	1.000		UR	UR	UR
ERS	LGDP_World	1.000	1.000		UR	UR	UR
ERS	LRAGExp_Brazil	1.000	0.990		UR	UR	UR
ERS	LRAGExp_China	1.000	0.357		UR	UR	UR
ERS	LRAGExp_Honduras	1.000	0.996		UR	UR	UR
ERS	LRAGExp_India	1.000	0.068		ST	UR	UR
ERS	LRAGExp_Russia	1.000	1.000		UR	UR	UR
ERS	LRAGExp_South_Africa	1.000	0.924		UR	UR	UR
ERS	LRAGExp_Turkey	1.000	1.000		UR	UR	UR
ERS	LREXP_Brazil	1.000	0.994		UR	UR	UR
ERS	LREXP_China	1.000	0.991		UR	UR	UR
ERS	LREXP_Honduras	1.000	0.999		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
ERS	LREXP_India	1.000	0.763		UR	UR	UR
ERS	LREXP_Russia	1.000	1.000		UR	UR	UR
ERS	LREXP_South_Africa	1.000	0.453		UR	UR	UR
ERS	LREXP_Turkey	1.000	1.000		UR	UR	UR
ERS	LRGDP_World	1.000	1.000		UR	UR	UR
ERS	LR_BRL_USD	1.000	0.406		UR	UR	UR
ERS	LR_CNY_USD	1.000	0.720		UR	UR	UR
ERS	LR_EUR_USD	1.000	0.060		ST	UR	UR
ERS	LR_HNL_USD	1.000	0.179		UR	UR	UR
ERS	LR_INR_USD	1.000	0.700		UR	UR	UR
ERS	LR_JPY_USD	1.000	0.562		UR	UR	UR
ERS	LR_RUB_USD	1.000	0.631		UR	UR	UR
ERS	LR_TRY_USD	1.000	0.202		UR	UR	UR
ERS	LR_ZAR_USD	1.000	0.086		ST	UR	UR
ERS	L_BRL_USD	1.000	0.978		UR	UR	UR
ERS	L_CNY_USD	1.000	0.879		UR	UR	UR
ERS	L_EUR_USD	1.000	0.165		UR	UR	UR
ERS	L_HNL_USD	1.000	0.974		UR	UR	UR
ERS	L_INR_USD	1.000	1.000		UR	UR	UR
ERS	L_JPY_USD	1.000	0.848		UR	UR	UR
ERS	L_RUB_USD	1.000	0.971		UR	UR	UR
ERS	L_TRY_USD	1.000	1.000		UR	UR	UR
ERS	L_ZAR_USD	1.000	0.967		UR	UR	UR
ERS	REER_BRL_USD	1.000	0.001		ST	ST	ST
ERS	REER_CNY_USD	1.000	0.992		UR	UR	UR
ERS	REER_EUR_USD	1.000	0.095		ST	UR	UR
ERS	REER_JPY_USD	1.000	0.217		UR	UR	UR
ERS	REER_RUB_USD	1.000	0.657		UR	UR	UR
ERS	REER_ZAR_USD	1.000	0.200		UR	UR	UR
ERS	STD_ROC_EUR_USD	0.999	0.002		ST	ST	ST
ERS	STD_ROC_JPY_USD	0.992	0.001		ST	ST	ST
ERS	STD_ROC_R_EUR_USD	1.000	0.001		ST	ST	ST
ERS	STD_ROC_R_JPY_USD	0.979	0.000		ST	ST	ST
KPSS	CV_EUR_USD	0.132	0.503		ST	ST	ST
KPSS	CV_JPY_USD	0.120	0.381		ST	ST	ST
KPSS	CV_R_EUR_USD	0.171	0.429		ST	ST	ST
KPSS	CV_R_JPY_USD	0.217	0.385		ST	ST	ST
KPSS	LAGExp_Brazil	0.021	0.001		UR	UR	ST
KPSS	LAGExp_China	0.072	0.002		UR	ST	ST
KPSS	LAGExp_Honduras	0.219	0.021		ST	ST	ST
KPSS	LAGExp_India	0.025	0.001		UR	UR	ST
KPSS	LAGExp_Russia	0.053	0.015		UR	ST	ST
KPSS	LAGExp_South_Africa	0.009	0.002		UR	UR	UR
KPSS	LAGExp_Turkey	0.048	0.001		UR	UR	ST
KPSS	LEXP_Brazil	0.051	0.000		UR	ST	ST
KPSS	LEXP_China	0.041	0.002		UR	UR	ST
KPSS	LEXP_Honduras	0.091	0.007		UR	ST	ST
KPSS	LEXP_India	0.012	0.000		UR	UR	ST

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
KPSS	LEXP_Russia	0.162	0.007		ST	ST	ST
KPSS	LEXP_South_Africa	0.067	0.001		UR	ST	ST
KPSS	LEXP_Turkey	0.032	0.000		UR	UR	ST
KPSS	LGDP_World	0.001	0.000		UR	UR	UR
KPSS	LRAGExp_Brazil	0.004	0.003		UR	UR	UR
KPSS	LRAGExp_China	0.008	0.102		ST	ST	ST
KPSS	LRAGExp_Honduras	0.016	0.010		UR	UR	ST
KPSS	LRAGExp_India	0.014	0.101		ST	ST	ST
KPSS	LRAGExp_Russia	0.017	0.057		UR	ST	ST
KPSS	LRAGExp_South_Africa	0.002	0.002		UR	UR	UR
KPSS	LRAGExp_Turkey	0.047	0.001		UR	UR	ST
KPSS	LREXP_Brazil	0.003	0.003		UR	UR	UR
KPSS	LREXP_China	0.017	0.004		UR	UR	ST
KPSS	LREXP_Honduras	0.009	0.019		UR	UR	ST
KPSS	LREXP_India	0.008	0.003		UR	UR	UR
KPSS	LREXP_Russia	0.016	0.042		UR	UR	ST
KPSS	LREXP_South_Africa	0.017	0.003		UR	UR	ST
KPSS	LREXP_Turkey	0.038	0.000		UR	UR	ST
KPSS	LRGDP_World	0.674	0.000		ST	ST	ST
KPSS	LR_BRL_USD	0.102	0.007		ST	ST	ST
KPSS	LR_CNY_USD	0.003	0.003		UR	UR	UR
KPSS	LR_EUR_USD	0.038	0.032		UR	UR	ST
KPSS	LR_HNL_USD	0.020	0.074		UR	ST	ST
KPSS	LR_INR_USD	0.004	0.003		UR	UR	UR
KPSS	LR_JPY_USD	0.009	0.018		UR	UR	ST
KPSS	LR_RUB_USD	0.005	0.064		UR	ST	ST
KPSS	LR_TRY_USD	0.006	0.199		ST	ST	ST
KPSS	LR_ZAR_USD	0.354	0.004		ST	ST	ST
KPSS	L_BRL_USD	0.012	0.001		UR	UR	ST
KPSS	L_CNY_USD	0.013	0.002		UR	UR	ST
KPSS	L_EUR_USD	0.404	0.241		ST	ST	ST
KPSS	L_HNL_USD	0.031	0.001		UR	UR	ST
KPSS	L_INR_USD	0.025	0.000		UR	UR	ST
KPSS	L_JPY_USD	0.018	0.001		UR	UR	ST
KPSS	L_RUB_USD	0.049	0.001		UR	UR	ST
KPSS	L_TRY_USD	0.030	0.000		UR	UR	ST
KPSS	L_ZAR_USD	0.029	0.000		UR	UR	ST
KPSS	REER_BRL_USD	0.227	0.469		ST	ST	ST
KPSS	REER_CNY_USD	0.004	0.015		UR	UR	ST
KPSS	REER_EUR_USD	0.323	0.734		ST	ST	ST
KPSS	REER_JPY_USD	0.007	0.179		ST	ST	ST
KPSS	REER_RUB_USD	0.089	0.015		UR	ST	ST
KPSS	REER_ZAR_USD	0.372	0.005		ST	ST	ST
KPSS	STD_ROC_EUR_USD	0.412	0.743		ST	ST	ST
KPSS	STD_ROC_JPY_USD	0.021	0.274		ST	ST	ST
KPSS	STD_ROC_R_EUR_USD	0.392	0.771		ST	ST	ST
KPSS	STD_ROC_R_JPY_USD	0.035	0.293		ST	ST	ST
NP_DFGLS	CV_EUR_USD	0.420	0.264		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_DFGLS	CV_JPY_USD	0.186	0.227		UR	UR	UR
NP_DFGLS	CV_R_EUR_USD	0.291	0.177		UR	UR	UR
NP_DFGLS	CV_R_JPY_USD	0.097	0.125		ST	UR	UR
NP_DFGLS	LAGExp_Brazil	0.603	0.997		UR	UR	UR
NP_DFGLS	LAGExp_China	0.841	0.997		UR	UR	UR
NP_DFGLS	LAGExp_Honduras	0.649	0.332		UR	UR	UR
NP_DFGLS	LAGExp_India	0.737	0.997		UR	UR	UR
NP_DFGLS	LAGExp_Russia	0.280	0.848		UR	UR	UR
NP_DFGLS	LAGExp_South_Africa	0.567	0.946		UR	UR	UR
NP_DFGLS	LAGExp_Turkey	0.620	0.996		UR	UR	UR
NP_DFGLS	LEXP_Brazil	0.829	0.995		UR	UR	UR
NP_DFGLS	LEXP_China	0.471	0.956		UR	UR	UR
NP_DFGLS	LEXP_Honduras	0.961	0.927		UR	UR	UR
NP_DFGLS	LEXP_India	0.648	0.999		UR	UR	UR
NP_DFGLS	LEXP_Russia	0.520	0.962		UR	UR	UR
NP_DFGLS	LEXP_South_Africa	0.807	0.917		UR	UR	UR
NP_DFGLS	LEXP_Turkey	0.602	0.998		UR	UR	UR
NP_DFGLS	LGDP_World	0.860	0.595		UR	UR	UR
NP_DFGLS	LRAGExp_Brazil	0.845	0.721		UR	UR	UR
NP_DFGLS	LRAGExp_China	0.963	0.790		UR	UR	UR
NP_DFGLS	LRAGExp_Honduras	0.979	0.856		UR	UR	UR
NP_DFGLS	LRAGExp_India	0.841	0.302		UR	UR	UR
NP_DFGLS	LRAGExp_Russia	0.795	0.719		UR	UR	UR
NP_DFGLS	LRAGExp_South_Africa	0.782	0.730		UR	UR	UR
NP_DFGLS	LRAGExp_Turkey	0.778	0.841		UR	UR	UR
NP_DFGLS	LREXP_Brazil	0.914	0.739		UR	UR	UR
NP_DFGLS	LREXP_China	0.770	0.933		UR	UR	UR
NP_DFGLS	LREXP_Honduras	0.995	0.756		UR	UR	UR
NP_DFGLS	LREXP_India	0.660	0.942		UR	UR	UR
NP_DFGLS	LREXP_Russia	0.667	0.797		UR	UR	UR
NP_DFGLS	LREXP_South_Africa	0.764	0.466		UR	UR	UR
NP_DFGLS	LREXP_Turkey	0.721	0.840		UR	UR	UR
NP_DFGLS	LRGDP_World	0.098	0.993		ST	UR	UR
NP_DFGLS	LR_BRL_USD	0.458	0.371		UR	UR	UR
NP_DFGLS	LR_CNY_USD	0.915	0.585		UR	UR	UR
NP_DFGLS	LR_EUR_USD	0.291	0.107		UR	UR	UR
NP_DFGLS	LR_HNL_USD	0.711	0.209		UR	UR	UR
NP_DFGLS	LR_INR_USD	0.877	0.561		UR	UR	UR
NP_DFGLS	LR_JPY_USD	0.617	0.442		UR	UR	UR
NP_DFGLS	LR_RUB_USD	0.552	0.176		UR	UR	UR
NP_DFGLS	LR_TRY_USD	0.628	0.235		UR	UR	UR
NP_DFGLS	LR_ZAR_USD	0.091	0.118		ST	UR	UR
NP_DFGLS	L_BRL_USD	0.554	0.748		UR	UR	UR
NP_DFGLS	L_CNY_USD	0.950	0.784		UR	UR	UR
NP_DFGLS	L_EUR_USD	0.161	0.210		UR	UR	UR
NP_DFGLS	L_HNL_USD	0.801	0.916		UR	UR	UR
NP_DFGLS	L_INR_USD	0.760	0.961		UR	UR	UR
NP_DFGLS	L_JPY_USD	0.160	0.759		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_DFGLS	L_RUB_USD	0.610	0.902		UR	UR	UR
NP_DFGLS	L_TRY_USD	0.918	0.741		UR	UR	UR
NP_DFGLS	L_ZAR_USD	0.175	0.939		UR	UR	UR
NP_DFGLS	REER_BRL_USD	0.212	0.044		ST	ST	UR
NP_DFGLS	REER_CNY_USD	0.993	0.796		UR	UR	UR
NP_DFGLS	REER_EUR_USD	0.213	0.159		UR	UR	UR
NP_DFGLS	REER_JPY_USD	0.577	0.233		UR	UR	UR
NP_DFGLS	REER_RUB_USD	0.440	0.642		UR	UR	UR
NP_DFGLS	REER_ZAR_USD	0.158	0.254		UR	UR	UR
NP_DFGLS	STD_ROC_EUR_USD	0.070	0.084		ST	UR	UR
NP_DFGLS	STD_ROC_JPY_USD	0.265	0.327		UR	UR	UR
NP_DFGLS	STD_ROC_R_EUR_USD	0.058	0.046		ST	ST	UR
NP_DFGLS	STD_ROC_R_JPY_USD	0.117	0.183		UR	UR	UR
NP_MPT	CV_EUR_USD	0.455	0.293		UR	UR	UR
NP_MPT	CV_JPY_USD	0.189	0.229		UR	UR	UR
NP_MPT	CV_R_EUR_USD	0.321	0.187		UR	UR	UR
NP_MPT	CV_R_JPY_USD	0.067	0.128		ST	UR	UR
NP_MPT	LAGExp_Brazil	0.776	0.995		UR	UR	UR
NP_MPT	LAGExp_China	0.906	0.997		UR	UR	UR
NP_MPT	LAGExp_Honduras	0.558	0.251		UR	UR	UR
NP_MPT	LAGExp_India	0.573	0.977		UR	UR	UR
NP_MPT	LAGExp_Russia	0.276	0.736		UR	UR	UR
NP_MPT	LAGExp_South_Africa	0.513	0.863		UR	UR	UR
NP_MPT	LAGExp_Turkey	0.670	0.994		UR	UR	UR
NP_MPT	LEXP_Brazil	0.931	0.998		UR	UR	UR
NP_MPT	LEXP_China	0.454	0.985		UR	UR	UR
NP_MPT	LEXP_Honduras	0.956	0.815		UR	UR	UR
NP_MPT	LEXP_India	0.577	0.999		UR	UR	UR
NP_MPT	LEXP_Russia	0.407	0.982		UR	UR	UR
NP_MPT	LEXP_South_Africa	0.809	0.952		UR	UR	UR
NP_MPT	LEXP_Turkey	0.739	0.999		UR	UR	UR
NP_MPT	LGDP_World	0.000	0.214		ST	ST	ST
NP_MPT	LRAGExp_Brazil	0.406	0.736		UR	UR	UR
NP_MPT	LRAGExp_China	0.904	0.536		UR	UR	UR
NP_MPT	LRAGExp_Honduras	0.933	0.979		UR	UR	UR
NP_MPT	LRAGExp_India	0.708	0.210		UR	UR	UR
NP_MPT	LRAGExp_Russia	0.929	0.975		UR	UR	UR
NP_MPT	LRAGExp_South_Africa	0.787	0.904		UR	UR	UR
NP_MPT	LRAGExp_Turkey	0.580	0.896		UR	UR	UR
NP_MPT	LREXP_Brazil	0.633	0.806		UR	UR	UR
NP_MPT	LREXP_China	0.754	0.961		UR	UR	UR
NP_MPT	LREXP_Honduras	0.975	0.932		UR	UR	UR
NP_MPT	LREXP_India	0.502	0.878		UR	UR	UR
NP_MPT	LREXP_Russia	0.992	0.997		UR	UR	UR
NP_MPT	LREXP_South_Africa	0.761	0.509		UR	UR	UR
NP_MPT	LREXP_Turkey	0.547	0.888		UR	UR	UR
NP_MPT	LRGDP_World	0.191	0.998		UR	UR	UR
NP_MPT	LR_BRL_USD	0.388	0.413		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_MPT	LR_CNY_USD	0.868	0.768		UR	UR	UR
NP_MPT	LR_EUR_USD	0.267	0.098		ST	UR	UR
NP_MPT	LR_HNL_USD	0.619	0.200		UR	UR	UR
NP_MPT	LR_INR_USD	0.779	0.736		UR	UR	UR
NP_MPT	LR_JPY_USD	0.408	0.525		UR	UR	UR
NP_MPT	LR_RUB_USD	0.264	0.109		UR	UR	UR
NP_MPT	LR_TRY_USD	0.642	0.207		UR	UR	UR
NP_MPT	LR_ZAR_USD	0.056	0.084		ST	UR	UR
NP_MPT	L_BRL_USD	0.257	0.741		UR	UR	UR
NP_MPT	L_CNY_USD	0.972	0.939		UR	UR	UR
NP_MPT	L_EUR_USD	0.132	0.186		UR	UR	UR
NP_MPT	L_HNL_USD	0.859	0.938		UR	UR	UR
NP_MPT	L_INR_USD	0.807	0.970		UR	UR	UR
NP_MPT	L_JPY_USD	0.053	0.817		ST	UR	UR
NP_MPT	L_RUB_USD	0.566	0.940		UR	UR	UR
NP_MPT	L_TRY_USD	0.875	0.640		UR	UR	UR
NP_MPT	L_ZAR_USD	0.094	0.951		ST	UR	UR
NP_MPT	REER_BRL_USD	0.155	0.034		ST	ST	UR
NP_MPT	REER_CNY_USD	0.991	0.975		UR	UR	UR
NP_MPT	REER_EUR_USD	0.177	0.143		UR	UR	UR
NP_MPT	REER_JPY_USD	0.313	0.218		UR	UR	UR
NP_MPT	REER_RUB_USD	0.452	0.539		UR	UR	UR
NP_MPT	REER_ZAR_USD	0.157	0.196		UR	UR	UR
NP_MPT	STD_ROC_EUR_USD	0.044	0.069		ST	ST	UR
NP_MPT	STD_ROC_JPY_USD	0.279	0.356		UR	UR	UR
NP_MPT	STD_ROC_R_EUR_USD	0.049	0.040		ST	ST	UR
NP_MPT	STD_ROC_R_JPY_USD	0.076	0.199		ST	UR	UR
NP_MSB	CV_EUR_USD	0.408	0.378		UR	UR	UR
NP_MSB	CV_JPY_USD	0.227	0.270		UR	UR	UR
NP_MSB	CV_R_EUR_USD	0.289	0.256		UR	UR	UR
NP_MSB	CV_R_JPY_USD	0.088	0.136		ST	UR	UR
NP_MSB	LAGExp_Brazil	0.813	0.993		UR	UR	UR
NP_MSB	LAGExp_China	0.926	0.996		UR	UR	UR
NP_MSB	LAGExp_Honduras	0.556	0.259		UR	UR	UR
NP_MSB	LAGExp_India	0.532	0.957		UR	UR	UR
NP_MSB	LAGExp_Russia	0.314	0.652		UR	UR	UR
NP_MSB	LAGExp_South_Africa	0.522	0.792		UR	UR	UR
NP_MSB	LAGExp_Turkey	0.717	0.993		UR	UR	UR
NP_MSB	LEXP_Brazil	0.950	0.999		UR	UR	UR
NP_MSB	LEXP_China	0.516	0.981		UR	UR	UR
NP_MSB	LEXP_Honduras	0.971	0.771		UR	UR	UR
NP_MSB	LEXP_India	0.573	0.999		UR	UR	UR
NP_MSB	LEXP_Russia	0.440	0.981		UR	UR	UR
NP_MSB	LEXP_South_Africa	0.837	0.949		UR	UR	UR
NP_MSB	LEXP_Turkey	0.757	0.999		UR	UR	UR
NP_MSB	LGDP_World	0.000	0.180		ST	ST	ST
NP_MSB	LRAGExp_Brazil	0.348	0.761		UR	UR	UR
NP_MSB	LRAGExp_China	0.889	0.414		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_MSB	LRAGExp_Honduras	0.919	0.987		UR	UR	UR
NP_MSB	LRAGExp_India	0.665	0.187		UR	UR	UR
NP_MSB	LRAGExp_Russia	0.929	0.988		UR	UR	UR
NP_MSB	LRAGExp_South_Africa	0.759	0.926		UR	UR	UR
NP_MSB	LRAGExp_Turkey	0.583	0.893		UR	UR	UR
NP_MSB	LREXP_Brazil	0.594	0.829		UR	UR	UR
NP_MSB	LREXP_China	0.801	0.948		UR	UR	UR
NP_MSB	LREXP_Honduras	0.978	0.953		UR	UR	UR
NP_MSB	LREXP_India	0.498	0.802		UR	UR	UR
NP_MSB	LREXP_Russia	0.995	0.999		UR	UR	UR
NP_MSB	LREXP_South_Africa	0.805	0.557		UR	UR	UR
NP_MSB	LREXP_Turkey	0.563	0.886		UR	UR	UR
NP_MSB	LRGDP_World	0.222	0.998		UR	UR	UR
NP_MSB	LR_BRL_USD	0.368	0.480		UR	UR	UR
NP_MSB	LR_CNY_USD	0.846	0.828		UR	UR	UR
NP_MSB	LR_EUR_USD	0.308	0.134		UR	UR	UR
NP_MSB	LR_HNL_USD	0.590	0.263		UR	UR	UR
NP_MSB	LR_INR_USD	0.725	0.801		UR	UR	UR
NP_MSB	LR_JPY_USD	0.340	0.596		UR	UR	UR
NP_MSB	LR_RUB_USD	0.278	0.160		UR	UR	UR
NP_MSB	LR_TRY_USD	0.668	0.191		UR	UR	UR
NP_MSB	LR_ZAR_USD	0.074	0.074		ST	UR	UR
NP_MSB	L_BRL_USD	0.239	0.748		UR	UR	UR
NP_MSB	L_CNY_USD	0.978	0.957		UR	UR	UR
NP_MSB	L_EUR_USD	0.165	0.188		UR	UR	UR
NP_MSB	L_HNL_USD	0.892	0.933		UR	UR	UR
NP_MSB	L_INR_USD	0.838	0.968		UR	UR	UR
NP_MSB	L_JPY_USD	0.038	0.825		ST	ST	UR
NP_MSB	L_RUB_USD	0.599	0.940		UR	UR	UR
NP_MSB	L_TRY_USD	0.874	0.623		UR	UR	UR
NP_MSB	L_ZAR_USD	0.107	0.946		UR	UR	UR
NP_MSB	REER_BRL_USD	0.192	0.041		ST	ST	UR
NP_MSB	REER_CNY_USD	0.992	0.986		UR	UR	UR
NP_MSB	REER_EUR_USD	0.217	0.163		UR	UR	UR
NP_MSB	REER_JPY_USD	0.255	0.297		UR	UR	UR
NP_MSB	REER_RUB_USD	0.517	0.473		UR	UR	UR
NP_MSB	REER_ZAR_USD	0.196	0.163		UR	UR	UR
NP_MSB	STD_ROC_EUR_USD	0.040	0.103		ST	ST	UR
NP_MSB	STD_ROC_JPY_USD	0.322	0.399		UR	UR	UR
NP_MSB	STD_ROC_R_EUR_USD	0.033	0.061		ST	ST	UR
NP_MSB	STD_ROC_R_JPY_USD	0.099	0.223		ST	UR	UR
NP_MZ	CV_EUR_USD	0.496	0.248		UR	UR	UR
NP_MZ	CV_JPY_USD	0.186	0.225		UR	UR	UR
NP_MZ	CV_R_EUR_USD	0.340	0.172		UR	UR	UR
NP_MZ	CV_R_JPY_USD	0.069	0.133		ST	UR	UR
NP_MZ	LAGExp_Brazil	0.711	1.000		UR	UR	UR
NP_MZ	LAGExp_China	0.842	1.000		UR	UR	UR
NP_MZ	LAGExp_Honduras	0.568	0.267		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_MZ	LAGExp_India	0.621	0.999		UR	UR	UR
NP_MZ	LAGExp_Russia	0.267	0.842		UR	UR	UR
NP_MZ	LAGExp_South_Africa	0.513	0.955		UR	UR	UR
NP_MZ	LAGExp_Turkey	0.614	1.000		UR	UR	UR
NP_MZ	LEXP_Brazil	0.856	1.000		UR	UR	UR
NP_MZ	LEXP_China	0.418	0.994		UR	UR	UR
NP_MZ	LEXP_Honduras	0.883	0.866		UR	UR	UR
NP_MZ	LEXP_India	0.590	1.000		UR	UR	UR
NP_MZ	LEXP_Russia	0.394	0.973		UR	UR	UR
NP_MZ	LEXP_South_Africa	0.755	0.928		UR	UR	UR
NP_MZ	LEXP_Turkey	0.714	1.000		UR	UR	UR
NP_MZ	LGDP_World	0.000	0.251		ST	ST	ST
NP_MZ	LRAGExp_Brazil	0.446	0.683		UR	UR	UR
NP_MZ	LRAGExp_China	0.920	0.709		UR	UR	UR
NP_MZ	LRAGExp_Honduras	0.947	0.877		UR	UR	UR
NP_MZ	LRAGExp_India	0.768	0.240		UR	UR	UR
NP_MZ	LRAGExp_Russia	0.919	0.824		UR	UR	UR
NP_MZ	LRAGExp_South_Africa	0.831	0.768		UR	UR	UR
NP_MZ	LRAGExp_Turkey	0.585	0.866		UR	UR	UR
NP_MZ	LREXP_Brazil	0.683	0.730		UR	UR	UR
NP_MZ	LREXP_China	0.680	0.974		UR	UR	UR
NP_MZ	LREXP_Honduras	0.956	0.795		UR	UR	UR
NP_MZ	LREXP_India	0.514	0.971		UR	UR	UR
NP_MZ	LREXP_Russia	0.975	0.917		UR	UR	UR
NP_MZ	LREXP_South_Africa	0.683	0.463		UR	UR	UR
NP_MZ	LREXP_Turkey	0.541	0.857		UR	UR	UR
NP_MZ	LRGDP_World	0.188	1.000		UR	UR	UR
NP_MZ	LR_BRL_USD	0.406	0.359		UR	UR	UR
NP_MZ	LR_CNY_USD	0.900	0.584		UR	UR	UR
NP_MZ	LR_EUR_USD	0.259	0.098		ST	UR	UR
NP_MZ	LR_HNL_USD	0.659	0.187		UR	UR	UR
NP_MZ	LR_INR_USD	0.855	0.564		UR	UR	UR
NP_MZ	LR_JPY_USD	0.455	0.434		UR	UR	UR
NP_MZ	LR_RUB_USD	0.264	0.106		UR	UR	UR
NP_MZ	LR_TRY_USD	0.619	0.234		UR	UR	UR
NP_MZ	LR_ZAR_USD	0.057	0.084		ST	UR	UR
NP_MZ	L_BRL_USD	0.266	0.726		UR	UR	UR
NP_MZ	L_CNY_USD	0.940	0.783		UR	UR	UR
NP_MZ	L_EUR_USD	0.133	0.200		UR	UR	UR
NP_MZ	L_HNL_USD	0.771	0.918		UR	UR	UR
NP_MZ	L_INR_USD	0.744	0.958		UR	UR	UR
NP_MZ	L_JPY_USD	0.048	0.775		ST	ST	UR
NP_MZ	L_RUB_USD	0.540	0.903		UR	UR	UR
NP_MZ	L_TRY_USD	0.872	0.688		UR	UR	UR
NP_MZ	L_ZAR_USD	0.095	0.936		ST	UR	UR
NP_MZ	REER_BRL_USD	0.154	0.031		ST	ST	UR
NP_MZ	REER_CNY_USD	0.987	0.804		UR	UR	UR
NP_MZ	REER_EUR_USD	0.174	0.146		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_MZ	REER_JPY_USD	0.341	0.196		UR	UR	UR
NP_MZ	REER_RUB_USD	0.417	0.646		UR	UR	UR
NP_MZ	REER_ZAR_USD	0.156	0.227		UR	UR	UR
NP_MZ	STD_ROC_EUR_USD	0.041	0.069		ST	ST	UR
NP_MZ	STD_ROC_JPY_USD	0.269	0.340		UR	UR	UR
NP_MZ	STD_ROC_R_EUR_USD	0.043	0.040		ST	ST	UR
NP_MZ	STD_ROC_R_JPY_USD	0.078	0.205		ST	UR	UR
NP_MZA	CV_EUR_USD	0.453	0.286		UR	UR	UR
NP_MZA	CV_JPY_USD	0.201	0.232		UR	UR	UR
NP_MZA	CV_R_EUR_USD	0.313	0.196		UR	UR	UR
NP_MZA	CV_R_JPY_USD	0.076	0.127		ST	UR	UR
NP_MZA	LAGExp_Brazil	0.752	0.981		UR	UR	UR
NP_MZA	LAGExp_China	0.878	0.985		UR	UR	UR
NP_MZA	LAGExp_Honduras	0.558	0.252		UR	UR	UR
NP_MZA	LAGExp_India	0.578	0.992		UR	UR	UR
NP_MZA	LAGExp_Russia	0.286	0.851		UR	UR	UR
NP_MZA	LAGExp_South_Africa	0.513	0.968		UR	UR	UR
NP_MZA	LAGExp_Turkey	0.655	0.977		UR	UR	UR
NP_MZA	LEXP_Brazil	0.898	0.954		UR	UR	UR
NP_MZA	LEXP_China	0.459	0.963		UR	UR	UR
NP_MZA	LEXP_Honduras	0.924	0.873		UR	UR	UR
NP_MZA	LEXP_India	0.578	0.987		UR	UR	UR
NP_MZA	LEXP_Russia	0.412	0.941		UR	UR	UR
NP_MZA	LEXP_South_Africa	0.787	0.899		UR	UR	UR
NP_MZA	LEXP_Turkey	0.728	0.959		UR	UR	UR
NP_MZA	LGDP_World	0.000	0.210		ST	ST	ST
NP_MZA	LRAGExp_Brazil	0.398	0.688		UR	UR	UR
NP_MZA	LRAGExp_China	0.914	0.667		UR	UR	UR
NP_MZA	LRAGExp_Honduras	0.943	0.849		UR	UR	UR
NP_MZA	LRAGExp_India	0.724	0.207		UR	UR	UR
NP_MZA	LRAGExp_Russia	0.924	0.816		UR	UR	UR
NP_MZA	LRAGExp_South_Africa	0.803	0.765		UR	UR	UR
NP_MZA	LRAGExp_Turkey	0.580	0.856		UR	UR	UR
NP_MZA	LREXP_Brazil	0.640	0.734		UR	UR	UR
NP_MZA	LREXP_China	0.731	0.955		UR	UR	UR
NP_MZA	LREXP_Honduras	0.965	0.795		UR	UR	UR
NP_MZA	LREXP_India	0.503	0.980		UR	UR	UR
NP_MZA	LREXP_Russia	0.982	0.860		UR	UR	UR
NP_MZA	LREXP_South_Africa	0.733	0.477		UR	UR	UR
NP_MZA	LREXP_Turkey	0.547	0.848		UR	UR	UR
NP_MZA	LRGDP_World	0.200	0.969		UR	UR	UR
NP_MZA	LR_BRL_USD	0.386	0.387		UR	UR	UR
NP_MZA	LR_CNY_USD	0.885	0.628		UR	UR	UR
NP_MZA	LR_EUR_USD	0.278	0.107		UR	UR	UR
NP_MZA	LR_HNL_USD	0.625	0.208		UR	UR	UR
NP_MZA	LR_INR_USD	0.810	0.609		UR	UR	UR
NP_MZA	LR_JPY_USD	0.400	0.471		UR	UR	UR
NP_MZA	LR_RUB_USD	0.267	0.122		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_MZA	LR_TRY_USD	0.635	0.205		UR	UR	UR
NP_MZA	LR_ZAR_USD	0.064	0.075		ST	UR	UR
NP_MZA	L_BRL_USD	0.250	0.725		UR	UR	UR
NP_MZA	L_CNY_USD	0.956	0.774		UR	UR	UR
NP_MZA	L_EUR_USD	0.144	0.185		UR	UR	UR
NP_MZA	L_HNL_USD	0.823	0.896		UR	UR	UR
NP_MZA	L_INR_USD	0.782	0.919		UR	UR	UR
NP_MZA	L_JPY_USD	0.042	0.774		ST	ST	UR
NP_MZA	L_RUB_USD	0.562	0.879		UR	UR	UR
NP_MZA	L_TRY_USD	0.874	0.677		UR	UR	UR
NP_MZA	L_ZAR_USD	0.098	0.909		ST	UR	UR
NP_MZA	REER_BRL_USD	0.168	0.035		ST	ST	UR
NP_MZA	REER_CNY_USD	0.988	0.789		UR	UR	UR
NP_MZA	REER_EUR_USD	0.190	0.146		UR	UR	UR
NP_MZA	REER_JPY_USD	0.297	0.226		UR	UR	UR
NP_MZA	REER_RUB_USD	0.459	0.601		UR	UR	UR
NP_MZA	REER_ZAR_USD	0.171	0.190		UR	UR	UR
NP_MZA	STD_ROC_EUR_USD	0.040	0.080		ST	ST	UR
NP_MZA	STD_ROC_JPY_USD	0.290	0.348		UR	UR	UR
NP_MZA	STD_ROC_R_EUR_USD	0.037	0.048		ST	ST	UR
NP_MZA	STD_ROC_R_JPY_USD	0.085	0.202		ST	UR	UR
NP_PT	CV_EUR_USD	0.494	0.322		UR	UR	UR
NP_PT	CV_JPY_USD	0.222	0.267		UR	UR	UR
NP_PT	CV_R_EUR_USD	0.353	0.208		UR	UR	UR
NP_PT	CV_R_JPY_USD	0.079	0.154		ST	UR	UR
NP_PT	LAGExp_Brazil	0.803	0.995		UR	UR	UR
NP_PT	LAGExp_China	0.901	0.997		UR	UR	UR
NP_PT	LAGExp_Honduras	0.621	0.216		UR	UR	UR
NP_PT	LAGExp_India	0.547	0.977		UR	UR	UR
NP_PT	LAGExp_Russia	0.245	0.731		UR	UR	UR
NP_PT	LAGExp_South_Africa	0.491	0.866		UR	UR	UR
NP_PT	LAGExp_Turkey	0.671	0.995		UR	UR	UR
NP_PT	LEXP_Brazil	0.950	0.999		UR	UR	UR
NP_PT	LEXP_China	0.448	0.984		UR	UR	UR
NP_PT	LEXP_Honduras	0.953	0.787		UR	UR	UR
NP_PT	LEXP_India	0.546	0.999		UR	UR	UR
NP_PT	LEXP_Russia	0.390	0.983		UR	UR	UR
NP_PT	LEXP_South_Africa	0.843	0.957		UR	UR	UR
NP_PT	LEXP_Turkey	0.735	0.999		UR	UR	UR
NP_PT	LGDP_World	0.000	0.253		ST	ST	ST
NP_PT	LRAGExp_Brazil	0.393	0.753		UR	UR	UR
NP_PT	LRAGExp_China	0.879	0.476		UR	UR	UR
NP_PT	LRAGExp_Honduras	0.954	0.984		UR	UR	UR
NP_PT	LRAGExp_India	0.674	0.186		UR	UR	UR
NP_PT	LRAGExp_Russia	0.960	0.984		UR	UR	UR
NP_PT	LRAGExp_South_Africa	0.755	0.901		UR	UR	UR
NP_PT	LRAGExp_Turkey	0.584	0.892		UR	UR	UR
NP_PT	LREXP_Brazil	0.615	0.818		UR	UR	UR

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_PT	LREXP_China	0.727	0.958		UR	UR	UR
NP_PT	LREXP_Honduras	0.981	0.948		UR	UR	UR
NP_PT	LREXP_India	0.471	0.873		UR	UR	UR
NP_PT	LREXP_Russia	0.996	0.998		UR	UR	UR
NP_PT	LREXP_South_Africa	0.767	0.473		UR	UR	UR
NP_PT	LREXP_Turkey	0.547	0.884		UR	UR	UR
NP_PT	LRGDP_World	0.174	0.998		UR	UR	UR
NP_PT	LR_BRL_USD	0.362	0.425		UR	UR	UR
NP_PT	LR_CNY_USD	0.842	0.758		UR	UR	UR
NP_PT	LR_EUR_USD	0.251	0.095		ST	UR	UR
NP_PT	LR_HNL_USD	0.586	0.188		UR	UR	UR
NP_PT	LR_INR_USD	0.747	0.733		UR	UR	UR
NP_PT	LR_JPY_USD	0.459	0.565		UR	UR	UR
NP_PT	LR_RUB_USD	0.307	0.124		UR	UR	UR
NP_PT	LR_TRY_USD	0.608	0.194		UR	UR	UR
NP_PT	LR_ZAR_USD	0.053	0.095		ST	UR	UR
NP_PT	L_BRL_USD	0.241	0.743		UR	UR	UR
NP_PT	L_CNY_USD	0.966	0.927		UR	UR	UR
NP_PT	L_EUR_USD	0.141	0.222		UR	UR	UR
NP_PT	L_HNL_USD	0.858	0.930		UR	UR	UR
NP_PT	L_INR_USD	0.788	0.968		UR	UR	UR
NP_PT	L_JPY_USD	0.060	0.828		ST	UR	UR
NP_PT	L_RUB_USD	0.551	0.937		UR	UR	UR
NP_PT	L_TRY_USD	0.864	0.647		UR	UR	UR
NP_PT	L_ZAR_USD	0.091	0.949		ST	UR	UR
NP_PT	REER_BRL_USD	0.139	0.033		ST	ST	UR
NP_PT	REER_CNY_USD	0.993	0.979		UR	UR	UR
NP_PT	REER_EUR_USD	0.222	0.192		UR	UR	UR
NP_PT	REER_JPY_USD	0.350	0.261		UR	UR	UR
NP_PT	REER_RUB_USD	0.406	0.556		UR	UR	UR
NP_PT	REER_ZAR_USD	0.145	0.215		UR	UR	UR
NP_PT	STD_ROC_EUR_USD	0.058	0.092		ST	UR	UR
NP_PT	STD_ROC_JPY_USD	0.318	0.397		UR	UR	UR
NP_PT	STD_ROC_R_EUR_USD	0.060	0.051		ST	UR	UR
NP_PT	STD_ROC_R_JPY_USD	0.086	0.231		ST	UR	UR
PP	CV_EUR_USD	0.000	0.000	0.020	ST	ST	ST
PP	CV_JPY_USD	0.000	0.000	0.012	ST	ST	ST
PP	CV_R_EUR_USD	0.000	0.000	0.021	ST	ST	ST
PP	CV_R_JPY_USD	0.000	0.000	0.013	ST	ST	ST
PP	LAGExp_Brazil	0.068	0.576	0.996	ST	UR	UR
PP	LAGExp_China	0.000	0.618	0.981	ST	ST	ST
PP	LAGExp_Honduras	0.000	0.009	0.676	ST	ST	ST
PP	LAGExp_India	0.783	0.962	0.999	UR	UR	UR
PP	LAGExp_Russia	0.471	0.832	0.951	UR	UR	UR
PP	LAGExp_South_Africa	0.476	0.764	0.970	UR	UR	UR
PP	LAGExp_Turkey	0.000	0.546	0.963	ST	ST	ST
PP	LEXP_Brazil	0.001	0.255	0.999	ST	ST	ST
PP	LEXP_China	0.000	0.921	1.000	ST	ST	ST

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.

Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
PP	LEXP_Honduras	0.000	0.366	0.819	ST	ST	ST
PP	LEXP_India	0.498	0.966	1.000	UR	UR	UR
PP	LEXP_Russia	0.111	0.668	0.992	UR	UR	UR
PP	LEXP_South_Africa	0.093	0.164	0.998	ST	UR	UR
PP	LEXP_Turkey	0.000	0.726	0.997	ST	ST	ST
PP	LGDP_World	0.994	0.169	1.000	UR	UR	UR
PP	LRAGExp_Brazil	1.000	0.035	0.000	ST	ST	ST
PP	LRAGExp_China	0.054	0.051	0.811	ST	UR	UR
PP	LRAGExp_Honduras	0.015	0.040	0.154	ST	ST	UR
PP	LRAGExp_India	0.878	0.527	0.793	UR	UR	UR
PP	LRAGExp_Russia	0.025	0.000	0.003	ST	ST	ST
PP	LRAGExp_South_Africa	0.959	0.638	0.129	UR	UR	UR
PP	LRAGExp_Turkey	0.940	0.876	0.000	ST	ST	ST
PP	LREXP_Brazil	0.999	0.033	0.000	ST	ST	ST
PP	LREXP_China	0.039	0.896	0.992	ST	ST	UR
PP	LREXP_Honduras	0.012	0.011	0.319	ST	ST	UR
PP	LREXP_India	0.665	0.878	0.970	UR	UR	UR
PP	LREXP_Russia	0.000	0.000	0.001	ST	ST	ST
PP	LREXP_South_Africa	0.632	0.807	0.452	UR	UR	UR
PP	LREXP_Turkey	0.938	0.878	0.000	ST	ST	ST
PP	LRGDP_World	0.000	0.902	1.000	ST	ST	ST
PP	LR_BRL_USD	0.674	0.397	0.349	UR	UR	UR
PP	LR_CNY_USD	0.986	0.684	0.806	UR	UR	UR
PP	LR_EUR_USD	0.670	0.462	0.227	UR	UR	UR
PP	LR_HNL_USD	0.860	0.476	0.600	UR	UR	UR
PP	LR_INR_USD	0.978	0.608	0.834	UR	UR	UR
PP	LR_JPY_USD	0.429	0.046	0.366	ST	ST	UR
PP	LR_RUB_USD	0.629	0.722	0.624	UR	UR	UR
PP	LR_TRY_USD	0.819	0.540	0.231	UR	UR	UR
PP	LR_ZAR_USD	0.195	0.357	0.755	UR	UR	UR
PP	L_BRL_USD	0.999	0.645	0.000	ST	ST	ST
PP	L_CNY_USD	0.978	0.838	0.917	UR	UR	UR
PP	L_EUR_USD	0.344	0.126	0.132	UR	UR	UR
PP	L_HNL_USD	0.803	0.948	0.995	UR	UR	UR
PP	L_INR_USD	0.906	0.895	1.000	UR	UR	UR
PP	L_JPY_USD	0.494	0.401	0.057	ST	UR	UR
PP	L_RUB_USD	0.954	0.879	0.126	UR	UR	UR
PP	L_TRY_USD	0.996	0.817	0.000	ST	ST	ST
PP	L_ZAR_USD	0.666	0.855	0.969	UR	UR	UR
PP	REER_BRL_USD	0.382	0.164	0.601	UR	UR	UR
PP	REER_CNY_USD	0.512	0.001	0.001	ST	ST	ST
PP	REER_EUR_USD	0.160	0.047	0.414	ST	ST	UR
PP	REER_JPY_USD	0.655	0.210	0.625	UR	UR	UR
PP	REER_RUB_USD	0.493	0.736	0.903	UR	UR	UR
PP	REER_ZAR_USD	0.257	0.446	0.282	UR	UR	UR
PP	STD_ROC_EUR_USD	0.000	0.000	0.032	ST	ST	ST
PP	STD_ROC_JPY_USD	0.000	0.000	0.023	ST	ST	ST
PP	STD_ROC_R_EUR_USD	0.000	0.000	0.034	ST	ST	ST

Table A. Unit Root Tests (P-Values) in Quarterly Log Levels.							
Test	Variable	Trend	Single Mean	Zero Mean	UR 10	UR 05	UR 01
PP	STD_ROC_R_JPY_USD	0.000	0.000	0.024	ST	ST	ST

B. Unit Root Tests in Log First Differences

Table B. Unit Root Tests (P-Values) in Quarterly Log First Differences.						
Test	Variable	Single Mean	Zero Mean	UR 10	UR 05	UR 01
ADF	LAGExp_Brazil	0.000	0.000	ST	ST	ST
ADF	LAGExp_China	0.000	0.000	ST	ST	ST
ADF	LAGExp_India	0.000	0.000	ST	ST	ST
ADF	LAGExp_Russia	0.000	0.000	ST	ST	ST
ADF	LAGExp_South_Africa	0.000	0.000	ST	ST	ST
ADF	LAGExp_Turkey	0.000	0.000	ST	ST	ST
ADF	LEXP_Honduras	0.000	0.000	ST	ST	ST
ADF	LEXP_India	0.000	0.000	ST	ST	ST
ADF	LEXP_Russia	0.000	0.000	ST	ST	ST
ADF	LEXP_Turkey	0.000	0.000	ST	ST	ST
ADF	LRAGExp_China	0.000	0.000	ST	ST	ST
ADF	LRAGExp_Honduras	0.000	0.000	ST	ST	ST
ADF	LRAGExp_India	0.000	0.000	ST	ST	ST
ADF	LREXP_China	0.000	0.000	ST	ST	ST
ADF	LREXP_Honduras	0.000	0.000	ST	ST	ST
ADF	LREXP_India	0.000	0.000	ST	ST	ST
ADF	LREXP_South_Africa	0.000	0.000	ST	ST	ST
ADF	LR_BRL_USD	0.000	0.000	ST	ST	ST
ADF	LR_CNY_USD	0.000	0.000	ST	ST	ST
ADF	LR_EUR_USD	0.000	0.000	ST	ST	ST
ADF	LR_HNL_USD	0.000	0.000	ST	ST	ST
ADF	LR_INR_USD	0.000	0.000	ST	ST	ST
ADF	LR_RUB_USD	0.000	0.000	ST	ST	ST
ADF	LR_TRY_USD	0.000	0.000	ST	ST	ST
ADF	L_CNY_USD	0.000	0.000	ST	ST	ST
ADF	L_HNL_USD	0.000	0.000	ST	ST	ST
ADF	L_INR_USD	0.000	0.000	ST	ST	ST
ADF	L_JPY_USD	0.000	0.000	ST	ST	ST
ADF	L_RUB_USD	0.000	0.000	ST	ST	ST
ADF	L_ZAR_USD	0.000	0.000	ST	ST	ST
ADF	REER_BRL_USD	0.000	0.000	ST	ST	ST
ADF	REER_JPY_USD	0.000	0.000	ST	ST	ST
ADF	REER_RUB_USD	0.000	0.000	ST	ST	ST
ERS	LAGExp_Brazil	0.131		UR	UR	UR
ERS	LAGExp_China	0.557		UR	UR	UR
ERS	LAGExp_Honduras	0.001		ST	ST	ST
ERS	LAGExp_India	0.003		ST	ST	ST
ERS	LAGExp_Russia	0.000		ST	ST	ST

Test	Variable	Single Mean	Zero Mean	UR 10	UR 05	UR 01
ERS	LAGExp_South_Africa	0.000		ST	ST	ST
ERS	LAGExp_Turkey	0.118		UR	UR	UR
ERS	LEXP_Brazil	0.189		UR	UR	UR
ERS	LEXP_China	0.514		UR	UR	UR
ERS	LEXP_Honduras	0.001		ST	ST	ST
ERS	LEXP_India	0.011		ST	ST	UR
ERS	LEXP_Russia	0.000		ST	ST	ST
ERS	LEXP_South_Africa	0.017		ST	ST	UR
ERS	LEXP_Turkey	0.225		UR	UR	UR
ERS	LGDP_World	0.855		UR	UR	UR
ERS	LRAGExp_Brazil	0.031		ST	ST	UR
ERS	LRAGExp_China	0.881		UR	UR	UR
ERS	LRAGExp_Honduras	0.004		ST	ST	ST
ERS	LRAGExp_Russia	0.017		ST	ST	UR
ERS	LRAGExp_South_Africa	0.001		ST	ST	ST
ERS	LRAGExp_Turkey	0.511		UR	UR	UR
ERS	LREXP_Brazil	0.017		ST	ST	UR
ERS	LREXP_China	0.798		UR	UR	UR
ERS	LREXP_Honduras	0.015		ST	ST	UR
ERS	LREXP_India	0.022		ST	ST	UR
ERS	LREXP_Russia	0.301		UR	UR	UR
ERS	LREXP_South_Africa	0.028		ST	ST	UR
ERS	LREXP_Turkey	0.589		UR	UR	UR
ERS	LRGDP_World	0.344		UR	UR	UR
ERS	LR_BRL_USD	0.000		ST	ST	ST
ERS	LR_CNY_USD	0.000		ST	ST	ST
ERS	LR_HNL_USD	0.000		ST	ST	ST
ERS	LR_INR_USD	0.000		ST	ST	ST
ERS	LR_JPY_USD	0.000		ST	ST	ST
ERS	LR_RUB_USD	0.000		ST	ST	ST
ERS	LR_TRY_USD	0.000		ST	ST	ST
ERS	L_BRL_USD	0.026		ST	ST	UR
ERS	L_CNY_USD	0.000		ST	ST	ST
ERS	L_EUR_USD	0.000		ST	ST	ST
ERS	L_HNL_USD	0.000		ST	ST	ST
ERS	L_INR_USD	0.000		ST	ST	ST
ERS	L_JPY_USD	0.000		ST	ST	ST
ERS	L_RUB_USD	0.000		ST	ST	ST
ERS	L_TRY_USD	0.001		ST	ST	ST
ERS	L_ZAR_USD	0.000		ST	ST	ST
ERS	REER_CNY_USD	0.001		ST	ST	ST
ERS	REER_JPY_USD	0.000		ST	ST	ST
ERS	REER_RUB_USD	0.000		ST	ST	ST
ERS	REER_ZAR_USD	0.000		ST	ST	ST
KPSS	LAGExp_Brazil	0.319		ST	ST	ST
KPSS	LAGExp_China	0.551		ST	ST	ST
KPSS	LAGExp_India	0.331		ST	ST	ST
KPSS	LAGExp_Russia	0.559		ST	ST	ST

Table B. Unit Root Tests (P-Values) in Quarterly Log First Differences.

Test	Variable	Single Mean	Zero Mean	UR 10	UR 05	UR 01
KPSS	LAGExp_South_Africa	0.644		ST	ST	ST
KPSS	LAGExp_Turkey	0.713		ST	ST	ST
KPSS	LEXP_Brazil	0.168		ST	ST	ST
KPSS	LEXP_China	0.768		ST	ST	ST
KPSS	LEXP_Honduras	0.448		ST	ST	ST
KPSS	LEXP_India	0.389		ST	ST	ST
KPSS	LEXP_South_Africa	0.217		ST	ST	ST
KPSS	LEXP_Turkey	0.658		ST	ST	ST
KPSS	LGDP_World	0.019		UR	UR	ST
KPSS	LRAGExp_Brazil	0.034		UR	UR	ST
KPSS	LRAGExp_Honduras	0.063		UR	ST	ST
KPSS	LRAGExp_Russia	0.029		UR	UR	ST
KPSS	LRAGExp_South_Africa	0.241		ST	ST	ST
KPSS	LRAGExp_Turkey	0.203		ST	ST	ST
KPSS	LREXP_Brazil	0.033		UR	UR	ST
KPSS	LREXP_China	0.483		ST	ST	ST
KPSS	LREXP_Honduras	0.066		UR	ST	ST
KPSS	LREXP_India	0.357		ST	ST	ST
KPSS	LREXP_Russia	0.032		UR	UR	ST
KPSS	LREXP_South_Africa	0.388		ST	ST	ST
KPSS	LREXP_Turkey	0.224		ST	ST	ST
KPSS	LR_CNY_USD	0.192		ST	ST	ST
KPSS	LR_EUR_USD	0.793		ST	ST	ST
KPSS	LR_HNL_USD	0.298		ST	ST	ST
KPSS	LR_INR_USD	0.118		ST	ST	ST
KPSS	LR_JPY_USD	0.169		ST	ST	ST
KPSS	LR_RUB_USD	0.098		UR	ST	ST
KPSS	L_BRL_USD	0.143		ST	ST	ST
KPSS	L_CNY_USD	0.192		ST	ST	ST
KPSS	L_HNL_USD	0.279		ST	ST	ST
KPSS	L_INR_USD	0.361		ST	ST	ST
KPSS	L_JPY_USD	0.453		ST	ST	ST
KPSS	L_RUB_USD	0.390		ST	ST	ST
KPSS	L_TRY_USD	0.170		ST	ST	ST
KPSS	L_ZAR_USD	0.636		ST	ST	ST
KPSS	REER_CNY_USD	0.012		UR	UR	ST
KPSS	REER_RUB_USD	0.746		ST	ST	ST
NP_DFGLS	CV_EUR_USD	0.002		ST	ST	ST
NP_DFGLS	CV_JPY_USD	0.000		ST	ST	ST
NP_DFGLS	CV_R_EUR_USD	0.007		ST	ST	ST
NP_DFGLS	LAGExp_Brazil	0.674		UR	UR	UR
NP_DFGLS	LAGExp_China	0.544		UR	UR	UR
NP_DFGLS	LAGExp_Honduras	0.163		UR	UR	UR
NP_DFGLS	LAGExp_India	0.036		ST	ST	UR
NP_DFGLS	LAGExp_Russia	0.541		UR	UR	UR
NP_DFGLS	LAGExp_South_Africa	0.287		UR	UR	UR
NP_DFGLS	LAGExp_Turkey	0.532		UR	UR	UR
NP_DFGLS	LEXP_Brazil	0.722		UR	UR	UR

Table B. Unit Root Tests (P-Values) in Quarterly Log First Differences.

Test	Variable	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_DFGLS	LEXP_China	0.504		UR	UR	UR
NP_DFGLS	LEXP_Honduras	0.163		UR	UR	UR
NP_DFGLS	LEXP_India	0.078		ST	UR	UR
NP_DFGLS	LEXP_Russia	0.671		UR	UR	UR
NP_DFGLS	LEXP_South_Africa	0.269		UR	UR	UR
NP_DFGLS	LEXP_Turkey	0.474		UR	UR	UR
NP_DFGLS	LGDP_World	0.340		UR	UR	UR
NP_DFGLS	LRAGExp_Brazil	0.199		UR	UR	UR
NP_DFGLS	LRAGExp_China	0.428		UR	UR	UR
NP_DFGLS	LRAGExp_Honduras	0.066		ST	UR	UR
NP_DFGLS	LRAGExp_India	0.012		ST	ST	UR
NP_DFGLS	LRAGExp_Russia	0.533		UR	UR	UR
NP_DFGLS	LRAGExp_South_Africa	0.257		UR	UR	UR
NP_DFGLS	LRAGExp_Turkey	0.502		UR	UR	UR
NP_DFGLS	LREXP_Brazil	0.147		UR	UR	UR
NP_DFGLS	LREXP_China	0.534		UR	UR	UR
NP_DFGLS	LREXP_Honduras	0.000		ST	ST	ST
NP_DFGLS	LREXP_India	0.048		ST	ST	UR
NP_DFGLS	LREXP_Russia	0.553		UR	UR	UR
NP_DFGLS	LREXP_South_Africa	0.214		UR	UR	UR
NP_DFGLS	LREXP_Turkey	0.457		UR	UR	UR
NP_DFGLS	LR_BRL_USD	0.001		ST	ST	ST
NP_DFGLS	LR_CNY_USD	0.000		ST	ST	ST
NP_DFGLS	LR_EUR_USD	0.001		ST	ST	ST
NP_DFGLS	LR_HNL_USD	0.000		ST	ST	ST
NP_DFGLS	LR_INR_USD	0.000		ST	ST	ST
NP_DFGLS	LR_JPY_USD	0.000		ST	ST	ST
NP_DFGLS	LR_RUB_USD	0.067		ST	UR	UR
NP_DFGLS	LR_TRY_USD	0.000		ST	ST	ST
NP_DFGLS	L_BRL_USD	0.037		ST	ST	UR
NP_DFGLS	L_CNY_USD	0.002		ST	ST	ST
NP_DFGLS	L_EUR_USD	0.000		ST	ST	ST
NP_DFGLS	L_HNL_USD	0.000		ST	ST	ST
NP_DFGLS	L_INR_USD	0.006		ST	ST	ST
NP_DFGLS	L_JPY_USD	0.000		ST	ST	ST
NP_DFGLS	L_RUB_USD	0.006		ST	ST	ST
NP_DFGLS	L_TRY_USD	0.137		UR	UR	UR
NP_DFGLS	L_ZAR_USD	0.000		ST	ST	ST
NP_DFGLS	REER_CNY_USD	0.039		ST	ST	UR
NP_DFGLS	REER_EUR_USD	0.009		ST	ST	ST
NP_DFGLS	REER_JPY_USD	0.054		ST	UR	UR
NP_DFGLS	REER_RUB_USD	0.001		ST	ST	ST
NP_DFGLS	REER_ZAR_USD	0.000		ST	ST	ST
NP_DFGLS	STD_ROC_JPY_USD	0.000		ST	ST	ST
NP_DFGLS	STD_ROC_R_JPY_USD	0.000		ST	ST	ST
NP_MPT	CV_EUR_USD	0.049		ST	ST	UR
NP_MPT	CV_JPY_USD	0.000		ST	ST	ST
NP_MPT	CV_R_EUR_USD	0.102		UR	UR	UR

Table B. Unit Root Tests (P-Values) in Quarterly Log First Differences.

Table B. Unit Root Tests (P-Values) in Quarterly Log First Differences.

Test	Variable	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_MPT	LAGExp_Brazil	0.977		UR	UR	UR
NP_MPT	LAGExp_China	0.997		UR	UR	UR
NP_MPT	LAGExp_Honduras	0.840		UR	UR	UR
NP_MPT	LAGExp_India	0.238		UR	UR	UR
NP_MPT	LAGExp_Russia	0.866		UR	UR	UR
NP_MPT	LAGExp_South_Africa	0.554		UR	UR	UR
NP_MPT	LAGExp_Turkey	0.997		UR	UR	UR
NP_MPT	LEXP_Brazil	0.935		UR	UR	UR
NP_MPT	LEXP_China	0.986		UR	UR	UR
NP_PT	LAGExp_Honduras	0.778		UR	UR	UR
NP_PT	LAGExp_India	0.222		UR	UR	UR
NP_PT	LAGExp_Russia	0.839		UR	UR	UR
NP_PT	LAGExp_South_Africa	0.553		UR	UR	UR
NP_PT	LAGExp_Turkey	0.998		UR	UR	UR
NP_PT	LEXP_Brazil	0.936		UR	UR	UR
NP_PT	LEXP_China	0.978		UR	UR	UR
NP_PT	LEXP_Honduras	0.967		UR	UR	UR
NP_PT	LEXP_India	0.530		UR	UR	UR
NP_PT	LEXP_Russia	0.910		UR	UR	UR
NP_PT	LEXP_South_Africa	0.405		UR	UR	UR
NP_PT	LEXP_Turkey	0.998		UR	UR	UR
NP_PT	LRAGExp_Brazil	0.185		UR	UR	UR
NP_PT	LRAGExp_China	0.999		UR	UR	UR
NP_PT	LRAGExp_Honduras	0.596		UR	UR	UR
NP_PT	LRAGExp_India	0.147		UR	UR	UR
NP_PT	LRAGExp_Russia	0.833		UR	UR	UR
NP_PT	LRAGExp_South_Africa	0.516		UR	UR	UR
NP_PT	LRAGExp_Turkey	0.989		UR	UR	UR
NP_PT	LREXP_Brazil	0.159		UR	UR	UR
NP_PT	LREXP_China	0.994		UR	UR	UR
NP_PT	LREXP_Honduras	0.000		ST	ST	ST
NP_PT	LREXP_India	0.444		UR	UR	UR
NP_PT	LREXP_Russia	0.793		UR	UR	UR
NP_PT	LREXP_South_Africa	0.348		UR	UR	UR
NP_PT	LREXP_Turkey	0.992		UR	UR	UR
NP_PT	LRGDP_World	0.965		UR	UR	UR
NP_PT	LR_BRL_USD	0.012		ST	ST	UR
NP_PT	LR_CNY_USD	0.001		ST	ST	ST
NP_PT	LR_HNL_USD	0.000		ST	ST	ST
NP_PT	LR_INR_USD	0.000		ST	ST	ST
NP_PT	LR_JPY_USD	0.000		ST	ST	ST
NP_PT	LR_RUB_USD	0.267		UR	UR	UR
NP_PT	LR_TRY_USD	0.002		ST	ST	ST
NP_PT	L_BRL_USD	0.032		ST	ST	UR
NP_PT	L_CNY_USD	0.009		ST	ST	ST
NP_PT	L_EUR_USD	0.001		ST	ST	ST
NP_PT	L_HNL_USD	0.000		ST	ST	ST
NP_PT	L_INR_USD	0.026		ST	ST	UR

Table B. Unit Root Tests (P-Values) in Quarterly Log First Differences.

Test	Variable	Single Mean	Zero Mean	UR 10	UR 05	UR 01
NP_PT	L_RUB_USD	0.005		ST	ST	ST
NP_PT	L_TRY_USD	0.216		UR	UR	UR
NP_PT	REER_CNY_USD	0.062		ST	UR	UR
NP_PT	REER_EUR_USD	0.016		ST	ST	UR
NP_PT	REER_JPY_USD	0.058		ST	UR	UR
NP_PT	REER_RUB_USD	0.002		ST	ST	ST
NP_PT	REER_ZAR_USD	0.000		ST	ST	ST
NP_PT	STD_ROC_JPY_USD	0.000		ST	ST	ST
PP	LAGExp_India	0.000	0.000	ST	ST	ST
PP	LAGExp_Russia	0.000	0.000	ST	ST	ST
PP	LAGExp_South_Africa	0.000	0.000	ST	ST	ST
PP	LEXP_India	0.000	0.000	ST	ST	ST
PP	LEXP_Russia	0.000	0.000	ST	ST	ST
PP	LGDP_World	0.000	0.000	ST	ST	ST
PP	LRAGExp_India	0.000	0.000	ST	ST	ST
PP	LRAGExp_South_Africa	0.000	0.000	ST	ST	ST
PP	LREXP_India	0.000	0.000	ST	ST	ST
PP	LREXP_South_Africa	0.000	0.000	ST	ST	ST
PP	LR_BRL_USD	0.000	0.000	ST	ST	ST
PP	LR_CNY_USD	0.000	0.000	ST	ST	ST
PP	LR_EUR_USD	0.000	0.000	ST	ST	ST
PP	LR_HNL_USD	0.000	0.000	ST	ST	ST
PP	LR_INR_USD	0.000	0.000	ST	ST	ST
PP	LR_RUB_USD	0.000	0.000	ST	ST	ST
PP	LR_TRY_USD	0.000	0.000	ST	ST	ST
PP	LR_ZAR_USD	0.000	0.000	ST	ST	ST
PP	L_CNY_USD	0.000	0.000	ST	ST	ST
PP	L_EUR_USD	0.000	0.000	ST	ST	ST
PP	L_HNL_USD	0.000	0.000	ST	ST	ST
PP	L_INR_USD	0.000	0.000	ST	ST	ST
PP	L_RUB_USD	0.000	0.000	ST	ST	ST
PP	L_ZAR_USD	0.000	0.000	ST	ST	ST
PP	REER_BRL_USD	0.000	0.000	ST	ST	ST
PP	REER_JPY_USD	0.000	0.000	ST	ST	ST
PP	REER_RUB_USD	0.000	0.000	ST	ST	ST
PP	REER_ZAR_USD	0.000	0.000	ST	ST	ST

C. Unit Root Tests in Log Second Differences

Table C. Unit Root Tests (P-Values) in Quarterly Log Second Differences.

Test	Variable	Single Mean	Zero Mean	UR1 0	UR0 5	UR0 1
ERS	LAGExp_Brazil		1.000		UR	UR
ERS	LAGExp_China		0.837		UR	UR
ERS	LAGExp_Turkey		1.000		UR	UR

Test	Variable	Single Mean	Zero Mean	UR1 0	UR0 5	UR0 1

Table C. Unit Root Tests (P-Values) in Quarterly Log Second Differences.

Test	Variable	Single Mean	Zero Mean	UR1 0	UR0 5	UR0 1
ERS	LEXP_Brazil		0.051		ST	UR
ERS	LEXP_China		0.344		UR	UR
ERS	LEXP_Turkey		0.873		UR	UR
ERS	LGDP_World		1.000		UR	UR
ERS	LRAGExp_China		0.874		UR	UR
ERS	LRAGExp_Turkey		0.772		UR	UR
ERS	LREXP_China		0.142		UR	UR
ERS	LREXP_Russia		0.157		UR	UR
ERS	LREXP_Turkey		0.795		UR	UR
ERS	LRGDP_World		0.000		ST	ST
KPSS	LGDP_World		0.938		ST	ST
KPSS	LRAGExp_Brazil		0.705		ST	ST
KPSS	LRAGExp_Honduras		0.505		ST	ST
KPSS	LRAGExp_Russia		0.759		ST	ST
KPSS	LREXP_Brazil		0.634		ST	ST
KPSS	LREXP_Honduras		0.439		ST	ST
KPSS	LREXP_Russia		0.384		ST	ST
KPSS	LR_RUB_USD		0.900		ST	ST
KPSS	REER_CNY_USD		0.891		ST	ST
NP_DFGLS	LAGExp_Brazil	0.372	0.592		UR	UR
NP_DFGLS	LAGExp_China	0.000	0.470		UR	UR
NP_DFGLS	LAGExp_Honduras	0.895	0.754		UR	UR
NP_DFGLS	LAGExp_Russia	0.349	0.579		UR	UR
NP_DFGLS	LAGExp_South_Africa	0.300	0.358		UR	UR
NP_DFGLS	LAGExp_Turkey	0.147	0.744		UR	UR
NP_DFGLS	LEXP_Brazil	0.852	0.542		UR	UR
NP_DFGLS	LEXP_China	0.772	0.406		UR	UR
NP_DFGLS	LEXP_Honduras	0.674	0.649		UR	UR
NP_DFGLS	LEXP_Russia	0.387	0.627		UR	UR
NP_DFGLS	LEXP_South_Africa	0.121	0.276		UR	UR
NP_DFGLS	LEXP_Turkey	0.148	0.762		UR	UR
NP_DFGLS	LGDP_World	0.000	0.000		ST	ST
NP_DFGLS	LRAGExp_Brazil	0.325	0.381		UR	UR
NP_DFGLS	LRAGExp_China	0.707	0.666		UR	UR
NP_DFGLS	LRAGExp_Russia	0.000	0.000		ST	ST
NP_DFGLS	LRAGExp_South_Africa	0.233	0.297		UR	UR
NP_DFGLS	LRAGExp_Turkey	0.198	0.737		UR	UR
NP_DFGLS	LREXP_Brazil	0.397	0.389		UR	UR
NP_DFGLS	LREXP_China	0.714	0.616		UR	UR
NP_DFGLS	LREXP_Russia	0.000	0.000		ST	ST
NP_DFGLS	LREXP_South_Africa	0.065	0.202		UR	UR
NP_DFGLS	LREXP_Turkey	0.167	0.749		UR	UR
NP_DFGLS	L_TRY_USD	0.000	0.000		ST	ST
NP_MPT	CV_R_EUR_USD	0.000	0.000		ST	ST
NP_MPT	LAGExp_Brazil	1.000	0.999		UR	UR
NP_MPT	LAGExp_China	0.001	1.000		UR	UR
NP_MPT	LAGExp_Honduras	1.000	1.000		UR	UR
NP_MPT	LAGExp_India	1.000	0.989		UR	UR

Table C. Unit Root Tests (P-Values) in Quarterly Log Second Differences.

Test	Variable	Single Mean	Zero Mean	UR10	UR05	UR01
NP_MPT	LAGExp_Russia	1.000	0.998		UR	UR
NP_MPT	LAGExp_South_Africa	1.000	0.980		UR	UR
NP_MPT	LAGExp_Turkey	1.000	1.000		UR	UR
NP_MPT	LEXP_Brazil	1.000	0.999		UR	UR
NP_MPT	LEXP_China	1.000	1.000		UR	UR
NP_MPT	LEXP_Honduras	1.000	1.000		UR	UR
NP_MPT	LEXP_India	1.000	0.995		UR	UR
NP_MPT	LEXP_Russia	1.000	0.999		UR	UR
NP_MPT	LEXP_South_Africa	0.999	0.923		UR	UR
NP_MPT	LEXP_Turkey	1.000	1.000		UR	UR
NP_MPT	LRAGExp_Brazil	0.999	0.945		UR	UR
NP_MPT	LRAGExp_China	1.000	1.000		UR	UR
NP_MPT	LRAGExp_Honduras	1.000	1.000		UR	UR
NP_MPT	LRAGExp_India	1.000	0.976		UR	UR
NP_MPT	LRAGExp_Russia	0.001	0.000		ST	ST
NP_MPT	LRAGExp_South_Africa	1.000	0.978		UR	UR
NP_MPT	LRAGExp_Turkey	1.000	1.000		UR	UR
NP_MPT	LREXP_Brazil	0.999	0.920		UR	UR
NP_MPT	LREXP_China	1.000	1.000		UR	UR
NP_MPT	LREXP_India	1.000	0.990		UR	UR
NP_MPT	LREXP_Russia	0.001	0.000		ST	ST
NP_MPT	LREXP_South_Africa	0.998	0.899		UR	UR
NP_MPT	LREXP_Turkey	1.000	1.000		UR	UR
NP_MPT	LRGDP_World	1.000	1.000		UR	UR
NP_MPT	LR_RUB_USD	0.000	0.000		ST	ST
NP_MPT	L_TRY_USD	0.000	0.000		ST	ST
NP_MSB	CV_R_EUR_USD	0.000	0.000		ST	ST
NP_MSB	LAGExp_Brazil	1.000	1.000		UR	UR
NP_MSB	LAGExp_China	0.001	1.000		UR	UR
NP_MSB	LAGExp_Honduras	1.000	1.000		UR	UR
NP_MSB	LAGExp_India	1.000	0.995		UR	UR
NP_MSB	LAGExp_Russia	1.000	1.000		UR	UR
NP_MSB	LAGExp_South_Africa	1.000	0.992		UR	UR
NP_MSB	LAGExp_Turkey	1.000	1.000		UR	UR
NP_MSB	LEXP_Brazil	1.000	0.999		UR	UR
NP_MSB	LEXP_China	1.000	1.000		UR	UR
NP_MSB	LEXP_Honduras	1.000	1.000		UR	UR
NP_MSB	LEXP_India	1.000	0.999		UR	UR
NP_MSB	LEXP_Russia	1.000	1.000		UR	UR
NP_MSB	LEXP_South_Africa	1.000	0.960		UR	UR
NP_MSB	LEXP_Turkey	1.000	1.000		UR	UR
NP_MSB	LRAGExp_Brazil	1.000	0.966		UR	UR
NP_MSB	LRAGExp_China	1.000	1.000		UR	UR
NP_MSB	LRAGExp_Honduras	1.000	1.000		UR	UR
NP_MSB	LRAGExp_India	1.000	0.990		UR	UR
NP_MSB	LRAGExp_Russia	0.001	0.000		ST	ST
NP_MSB	LRAGExp_South_Africa	1.000	0.991		UR	UR
NP_MSB	LRAGExp_Turkey	1.000	1.000		UR	UR

Table C. Unit Root Tests (P-Values) in Quarterly Log Second Differences.

Test	Variable	Single Mean	Zero Mean	UR10	UR05	UR01
NP_MSB	LREXP_Brazil	1.000	0.947		UR	UR
NP_MSB	LREXP_China	1.000	1.000		UR	UR
NP_MSB	LREXP_India	1.000	0.997		UR	UR
NP_MSB	LREXP_Russia	0.000	0.000		ST	ST
NP_MSB	LREXP_South_Africa	0.999	0.945		UR	UR
NP_MSB	LREXP_Turkey	1.000	1.000		UR	UR
NP_MSB	LRGDP_World	1.000	1.000		UR	UR
NP_MSB	LR_RUB_USD	0.000	0.000		ST	ST
NP_MSB	L_TRY_USD	0.000	0.000		ST	ST
NP_MZ	CV_R_EUR_USD	0.000	0.000		ST	ST
NP_MZ	LAGExp_Brazil	0.999	0.695		UR	UR
NP_MZ	LAGExp_China	0.000	0.763		UR	UR
NP_MZ	LAGExp_Honduras	0.999	1.000		UR	UR
NP_MZ	LAGExp_India	0.983	0.789		UR	UR
NP_MZ	LAGExp_Russia	0.989	0.862		UR	UR
NP_MZ	LAGExp_South_Africa	0.993	0.682		UR	UR
NP_MZ	LAGExp_Turkey	0.998	0.930		UR	UR
NP_MZ	LEXP_Brazil	1.000	1.000		UR	UR
NP_MZ	LEXP_China	0.997	0.890		UR	UR
NP_MZ	LEXP_Honduras	0.998	0.864		UR	UR
NP_MZ	LEXP_India	0.995	0.678		UR	UR
NP_MZ	LEXP_Russia	1.000	0.753		UR	UR
NP_MZ	LEXP_South_Africa	0.971	0.597		UR	UR
NP_MZ	LEXP_Turkey	0.994	0.995		UR	UR
NP_MZ	LRAGExp_Brazil	0.968	0.767		UR	UR
NP_MZ	LRAGExp_China	0.999	0.773		UR	UR
NP_MZ	LRAGExp_Honduras	0.999	1.000		UR	UR
NP_MZ	LRAGExp_India	0.972	0.701		UR	UR
NP_MZ	LRAGExp_Russia	0.000	0.000		ST	ST
NP_MZ	LRAGExp_South_Africa	0.991	0.685		UR	UR
NP_MZ	LRAGExp_Turkey	0.996	0.941		UR	UR
NP_MZ	LREXP_Brazil	0.998	0.733		UR	UR
NP_MZ	LREXP_China	0.998	0.981		UR	UR
NP_MZ	LREXP_India	0.989	0.683		UR	UR
NP_MZ	LREXP_Russia	0.000	0.000		ST	ST
NP_MZ	LREXP_South_Africa	0.960	0.584		UR	UR
NP_MZ	LREXP_Turkey	0.994	0.989		UR	UR
NP_MZ	LRGDP_World	0.998	0.761		UR	UR
NP_MZ	LR_RUB_USD	0.000	0.000		ST	ST
NP_MZ	L_TRY_USD	0.000	0.000		ST	ST
NP_MZA	CV_R_EUR_USD	0.000	0.000		ST	ST
NP_MZA	LAGExp_Brazil	0.996	0.742		UR	UR
NP_MZA	LAGExp_China	0.001	0.775		UR	UR
NP_MZA	LAGExp_Honduras	0.998	0.990		UR	UR
NP_MZA	LAGExp_India	0.992	0.773		UR	UR
NP_MZA	LAGExp_Russia	0.995	0.831		UR	UR
NP_MZA	LAGExp_South_Africa	0.994	0.725		UR	UR

VITA

David Isaias Maradiaga Pineda was born in Tegucigalpa, Honduras. After completing high school in 2001 at the Instituto Departamental de Oriente, in Danli, Honduras, he matriculated in Escuela Agricola Panamericana (El Zamorano) in 2002, where he completed his **Bachelor of Science** in **Agriculture Engineering** with a minor in **Food Science** in 2005. He obtained two **Masters of Science** from Louisiana State University. The first in **Agricultural Economics** in 2010 from the Department of Agricultural Economics and Agribusiness -LSU College of Agriculture-. The second in **Data and Business Analytics** in 2013 from the Department of Information Systems and Decision Sciences -E.J. Ourso College of Business-. He enrolled the **Doctorate** (PhD) program at the Department of **Agricultural Economics and Agribusiness** in 2011.