

The Impact of Exchange Rate Volatility on Trade Balance of Iran

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Abstract The real effective exchange rate is one of the essential indicators of economy's international competitiveness, and therefore, has a strong impact on a country's foreign trade development. It is commonly believed that the movements of the real effective exchange rate have a permanent effect on exports and imports. This study addresses the question of whether exchange rate volatility has any significant and direct impact on trade balance. Hence, the purpose of this study is to estimate the effect of real effective exchange rate volatility on the balance of trade of Iran during the year 1993 to 2011. By using Unit Root Tests, GARCH (1, 1) approach and balance PANEL data model. Results demonstrate that the real effective exchange rate has no significant effect on the trade balance. So, it is important to stress that real effective exchange rate volatility cannot be used solely in managing the trade balance of Iran with main trading partners. We find that trade balance is affected by import, rather than export. Thus, in order to boost the trade balance the government should implement the policy that focuses on the production of imported substituting goods.

Keywords Real Effective Exchange Rate Volatility, Trade Balance, GARCH Approach, Panel Data Model

JEL: F14, F19

1. Introduction

Continuous growth and development in the economy need to attend its determinants. Trade is the necessary condition for economic growth and development. The role of trade in the stated processes is to extent that trade is the motive engine in economic growth (Sharifi et al, 2012:366). There is a continuously growing body of literature dealing with the effects of exchange rate uncertainty on international trade since the breakdown of the Bretton Woods system of fixed exchange rates when both real and nominal exchange rates have fluctuated widely. Most of the studies are focused on

estimating exchange rate volatility effects on international trade of developed countries, especially in the United States (U.S.) as well as on the trade between developed and developing countries (Ferto et al, 2012:1). The exchange rate in whatever conceptualization, is not only an important relative price, which connects domestic and world markets for goods and assets, but it also signals the competitiveness of a country's exchange power vis-à-vis the rest of the world in a pure market (Afolabi et al, 2011:175). It is one of the important prices in an open economy, since it affects so many business, investment and policy decisions (Khim-Sen, 2003:1). From a macroeconomic point of view, exchange rate changes can have strong effects on the economy, as they may affect the structure of output and investment, lead to inefficient allocation of domestic absorption and external trade, influence labour market and prices, and alter external accounts (Auboin et al, 2011: 3). In fact Exchange rate volatility is defined as the risk associated with unexpected movements in the exchange rate (Oz Turk, 2006: 85). So it is commonly believed that the movements of the real exchange rate have a permanent effect on exports and imports (Bakhromov, 2011: 149). If changes in exchange rates become unpredictable, this creates uncertainty about the profits to be made and, hence, reduces the benefits of international trade. Exchange-rate risk for all country is generally not hedged because forward markets are not accessible to all traders. Even if hedging in the forward markets were possible, there are limitations and costs (Oz Turk, 2006: 86). If the consumers and producers do not react immediately to change in price of traded products resulting from variations in the exchange rate, currency depreciation may actually hamper the trade balance in the short run. If in the longer run, however, the price effects actually give an impact on producer and consumer, the trade deficit would reduce gradually (Hermawan, 2011:1085). Policymakers interested in implementing such policies have taken a closer look at exchange rate movements. Simply stated, depreciation of a country's currency makes its exports cheaper and its imports more costly. In the reality of a globalised economy, however, industries are vertically integrated, and exported products contain a large proportion

of imported components. Imported components therefore become more costly for any given exporter and are not necessarily substitutable with domestically-produced products (Huchet-Bourdon et al, 2011: 6). Instability in exchange rate can influence longer-term decisions by affecting the volume of exports and imports, the allocation of investment and government sales and procurement policies. In medium term, it can affect the balance of payments and the level of economic activity, while in the short run local consumers and the local trader can be affected. Hence, any government at any point in time seek the stability of the exchange rate because it provides economic agents the opportunity to plan ahead without fear of varying costs and prices of goods and services. On the other hand, instability of exchange rate can cause a negative distortion in any economy (Afolabi et al, 2011:176). Also the variations in exchange rate play an important role in the determination of trade balance. Volatile exchange rate slows down the process of trade, destabilizes the capital movements, and shatters the investor's confidence to invest in a country with high exchange rate volatility, which in turn slows down the process of growth. Therefore, exchange rate is a vital macroeconomic variable and backbone of trade and it is as a key macroeconomic policy instrument that ensures export promotion and economic growth. Hence, the purpose of this study is to measure the impact of exchange rate volatility on trade balance of Iran and its trade partners. In fact this study addresses the question of whether exchange rate changes have any significant and direct impact on trade balance by using the GARCH approach and balance panel data model for the sample period from 1993 to 2011. The remainder of the paper is presented as follows: Section II discusses the literature review; Section III, the data are presented; Section IV, the methodological framework is discussed; Section V, the results of the utilized statistical tests, the estimated equations and analysis of the main empirical findings are discussed. Finally, the last section comes with the conclusion and addresses the issue of policy implications.

2. Literature Review

The impact of exchange rate volatility on trade has been much debated but the large body of existing empirical literature does not suggest an unequivocally clear picture of the trade impacts of changes in exchange rates. Hence, relationship between exchange rate and trade balance has been a subject of intense theoretical and empirical debate in economics literature. The first aspect of the relationship between exchange rates and trade, relates to exchange rate volatility. The basic argument which, increase exchange rate volatility would result lower international trade is risks and transaction costs associated with variability in the exchange rate (Nicita, 2013: 2). On the theoretical side the relationship between higher exchange-rate volatility and international trade transactions have been conducted by Hooper and Kohlhagen (1978). The argument is as follows:

Higher exchange rate volatility leads to higher cost for risk-averse traders which lead to less foreign trade. This is because the exchange rate is agreed on time of the trade contract, but payment is not made until the future delivery actually takes place. If changes in exchange rates become unpredictable, this creates uncertainty about the profits to be made and, hence, reduces the benefits of international trade. Exchange rate risk for the all countries is generally not hedged because forward markets are not accessible to all traders. Even if hedging in the forward markets were possible, there would be limitations and costs. On the other hand, recent theoretical developments suggest that there are situations in which the volatility of exchange rates could be expected to have either negative or positive effects on trade volume (Ozturk, 2006: 86). According to De Grauwe (1988), exchange rate variability may have either a positive or a negative impact on trade according to the degree of firms' risk aversion. If producers exhibit only a slight aversion to risk, they produce less for export as the higher exchange rate risk reduces the expected marginal utility of export revenues. If they are extremely risk averse, however, they will consider the worst possible outcome. This implies that an increase in exchange rate risk will raise the expected marginal utility of export revenue as producers will want to export more to avoid a drastic decline in their revenue (Huchet-Bourdon et al, 2011: 8). One of the main recent contributions comes from Brollet et al. (2006), who studied optimum production decisions by an international firm using portfolio theory. It is shown that an increase in exchange rate risk could have a negative, positive or neutral impact on trade. The impact depends upon the elasticity of risk aversion with respect to the standard deviation (or the mean) of the firm's random profit (Auboin et al, 2011: 16). The IMF's 2004 study on exchange rate volatility and trade flows indicated that there was no obvious negative relationship between aggregate exchange rate volatility and aggregate trade. It allowed for an exploration of the effects of exchange rate volatility on trade along several new dimensions, for example by type of volatility (short- and long-run, real and nominal, and other characteristics), by country group (with useful distinction by regions and income levels), and by type of trade (using disaggregated data across different types of goods). In its examination of the relationship between exchange rate volatility and trade, the IMF looked at the time paths of the two variables and found no obvious (negative) association. World trade increased steadily between 1970 and 2000, while the path of exchange rate volatility was less smooth (Auboin et al, 2011: 7). Moreover the sensitivity of the trade balance to movements in real exchange rates should be much lower in a country with a low level of intra-industry trade (low IIT) than in a country with high IIT. Its imports are unlikely to fall significantly following real exchange rate depreciation because no domestic industry can easily replace the imports that have become more expensive. Low IIT countries are typically those where raw materials or natural resources like oil account for a major share of imports. They

could also be countries that have specialized in particular industries in order to benefit from a comparative advantage in some sectors. By contrast, imports fall much more in a high IIT country that depreciates its real exchange rate, as the country can more easily provide domestic substitutes for imports that have become more expensive. The sensitivity of the trade balance to the real exchange rate should therefore depend positively on IIT (Kharroubi, 2011: 36). To summarize findings at the theoretical level, the effect of the exchange rate volatility on trade is ambiguous: the impact may be positive, negative or do not find any significant relationship depending on model assumptions, particularly on the behavior of traders facing increased risk and on the transaction delay (Huchet-Bourdon et al, 2011: 9), different time periods, types of exchange rates, different variables incorporated in the estimated equations and volatility measures (Serenis et al, 2011:580). The empirical evidence on this relationship is as ambiguous as the theoretical evidence. On the empirical side, Mohammadi et al., (2011) investigated the effect of exchange rate uncertainty on the Iran's import trade. They found significant and negative impact of exchange rate uncertainty on Iran's imports. But Baum and Caglayan, (2009) found exchange rate uncertainty does not affect the volume of trade flows of either industrialized countries. Zhao, (2010) investigated impact of real exchange rate volatility on the real bilateral export flows of New Zealand by using quarterly data over 1991Q1-2007Q1 period. Results show that real exchange rate volatility has a significant negative effect on real exports in the long run, but a weak positive effect in the short run for New Zealand. Wang and Barrett (2002) takes a new empirical look at the long standing question of the effect of exchange rate volatility on international trade flows by studying the case of Taiwan's exports to the United States from 1989-1998. They found that real exchange rate risk has insignificant effects in most sectors, although agricultural trade volumes appear highly responsive to real exchange rate volatility. Huchet-Bourdon and Korinek (2011), examines the impact of exchange rates and their volatility on trade flows in China, the Euro area and the United States in two broadly defined sectors, agriculture on the one hand and manufacturing and mining on the other. They found that exchange volatility impacts trade flows only slightly. Exchange rate levels, on the other hand, affect trade in agriculture and manufacturing and mining sectors but do not explain in their entirety the trade imbalances in the three countries examined. Byrne et al. (2006) consider the impact of exchange rate volatility on the volume of bilateral US trade (both exports and imports) using sectoral data. They report evidence to suggest that exchange rate volatility has a robust and significantly negative effect across sectors, although it is strongest for exports of differentiated goods. Bakhromov (2011) estimates the effect of exchange rate volatility on the international trade in Uzbekistan during the 1999-2009 period. Results show that the real exchange rate volatility has a substantial impact on the exports and imports

of the country during the given period. Hayakawa and Kimura (2008) empirically investigate the relationship between exchange rate volatility and international trade, focusing on East Asia. Their findings are summarized as follows: first, intra-East Asian trade is discouraged by exchange rate volatility more seriously than trade in other regions. Second, one important source for the discouragement is that intermediate goods trade in international production networks, which is quite sensitive to exchange rate volatility compared with other types of trade, occupies a significant fraction of East Asian trade. Third, the negative effect of the volatility is greater than that of tariffs and smaller than that of distance-related costs in East Asia. Nuroglu and Kunst (2012) analyze the effects of exchange rate volatility on international trade flows by using two different approaches, the panel data analysis and fuzzy logic model to compare the results. The estimated impact is clearly negative, which indicates that exchange rate volatility has a negative influence on bilateral trade flows. Khan et al. (2014) investigates the impact of domestic and foreign currency valued exchange rate volatility on the export and import demand functions with reference to Pakistan's trading partners. The results show that, when Pakistan employed the US dollar as the vehicle currency with its trading partners, volatility discouraged both imports and exports. In contrast, both the import and export demand functions remained unaffected by volatility distortions when Pakistan traded with its developing partners using bilateral exchange rates valued in domestic currency terms. Bahmani-Oskooee et al. (2010) have used aggregate trade flows data either between one country and the rest of the world or between two countries at the bilateral level. In most cases, trade flows are not affected by GARCH-based volatility of the real effective exchange rate of the dollar.

Onafowora's (2003) paper examined the effects of real exchange rate changes on the real trade balance. The study investigated three ASEAN countries, Malaysia, Indonesia and Thailand in their bilateral trade to the US and Japan by employing a co-integrating vector error correction model (VECM). The result indicates a positive long-run relationship between the real exchange rate and the real trade balance in all cases. Dhasmana (2012) analyzed the relationship between India's real exchange rate and its trade balance with major trading partners using quarterly trade data for 15 countries. She found that real exchange rate volatility is negatively correlated with India's trade balance in the long run. Bah and Amusi (2003) used ARCH and GARCH models to examine the effect of real exchange rate volatility on South African exports to the U.S. for the period 1990:1-2000:4. The findings are that Rand's real exchange rate variability exerts a significant and negative impact of exports both in the long and short-run. Arize et al. (2000) investigated real exchange rate volatility on the exports of 13 less developed countries with quarterly data series for the period 1973 -1996 using Johansen's multivariate procedure for long-run and error correction model to analyze the

short-run dynamics. Their study reveals a significant negative impact of volatility on export flows. De Vita and Abbott (2004) consider the impact of exchange rate volatility on UK aggregate exports to individual EU countries and a multilateral study of five sectors' exports to the other EU countries. Making a distinction between short-run and long-run uncertainties, they show there is no evidence of an impact from short-run uncertainty, although there is evidence of an impact from long-run volatility.

This paper surveys a wide body of economic literature on the relationship between exchange rate volatility and trade balance. In spite of many empirical studies having been conducted on the subject, the relationship of exchange rate volatility to international trade is ambiguous. Both the theoretical and empirical studies do not offer a firm conclusion on the effect of exchange rate volatility on trade.

3. Data Collection

The data used in this study are from three main sources. The real effective exchange rate data are collected from World-bank website and the data for export, import, trade balance and Iran's, 11, major trading partners has been extracted from Islamic Republic of Iran's Customs website and Chamber of Commerce. We use annually data on 11 major trading partners of Iran (Germany, the United Arab Emirates, Japan, France, Korea, Brazil, Italy, Russia, China, Britain and India) over the period of 1993 - 2011 to estimate the impact of exchange rate volatility on trade balance.

4. Methodology

The main goal of this research is the evaluation of volatility of exchange rate on trade balance in Iran by using panel data approach. Hence the estimated exchange rate volatility is essential. In order to investigate the exchange rate volatility commonly used ARCH and GARCH techniques.

The model estimated is the following form:

Balance trade = f (export, import, real effective exchange rate)

All variables are based on amount.

The existence of non stationary in the data may compromise standard tests used in the final regression, and therefore, it may lead to inaccurate conclusions. To avoid this miscalculation, in the first step, we will examine the property of stationary in the individual explanatory series by using the augmented Dickey–Fuller (ADF) unit roots test procedure. The results of the ADF unit roots tests (Appendix Table A) show that all variables, except volatility, are non stationary at their level and we get stationary after taking difference. We use Levin-Lin-Chu unit root test for exchange rate volatility. The results of the Levin-Lin-Chu unit root test (Appendix Table B) show that exchange rate

volatility is stationary at its level. In the next step, in order to estimate the volatility of the exchange rate is used from Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) model. Before estimating the GARCH model, it is necessary to be determined ARMA model for exchange rate variable. In fact in a GARCH model, the error variance is assumed to follow an ARMA process which means it allows for autoregressive and moving average components in the heteroskedastic variance. ARIMA models for exchange rate series based on the autocorrelations and partial autocorrelations would be ARIMA (1, 0, 1), ARIMA (1, 0, 0) (Appendix Fig.1). In the second phase of the study we model the conditional mean as well as the conditional variance of the given series simultaneously, which is called ARCH modeling. The analysis is completely based on the residuals obtained from the fitted ARIMA model built in the first phase.

Engle (1982) introduced ARCH model. ARCH model suggests that the variance of residuals at time t depend on the square errors terms from the past. The ARCH model can be defined as follow. Let Y_t is the return of the trade balance, then the following model is called ARCH (p) model.

$$Y_t = \alpha_0 + \sum_{i=1}^p \alpha_i y_{t-i} + \sum_{j=1}^q b_j \varepsilon_{t-j} + \varepsilon_t \quad (1)$$

$$\varepsilon_t = v_t \sqrt{h_t} \quad (2)$$

$$h_t = \alpha_0 + \sum_{i=1}^s \alpha_i \varepsilon_{t-i}^2 \quad (3)$$

Where p and q are the order of AR and MA process to yield an ARMA process. It is assumed that the error terms have mean zero and no autocorrelation at any lag. To specify an ARCH process it is assumed that the equation (2) can be decomposed in to two parts, v_t which is homoskedastic, with mean zero and $\sigma_v^2 = 1$ and h_t is heteroskedastic with variance given by equation (3) (Khan, 2010:7).

It is necessary to apply the formal ARCH test to confirm the order of the ARCH process, for this purpose we have used the Lagrange multiplier test of Engle (1982), which is called ARCH-LM test, especially design to test for ARCH error. ARCH-LM test is distributed as χ^2 with p degree of freedom under the null hypothesis to be true, where p is the number of lags, which are included in the test for testing ARCH error. Our null hypothesis is

H_0 : no ARCH effects $Vs. H_1$: ARCH (p) disturbance

Table 1. ARCH LM test

Lags (p)	Chi 2	df	prob>chi 2
1	61.317	1	0.000

So we have no difficulty to reject the null hypothesis of no ARCH error, and conclude that there is an ARCH error in the series. This confirms that the order of the ARCH error is one for AP series. These tests affirm the appropriateness of the GARCH model for analysing the exchange rate series. The generalization of ARCH model is called GARCH model. Bollerslov (1986) generalized ARCH model as GARCH model by allowing the past conditional variances in the conditional variance equation. The generalization was done

in the similar way as AR model was generalized to ARIMA model. The GARCH model can be defined as follow,

Let Y_t be the return of trade balance, and suppose Y_t follow an ARIMA process

$$Y_t = \alpha_0 + \sum_{i=1}^p \alpha_i y_{t-i} + \sum_{j=1}^q b_j \varepsilon_{t-j} + \varepsilon_t \quad (4)$$

$$\varepsilon_t = v_t \sqrt{h_t} \quad (5)$$

$$h_t = \alpha_0 + \sum_{i=1}^s \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^r \beta_j h_{t-j} \quad (6)$$

Where p and q are the order of AR and MA process to yield an ARIMA model. It is assumed that the error terms have mean zero and no autocorrelation. In equation (6) s is the order of ARCH terms and r is the order of GARCH process. Also α_i of order s are the coefficients of ARCH terms and β_j of order r are the coefficients of GARCH terms. The above Model is denoted by GARCH (s, r) model. It is important to remember that the GARCH model consist of two parts. One is an ARIMA equation and other is GARCH equation. If $r = 0$, the GARCH model reduced to ARCH model (Khan, 2010:7).

Black (1976) has noted a negative correlation between current returns and future volatility that tends to rise in response to bad news and fall in response to good news. It means that the impact of good news is not the same as that of bad news. GARCH model is symmetric and gives same weight to good and bad news of the same magnitude and ignore the sign of the news. In essence, good news and bad news have the same effect (Khan, 2010: 7).

Table 2. The estimated GARCH models of exchange rate.

Test	coefficient	standard error	z-value	p-value
GARCH (1,1)	0.408637	0.3973133	1.03	0.304

Therefore, GARCH (1, 1) successfully fulfills the criteria used to choose the valid models.

In the next step, put the results of GARCH approach as a measure of exchange rate volatility on trade balance function of Iran to investigate its effects. For this purpose, we use panel data technique. So, the fixed and random effects tests done to determine the type of panel test for the model studied. Therefore, to choose between Pooled-OLS model and Random Effects Model (REM), Breusch-Pagan Lagrange multiplier (LM) test is applied. The results of this test, p-values, reject the null hypothesis of no significant difference across panel units. Thus, REM is preferred to pooled-OLS model in the case of this study.

Then, the Hausman test is used in order to decide between REM and FEM (Fixed Effects Model). This test assumes the null - hypothesis of no correlation between the individual effects and regressors in the model (Hausman, 1978).

P-values of this test reject the null hypothesis implying that REM produces bias estimation. Hence, the FEM is preferable to REM in the case of this study. The p-values of this test are available upon request. Therefore and based on the results of two above-mentioned tests, FEM is the most

appropriate estimation strategy in the case of this study.

Table 3. The Husman test and results of the LM test

Test	Statistic	Value		P-Value	
		Export	Import	Export	Import
Chow	F	5.81	53.72	0	0
		LM	χ^2	46.24	43.12
Hausman	χ^2	-0.22	-0.43	0	0

5. Estimation Results and Interpretation

In the table below, the results of econometric model expressed to estimate the effect of exchange rate volatility, export and import variables on trade balance of Iran.

Table 4. estimation results

Variable	coefficient	t-value	p-value
Export	-0.54**	-2.43	0.016
Import	-0.87***	-47.60	0.000
Exchange rate volatility	55903.93	1.22	0.224
import	-4889.185	-0.37	0.711
Export	-1.21e+09***	-6.51	0.000
Import	2.00e+08***	3.53	0.001

*** signification at 1% level

** Signification at 5% level

The results showed that the real effective exchange rate has no significant effect on the trade balance. In other words, exchange rate depreciation is not an effective policy to increase trade balance, in terms of expected direction and the magnitude of the impact. Thus, there must be other variables in the demand side (such as income per capita, population and preference in the destination country), or supply side (such as efficiency in production and quality) that is influential in improving the trade balance. The lack of a robustly impact of exchange rate volatility on trade balance may well reflect the ambiguity of the theoretical results. Infact, Changes in the exchange rate may reflect changes in the volatility of the underlying shocks and/or changes in the policy regime. For example, trade liberalization undertaken together with a move to greater exchange rate flexibility could well be associated with increased trade flows as well as increased exchange rate volatility. This possibility is a reason for the ambiguity of the theoretical results as well as the difficulty in finding consistent and robust empirical results regarding the impact of volatility on trade balance. The result is consistent with estimates found in other studies such as Bailey and Tavlas (1988), Sekkat (1997), Gotur (1985), Medhora (1990), but it is not consistent with estimates of Lee and Saucier (2005), Hwang and Lee (2005), Arize et al. (2005), Tenreyro (2004), McKenzie and Brooks

(1997), Klein (1990). Therefore, one important implication from these results is that devaluation-based adjustment policies may not achieve the desired effects of real effective exchange rate changes (devaluation) on the balance of trade. In other words, exchange rate cannot be used solely in managing the external balances of Iran. Indeed, can not expect from using the exchange rate as a policy tool to boost trade balance of Iran and hence its growth. This confirms the view that Improve the trade balance is likely to require more efforts than simply adjusting exchange rates.

Also, this study indicates that export variable doesn't have significant impact on trade balance but sign of the coefficient on import variable is negative, and it is statistically significant. This implies that one possible reason for this surprising result is the important role that oil plays in Iran's exports. Iran is a major player on the international oil market. The earning from oil export re-spent on import rather than being spent to support national production and release from single product export. The reason behind this result is the reduction in tariff rates and removal of other trade barriers, which invite more imports to come in the country. This shows that Iran is significantly implementing the WTO agreements, leaving the imports substitution policies and concentrating on outward oriented policies.

6. Conclusions

One of the principal concerns since the flexible exchange rate regime was introduced has been whether the increase in exchange rate volatility has impacted on trade. On the question of the effects of exchange rate volatility on trade, the considerable array of theoretical and empirical literature remains somewhat ambiguous. In this research paper, we examined the impact of real exchange rate variability on trade balance of Iran. By using the GARCH approach and balance PANEL data model for the sample period from 1993

to 2011. In measuring real exchange rate variability, we employed GARCH (1, 1) model advanced by Bollerslev (1986). After undertaking careful unit root testing and finding that all other variables except real exchange rate volatility are I (1), we applied balance panel data model to study effect of exchange rate volatility on trade balance. The results showed that the real effective exchange rate has no significant effect on the trade balance. So, this variable is not an important determining factor of trade balance. In addition, this paper investigated the effect of export and import variables on trade balance and found that the only variable with significant effects on the trade balance is import.

From a policy perspective our results are important. They suggest that policy makers should not consider volatility when applying economic policy. Unfortunately, Iran has to compete with some very big competitors such as Arabic countries in its top most export item, oil. Thus, the experiences of those countries also can provide useful lessons for Iran exchange rate policy.

Also, the country should implement the policy that focuses on the production of imported substituted goods. Import-substitution policy may work well in improving domestic income and trade balance. On the other hand, if economical macro-economic politicians seek to minimize the barriers of import through joining the world trade organization that is with de-regulation and reduce tariffs, at the same time they should be emphasized on the production and non-oil exports especially industrial commodity and promote the foreign trade.

Lastly, the model estimation is based on GARCH approach and PANEL DATA with limited in included endogenous and exogenous variables. Results of the different studies are difficult to compare since the sample period, model specification, countries and the measure of risk vary widely.

Appendix

Table A. Augmented Dickey-Fuller test for unit root

Country	Variable	Statistic Z (t)	P-value		Adjudication	Lag
			%1	%5		
Germany	Trade Balance	0.765	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-2.590	-2.660	-1.950	I (0)	3
	Import	0.751	-3.750	-3.00	I (1)	-
	Import Difference	-2.559	-2.660	-1.950	I (0)	3
	Export	-12.061	-3.750	-3.00	I (0)	-
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
UAE	Trade Balance	-1.705	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-5.950	-2.660	-1.950	I (0)	1
	Import	-1.673	-3.750	-3.00	I (1)	-
	Import Difference	-5.069	-2.660	-1.950	I (0)	1

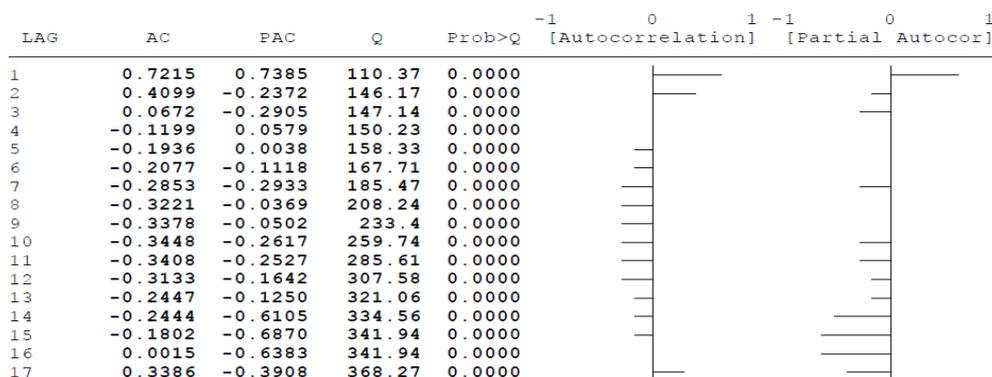
	Export	-0.976	-3.750	-3.00	I (1)	-
	Export Difference	-4.629	-2.660	-1.950	I (0)	1
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
Brazil	Trade Balance	-1.872	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-5.194	-2.660	-1.950	I (0)	1
	Import	-1.879	-3.750	-3.00	I (1)	-
	Import Difference	-5.357	-2.660	-1.950	I (0)	1
	Export	-0.387	-3.750	-3.00	I (1)	-
	Export Difference	-8.079	-2.660	-1.950	I (0)	1
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
India	Trade Balance	-1.182	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-5.294	-2.660	-1.950	I (0)	2
	Import	-0.914	-3.750	-3.00	I (1)	-
	Import Difference	-3.492	-2.660	-1.950	I (0)	1
	Export	3.015	-3.750	-3.00	I (0)	-
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
Korea	Trade Balance	-0.489	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-7.351	-2.660	-1.950	I (0)	1
	Import	1.945	-3.750	-3.00	I (1)	-
	Export	-5.425	-2.660	-1.950	I (0)	1
	Export Difference	-1.870	-3.750	-3.00	I (1)	-
	Exchange Rate	-6.402	-2.660	-1.950	I (0)	1
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
Country	Variable	Statistic Z (t)	P-value		Adjudication	Lag
			%1	%5		
France	Trade Balance	-1.230	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-2.934	-2.660	-1.950	I (0)	1
	Import	-1.183	-3.750	-3.00	I (1)	-
	Import Difference	-2.917	-2.660	-1.950	I (0)	1
	Export	-5.356	-3.750	-3.00	I (0)	-
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
Italy	Trade Balance	-4.646	-2.660	-1.950	I (0)	1
	Trade Balance Difference	-1.789	-3.750	-3.00	I (1)	-
	Import	-3.887	-2.660	-1.950	I (0)	1
	Import Difference	-1.898	-3.750	-3.00	I (1)	-
	Export	-5.976	-2.660	-1.950	I (0)	1
	Export Difference	-4.646	-2.660	-1.950	I (0)	1
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate	-2.530	-2.660	-1.950	I (0)	1

	Difference					
Japan	Trade Balance	-2.822	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-7.428	-2.660	-1.950	I (0)	1
	Import	-1.751	-3.750	-3.00	I (1)	-
	Import Difference	-8.229	-2.660	-1.950	I (0)	1
	Export	-1.249	-3.750	-3.00	I (1)	-
	Export Difference	-3.655	-2.660	-1.950	I (0)	1
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
Russia	Trade Balance	-2.729	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-5.750	-2.660	-1.950	I (0)	1
	Import	-2.265	-3.750	-3.00	I (1)	-
	Import Difference	-5.849	-2.660	-1.950	I (0)	1
	Export	-0.047	-3.750	-3.00	I (1)	-
	Export Difference	-2.321	-2.660	-1.950	I (0)	1
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
Country	Variable	Statistic Z (t)	P-value		Adjudication	Lag
China	Trade Balance	-2.223	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-5.612	-2.660	-1.950	I (0)	1
	Import	-0.398	-3.750	-3.00	I (1)	-
	Export	-6.318	-2.660	-1.950	I (0)	1
	Export Difference	-0.816	-3.750	-3.00	I (1)	-
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
UK	Trade Balance	-3.167	-3.750	-3.00	I (1)	-
	Import	-3.083	-3.750	-3.00	I (1)	-
	Export	-2.227	-3.750	-3.00	I (0)	-
	Export Difference	-4.186	-2.660	-1.950	I (1)	1
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1
Russia	Trade Balance	-2.729	-3.750	-3.00	I (1)	-
	Trade Balance Difference	-5.750	-2.660	-1.950	I (0)	1
	Import	-2.265	-3.750	-3.00	I (1)	-
	Import Difference	-5.849	-2.660	-1.950	I (0)	1
	Export	-0.047	-3.750	-3.00	I (1)	-
	Export Difference	-2.321	-2.660	-1.950	I (0)	1
	Exchange Rate	0.366	-3.750	-3.00	I (1)	-
	Exchange Rate Difference	-2.530	-2.660	-1.950	I (0)	1

Table B. Levin-Lin-Chu unit root test for exchange rate volatility

LR variance: Bartlett kernel, 8.00 lags average (chosen by LLC)

	Statistic	p-value
Unadjusted t	-84.6063	
Adjusted t*	-87.1007	0.0000

**Figure 1.** correlogram of the Autocorrelation and Partial autocorrelation of ARMA model

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