Consequence of Interactive Effect of Exchange Rate Volatility and Trade on GDP growth

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Introduction

- The exchange rate: An important macroeconomic policy variable.
- Previously it has never been a main focus variable in analyzing economic growth.
- It is an important determinant of competitiveness of the country: its surprising volatility might have impact on competitiveness.
- International Trade involvement of the country: Importance of exchange rate and its volatility.
- Following particular channel, a country's economic growth might also be affected by this movement.
- Therefore, exchange rate volatility has been regarded as a vital macroeconomic concern and its impact has gained much attention from the researchers earlier.

Research Question

What is the impact of exchange rate volatility on Economic Growth and does its interaction with international trade make the impact worse?

Review of Existing Literatures

- Despite the sources, impact of exchange rate volatility is not that much predicted.
- Surprisingly, the existing empirical studies have not been able to draw any concrete conclusion about the influence of exchange rate volatility on growth. The so called findings are rather **"mixed"** and **"ambiguous".** Some suggests that exchange rate volatility may positively affect economic growth of a country while others deny. It may also affect directly or indirectly through investment, trade or financial development of a country. However, some other literatures have remained **inconclusive** in this regard.

Review of Existing Literatures Contd.

Study	Data & Sample	Method	Findings
Bailliu, Lafrance & Perrault (2003)	60 Countries, Time : 1973 to 1998	Dynamic GMM Estimation	Positive (Importance of Monetary Policy Anchor)
Chen (2012)	28 Chinese Provinces, Time: 1992 to 2008	Dynamic Panel Data Estimation	Positive
Musyoki, Pokharlyal & Pundo (2012)	Kenya, Time: January 1993 to December 2009	GMM Estimation	Negative
Janus & Crichton (2015)	OECD Countries, Time: 1980 to 2011	Panel Data Estimation	Negative
Zdzienicka, Martin, Furceri, & Arratibel (2011)	CEE countries, Time: 1995 to 2008	Panel Data Estimation	Negative
Sanginabadi & Heidari (2012)		ARDL Bound Test Approach	Negative

Review of Existing Literatures Contd.

Study	Data & Sample	Method	Findings
Akpan & Atan (2012)	Nigeria, Time: 1986 to 2010	GMM Estimation	No Strong Evidence
Omojimite & Akrokodje (2010)	CFA and Non CFA Countries	Fixed Effect & GMM Estimation	Negative
Insah & Bangnyel (2014)	Ghana	Dynamic Ordinary Least Square (DOLS)	Positive
Danmola (2013)	Nigeria, Time: 1980 to 2010	Pair wise Correlation, Granger Causality Test , OLS	Positive
Azeez, Kolapo & Ajayi (2012)	Nigeria, Time: 1986 to 2010	OLS, Johansen Cointegration	Positive
Aghion, Bacchetta, Ranciere & Rogoff (2009)	83 Countries, Time: 1960 to 2000	GMM dynamic panel estimation	Effect is Subject to Financial Development of the Country
Kaur & Vikram (2013)	18 Asian Countries, Time: 1961 to 2006	2SLS and Fixed Effect Estimation	Independent Effect Positive, Negative for more open Economies

Motivation for the Current Study

- **Small number of works** on the volatility of exchange rate and growth nexus that targets Asian countries.
- **Even smaller in Number:** Analyze the nexus taking into account the trade openness of the country.

Methodology and Hypothesis Establishment

- ***Hypothesis: the exchange rate volatility has negative impact on GDP growth and which would become even more negative if we allow trade to interact with volatility of exchange rate.***
- Aghion *et. al.* (2009): Pioneer for empirically testing the relationship between exchange rate volatility and productivity growth conditioning upon **financial development.**
- Ndambendia & Hayky (2011): applied the same idea to test the impact of exchange rate volatility on economic growth conditioning on **domestic credit to GDP** ratio in Sub – Saharan Africa.

Methodology and Hypothesis Establishment Contd.

The main model that we would be estimating is as follows:

$$RGDP_{i,t} = \eta_i + \mu_t + \alpha_1 LVOL_{i,t} + \alpha_2 (LVOL_{i,t} * TGDP_{i,t}) + \beta\, TGDP_{i,t} + \psi' X_{i,t} + \varepsilon_{i,t} \qquad (1)$$

Depending on the sign of concern coefficients there could arise three following scenarios:

Scenario 1: $\boldsymbol{\alpha_1 < 0}$ ***and*** $\boldsymbol{\alpha_2 < 0}$

$$\frac{\delta RGDP_{i,t}}{\delta LVOL_{i,t}} = \alpha_1 + \alpha_2 TGDP_{i,t} < 0 \qquad (2)$$

Scenario 2: $\boldsymbol{\alpha_1 < 0}$ ***and*** $\boldsymbol{\alpha_2 > 0}$

$$\frac{\delta RGDP_{i,t}}{\delta LVOL_{i,t}} = \alpha_1 + \alpha_2 TGDP_{i,t} > 0 \qquad (3)$$

$$\Leftrightarrow \alpha_2 TGDP_{i,t} > \alpha_1 \ (as\ \alpha_1 < 0) \Leftrightarrow TGDP_{i,t} > \frac{\alpha_1}{\alpha_2} = \overline{TGDP_{i,t}}$$

Scenario 3: $\boldsymbol{\alpha_1 > 0}$ ***and*** $\boldsymbol{\alpha_2 < 0}$

$$\frac{\delta RGDP_{i,t}}{\delta LVOL_{i,t}} = \alpha_1 + \alpha_2 TGDP_{i,t} < 0 \qquad (4)$$

$$\Leftrightarrow -\alpha_2 TGDP_{i,t} < -\alpha_1 \ (as\ \alpha_1 > 0\ and\ \alpha_2 < 0)$$

$$\Leftrightarrow \alpha_2 TGDP_{i,t} > \alpha_1$$

$$\Leftrightarrow TGDP_{i,t} > \frac{\alpha_1}{\alpha_2} = \overline{TGDP_{i,t}}$$

Data & Statistical Software

- **Three secondary data sources: International Financial Statistics (IFS)** database from IMF, **World Development Indicators (WDI)** database from World Bank and **Penn World Table**, version 8.1.
- Eight countries from Asia namely Bangladesh, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand have been observed from 1985 to 2013.
- The yearly observations for variables Growth Rate of Real GDP, Trade – GDP ratio, Gross Fixed Capital Formation (as % of GDP), rate of Inflation has been taken form WDI database. IFS database and Penn World Table was used to collect data on employment growth.
- Monthly observations on nominal exchange rate defined as the "national currency per USD" and consumer price index have been collected using IFS database. We have used EVIEWS 9 and STATA 13 to perform the statistical analysis of the study.

Methodology and Hypothesis Establishment Contd.

- **Cross Sectional Dependence Test:** We would be focusing on four different cross sectional dependence tests namely Breuch – Pagan Lagrange Multiplier (LM) (1980), Pesaran Cross Sectional Dependence (CD) (2004), Pesaran Scaled LM (2004) and Baltagi, Feng and Kao Bias Corrected Sclaed LM (2012). The null hypothesis that would be tested in all the tests can be stated as ***the residuals from the standard panel regression should be contemporaneously uncorrelated.***

$$H_0: \rho_{ij} = \rho_{ji} = Cov(\varepsilon_{it}, \varepsilon_{jt}) = 0, for\ all\ t, i \neq j$$

$$H_1: \rho_{ij} = \rho_{ji} = Cov(\varepsilon_{it}, \varepsilon_{jt}) \neq 0, for\ all\ t, i \neq j$$

- **Panel Unit Root Test: Cross Section Dependence is a Crucial Assumption.**
- **Im, Pesaran and Shin (IPS) Test:** In order to perform the test at first for each variable, an AR(1) process is estimated and then for each cross section unit an Augmented Dickey Fuller (ADF) test regression is fitted. The IPS panel unit root test in particular, examines the significance of the autoregressive coefficient attached with lagged level dependent variable in ADF regression to detect the stationarity of the variables.

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij}\, \Delta y_{it-j} + x_{it}^{'} \delta + \varepsilon_{it} \qquad (5)$$

Construction of RER & Volatility Estimation

- RER of country " i " at time " t " is measured in the following way:

$$RER_{i,t} = \left(\frac{Currency\ of\ Country\ i_t}{USD_t}\right) * \left(\frac{US\ CPI_t}{CPI\ of\ Country\ i_t}\right)$$
$$= NER_{it} * \left(\frac{US\ CPI_t}{CPI\ of\ Country\ i_t}\right) \qquad (6)$$

The volatility of RER:

1. GARCH (1, 1) model with monthly observations of natural logarithm of RER.
2. Standard Deviation of RER

Results and Findings

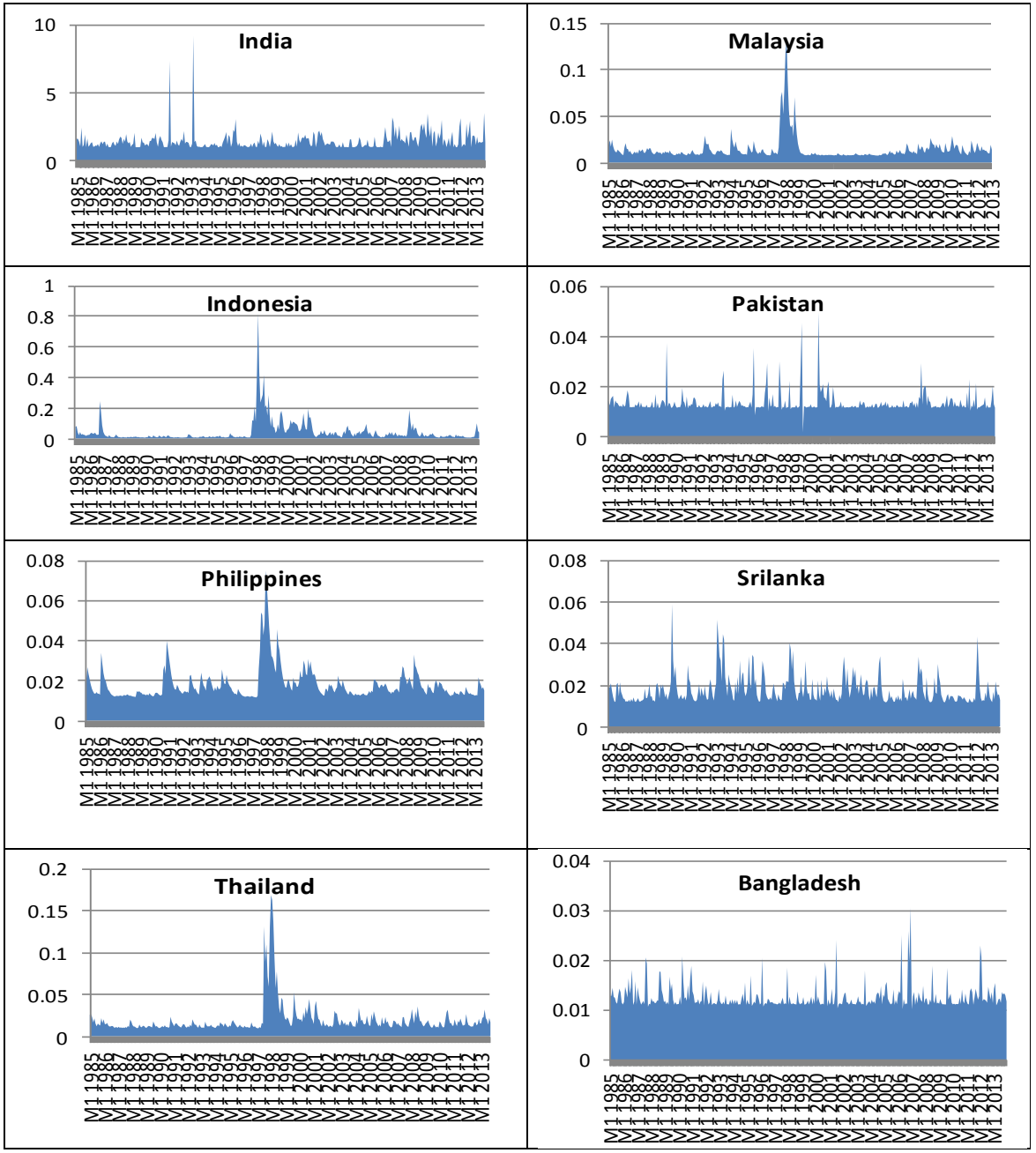
Table A1: Testing for Existence of ARCH effects in RER for the Countries

LM Test for Autoregressive Conditional Heteroscedasticity (ARCH)		
H_0: No ARCH Effects		
Country	**Chi – Sq. Stat.**	**Prob.**
Bangladesh	16.501*	0.000
India	0.102	0.749
Indonesia	34.927*	0.000
Malaysia	136.229*	0.000
Pakistan	12.342*	0.000
Philippines	49.057*	0.000
Srilanka	22.287*	0.000
Thailand	133.145*	0.000

Note: * Indicates 1 per cent level of significance.

A keen look on the table establishes the fact that the null hypothesis of ***"no ARCH effect"*** can convincingly be rejected at 1 per cent level for all the countries except India as the Chi – Square statistic is found to be significantly high. Thus we have estimated widely accepted "Generalized Autoregressive Conditional Heteroscedasticity" GARCH (1, 1) model for each of the countries and predicted the conditional variance which is used as a measure of conditional volatility of RER.

Conditional Volatility of RER from GARCH (1, 1) Model



Cross Sectional Dependence Test Results

Table A2: Test Results for Cross Sectional Dependence of the Variables

Variables and Test Names		Breusch - Pagan LM	Pesaran - Scaled LM	Bias Corrected Scaled LM	Pesarn CD
		H_0: No Cross - Section Dependence			
GDP growth (annual %)	Statistic	101.081*	9.765*	9.623*	5.678*
	Prob.	0.000	0.000	0.000	0.000
Trade (% of GDP)	Statistic	232.439*	21.319*	27.176*	7.345*
	Prob.	0.000	0.000	0.000	0.000
GFCF (% of GDP)	Statistic	151.329*	16.480*	16.337*	2.908*
	Prob.	0.000	0.000	0.000	0.003
Employment Growth (%)	Statistic	28.067	0.008	- 0.133	0.480
	Prob.	0.460	0.992	0.893	0.631
Log of Volatility of RER	Statistic	99.683*	9.579*	9.436*	3.681*
	Prob.	0.000	0.000	0.000	0.000
Log of Volatility of RER1	Statistic	65.762*	5.046*	4.903*	4.070*
	Prob.	0.000	0.000	0.000	0.000
Interaction Term	Statistic	109.707*	10.918*	10.770*	2.347**
	Prob.	0.000	0.000	0.000	0.018
Interaction Term1	Statistic	55.815*	3.716*	3.568*	0.312
	Prob.	0.001	0.000	0.000	0.754
Inflation (Annual %)	Statistic	90.450*	8.345*	8.202*	7.287*
	Prob.	0.000	0.000	0.000	0.000

Note: * Indicates 1 per cent level of significance and ** indicates 5 per cent level of significance

Panel Unit Root Test Results

Table A3: Panel Unit Root Test Results of the Variables

Variables	Im – Pesaran – Shin (IPS) Test for Panel Unit Root			
	Null: Panels Contain Unit Roots			
	Intercept		Intercept and Trend	
	IPS W - Stat	Prob.	IPS W - Stat	Prob.
Employment Growth	-11.580*	0.000	-10.459*	0.000
D(Employment Growth)	-17.620*	0.000	-16.296*	0.000
GDP Growth	-7.488*	0.000	-7.477*	0.000
D(GDP Growth)	-13.488*	0.000	-11.846*	0.000
GFCF (% of GDP)	-0.080	0.468	-0.697	0.242
D(GFCF (% of GDP))	-7.221*	0.000	-5.379*	0.000
Trade(% of GDP)	1.041	0.851	0.565	0.714
D(Trade(% of GDP))	-13.443*	0.000	-11.997*	0.000
Log of Volatility of RER	-6.507*	0.000	-4.897*	0.000
D(Log of Volatility of RER)	-13.486*	0.000	-10.668*	0.000
Log of Volatility of RER 1	-6.777*	0.000	-6.725*	0.000
D(Log of Volatility of RER1)	-18.255*	0.000	-15.210*	0.000
Interaction Term	-11.721*	0.000	-11.619*	0.000
D(Interaction Term)	-15.076*	0.000	-13.509*	0.000
Interaction Term1	-12.379*	0.000	-11.813*	0.000
D(Interaction Term1)	-16.493*	0.000	-13.782*	0.000
Inflation (Annual %)	-7.665*	0.000	-6.300*	0.000
D(Inflation)	-15.203*	0.000	-13.796*	0.000

Note: * Indicates 1 per cent level of significance.

Model Specification

Table A4: Hausman Model Specification Test

Correlated Random Effects - Hausman Test		
H_0: Random Effect Model is Appropriate		
Model Specification	**Chi - Sq. Stat.**	**Prob.**
Cross Section Random	42.928*	0.000
Period Random	21.684*	0.001

Note: * Indicates 1 per cent level of significance.

Table A5: Redundant Fixed Effects Tests

Effects Test	Statistic	Prob.
H_0: Cross Section Effects are Redundant		
Cross-section F	6.422*	0.000
Cross-section Chi-square	49.206*	0.000
H_0: Period Effects are Redundant		
Period F	1.614**	0.035
Period Chi-square	47.859*	0.008
H_0: Cross Section and Period Effects are Jointly Redundant		
Cross-Section/Period F	3.418*	0.000
Cross-Section/Period Chi-square	110.155*	0.000

Note: * Indicates 1 per cent level of significance and ** indicates 5 per cent level of significance.

Results and Findings Contd.

		Regression Results from Static Model					
		Pooled OLS	**Panel Least Squares**			**Panel EGLS**	
		1	**2**	**3**	**4**	**5**	**6**
Allowing Interaction Between RER and Trade - GDP Ratio	**Log Volatility of RER**	-0.960*	-2.394*	0.307*	-1.876*	-2.234*	-0.077
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.709)
	Interaction Term	-0.089*	-0.087*	-0.075*	-0.079*	-0.085*	-0.076*
		(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Regression Results from Dynamic Model					
Allowing Interaction Between RER and Trade - GDP Ratio	**Log Volatility of RER**	-0.476*	-2.084*	0.251*	-1.520*	-1.864*	
		(0.000)	(0.000)	(0.003)	(0.004)	(0.000)	
	Interaction Term	-0.134*	-0.101*	-0.099*	-0.096*	-0.099*	
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
Effect Specification	**Cross Section Effect**	None	Fixed	None	Fixed	Fixed	Random
	Period Effect	None	None	Fixed	Fixed	Random	Fixed

Results and Findings Contd.

- In the table, models have been separated with respect to the estimation method and on the basis of fixed effect specification.
- **Model 1** contains the estimation of benchmark regression using pooled OLS and ordinary formula for variance covariance matrix. Thus the estimated parameters are the regular least square estimators.
- **Model 2, 3 and 4** has been estimated using Panel Least Square and White diagonal robust variance covariance has been used which is robust to observation specific heteroscedasticity in the disturbances. The estimators could be characterized as fixed effect estimators or within estimators.
- **In Model 4,** the estimators could be characterized as both way fixed effect estimator where the model transformation is made from within unit as well as within period variation.
- **Model 5 and 6** estimated using Panel EGLS with White diagonal robust variance covariance estimate. In model 5, we have cross section effect as fixed and period effects as random while in model 6, we have the effects as the other way around. Thus these two models provide random effect estimators or between estimators.

The coefficient of the interactive variable is found to be negative and significant in all the models. Also the log of volatility of RER has remained negative and significant. Therefore, the impact of volatility on GDP growth is more negative when we consider the trade. The finding is in line with our hypothesis explained under scenario 1 in the methodology.

Robustness of The Results

		Regression Results from Static Model					
		Pooled OLS	**Panel Least Squares**			**Panel EGLS**	
		1	**2**	**3**	**4**	**5**	**6**
Allowing Interaction Between RER and Trade - GDP Ratio	**Log of Volatility of RER1**	-0.419*	-1.003*	-0.035	-0.958*	-0.995*	-0.035
		(0.000)	(0.000)	(0.588)	(0.000)	(0.000)	(0.588)
	Interaction1	-0.058*	-0.022*	-0.018*	-0.017*	-0.019*	-0.018*
		(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)
		Regression Results from Dynamic Model					
Allowing Interaction Between RER and Trade - GDP Ratio	**Log of Volatility of RER1**	-0.148***	-0.998*	-0.027	-0.829*	-0.875*	
		(0.091)	(0.000)	(0.674)	(0.000)	(0.000)	
	Interaction1	-0.048*	-0.024*	-0.021*	-0.020*	-0.022*	
		(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	
Effect Specification	**Cross Section Effect**	None	Fixed	None	Fixed	Fixed	Random
	Period Effect	None	None	Fixed	Fixed	Random	Fixed

Concluding Remarks

- Flexible exchange rate vs. Fixed Exchange
- One major concern is that the uncertainty associated with the exchange rate volatility could also create ambiguity about the trade return and thus conceive an amplified negative impact on the income or output growth of the economy.
- Almost all the models reveal that real GDP growth is negatively elastic with respect to volatility of RER. Most importantly, the elasticity becomes even more negative if we allow volatility of RER to interact with trade.
- Whenever the trade dependence measured by Trade – GDP ratio of the country becomes higher the monetary policy makers responsible for determining the exchange rate regime should remain more cautious.
- One of the major limitations of this study is that it could not address the structural break which if present, can cause instability of parameters and consequently the findings may also change. Thus, it could also remain as a further area of research.