MACROECONOMIC INDICATORS CONTRIBUTING TOWARDS EXCHANGE RATE VOLATILITY: EVIDENCE FROM INCOME GROUPS OF THE COUNTRIES

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The focus of the study is to explore the macroeconomic factors contributing towards exchange rate volatility in group of economies segregated on the basis of income. Further analysis is extended to identify the role of underlying macroeconomic indicators in explaining the exchange rate behavior at level. The Panel ARDL cointegration and Panel Granger Causality Test are employed on annual data sets for the period 1995-2015. The results of the separate analysis have been compared in first place on the basis of determinants of exchange rate volatility and the determinants of exchange rate level and secondly on the basis of income groups of the countries (high income, middle income and low income). The results provide the evidence that exchange rate behaviour both in terms of volatility and at level is entirely governed by the selected set of macroeconomic indicators in all three panel data sets. The findings of the study validated the fundamentals based macroeconomic models of exchange rate determination and suggested that macroeconomic fundamentals played important role in derivation of exchange rate volatility as well as exchange rate level. Moreover response of exchange rate volatility and exchange rate level to the different macroeconomic indicators has been observed very sensitive to the income level of the countries. The comparison of the factors of exchange rate volatility and exchange rate level will enhance exposure about the policies concerned about exchange rate behaviour.

Keywords: *Exchange Rate, Exchange Rate Volatility, Macroeconomic Indicators, High Income Countries, Middle Income Countries, Low Income Countries, PMG, Panel Granger Causality*
JEL Codes F31, E31, E47, E01, N1

Introduction

The theoretical and empirical literature asserted on the existence of linkages between exchange rate fluctuations and fundamental macroeconomic indicators. However as per research literature the role of macroeconomic variables in determination of exchange rate dynamics lacked general consensus. Moreover most of the previous research had been devoted to determine the factors that explain and forecast exchange rate equilibrium at level. However a few number of studies have tried to investigate the relationship between exchange rate volatility and macroeconomic indicators Thus it is relevant to see whether volatility in exchange rates is just the result of overshooting more than the changes in the macroeconomic fundamentals.

The theory has proposed several structural models that assume the patrons of exchange rate changes affected by macroeconomic indicators like portfolio balance models and monetary exchange rate models. In this respect most influential and mostly used exchange rate models are the monetary models of the exchange rate determination that depend on principle of interest rate parity and the purchasing power parity. The models which are designed to forecast and estimate exchange rate movements in relation to market fundamentals are called fundamentals based exchange rate models. However, Meese and Rogoff (1983) empirically established that exchange rate models based on fundamental macroeconomic variables failed to outperform the random walk models. The missing link between exchange rate and macroeconomic variables as identified by Meese and Rogoff (1983 a,b) got fame in theory as exchange rate disconnect puzzle. Thus, in any case it is worth mentioning that influence of macroeconomic indicators on exchange rate fluctuations is undoubtedly an open issue and controversial as well.

Another factor regarding the varying results in this regard is that there exist a number of approaches of exchange rate determination which are suitable in one way and criticized in the other way. Exchange rate as variable itself is proxied by number of ways like in real terms, nominal terms, in terms of volatility, as ratio of domestic currency to foreign currency, as ratio of foreign currency to domestic currency. Withal, selection of macroeconomic variables in this respect varies (Ricci et al., 2013; Rapetti, Skott & Razmi, 2012; Ojo & Allege, 2014). The selection of macroeconomic variable in first place depend on the theory, secondly on the model selection (model being selected for analysis) and finally on the area of study. Besides all of this the main matter of

research remained confined to the question that which macroeconomic variables drive exchange rate behaviour.

In this context the current study is aimed at investigating the determinants of exchange rate volatility and exchange rate level for panel data sets of advanced countries and least developed countries. The study will contribute to the empirical literature by incorporating the exchange rate volatility to the conventional open economy macroeconomic models of exchange rate determination. Moreover, it will try to fill the research gap regarding comparative analysis of the determinants of exchange rate volatility and determinants of exchange rate level in cross country perspective. Further the econometric issues regarding application of panel data methodology have been tried to overcome by application of multiple methodologies with different econometrical assumptions.

Literature Review

Most of the theoretical and empirical literature regarding exchange rate behavior is subject to determine the macroeconomic fundamentals of exchange rate level. It has created a kind of research gap in investigating the underlying variables which influence the exchange rate volatility. Generally the empirical research regarding exchange rate behaviour can be divided into three major categories with respect to application of different approaches of exchange rate determination. In first place there come empirical studies that have applied monetary models. These studies used monetary fundamentals as the factors of exchange rate level (Frenkel, 1976; Hodrick,1978; Bilson, 1978). Second stream of empirical studies applied optimum currency areas in a way that these studies incorporate trade linkages, economic shocks to output, geographical factors and country size as the determinants of exchange rate level (Aydin, 2010; Prabheesh, Malathy & Madhumathi, 2007; Rapach & Wohar, 2002). Respectively, third category of studies used new open economy macroeconomic theory wherein monetary and non-monetary indicators are modeled to estimate the exchange rate changes (Engel & West, 2005; Kearney & MacDonald, 1990; Mark & Sul, 2001). By the time as concept of variance of exchange rate is getting weightage the researchers has shifted their attention to measure the elements contributing towards volatility.

However, literature has identified a wide range of factors of determination of exchange rate by varying techniques, using different kinds of data sets for different economies and group of economies. For

instance, per capita GDP (Cakrani et al., 2013), net oil trade (Aydin, 2010), trade (Choudhri & Khan, 2005; Canzoneri, Cumby & Diba, 1999; Ricci et al., 2013), population growth (Aydin, 2010), remittances (Vitek, 2009; Aydin, 2010), trade openness (Cakrani et al., 2013; Aydin, 2010), foreign aid (Aydin, 2010), government expenditures (Mcpherson & Rakovski, 1998; Ricci et al., 2013), price controls (Ricci et al., 2013), net foeign assets (Vitek, 2009; Ricci et al., 2013; Aydin, 2010), fiscal imbalance (Aydin, 2010), money supply (Kandil & Mirzaie, 2005), foreign direct investment (Christiansen, Prati, Ricci & Tressel, 2009; Ojo & Allege, 2014), foreign assets (Christopoulos et al., 2012; Ricci et al., 2013), inflation (Ramasamy & Abar, 2015; Ojo & Allege, 2014), imports (Benetrix & Lane, 2013; Kemal & Qadir, 2005); exports (Kemal & Qadir, 2005) and financial sector development (Stavarek & Maglietti, 2015). Similarly, the macroeconomic indicators affecting the volatility of exchange rate have been analyzed and identified by a number of studies. They include national output (Calderon, 2004), GDP (Azeez, Kolapo & Ajayi, 2012), economic growth (Ebaidalla, 2014; Arratibel et al., 2011), financial openness (Calderon, 2004), money supply (Bobai et al., 2013), monetary aggregates (Calderon, 2004), central bank independence (Hau, 2002), foreign direct investment (Khraiche & Gaudette, 2013; Bobai et al., 2013), government expenditures (Calderon, 2004), current account deficit (Bobai et al., 2013), terms of trade (Rapetti et al., 2012; Calderon, 2004), trade openness (Hau, 2002; Calderon, 2004; Ebaidalla, 2014), exports (Khan et al., 2014; Zakaria, 2013), imports (Khan et al., 2014) revolution and coups (Hau, 2002), volatility in exports (Supaat, Jiun, Tiong & Robinson, 2003), volatility in imports (Supaat et al., 2003), volatility in money supply (Supaat et al., 2003; Morana, 2009), volatility in output (Supaat et al., 2003; Morana, 2009), volatility in interbank rate (Supaat et al., 2003), volatility in inflation (Morana, 2009), credit (Bobai et al., 2013) exchange rate regimes (Calderon, 2004), exchange rate commitments (Hau, 2002) and inflation (Rapetti et al., 2012; Bobai et al., 2013). A number of studies have given the evidence that there exist the bi-directional causality relationship between exchange rate volatility and macroeconomic indicators. Morana (2009) found bi-directional causality between exchange rate volatility and volatility in output, volatility in inflation and volatility in aggregate demand. Giannellis and Papadopoulos (2011) observed bi-directional causality between exchange rate volatility and interest rate differentials. Arize et al. (2000) found bi-directional causality between exchange rate volatility and exports. Mahmood, Ehsanullah and

Ahmed (2011) observed bi-directional causality between exchange rate volatility and public investment. Dlamini (2014) observed inflation cause exchange rate volatility. Azid, Jamil, Kousar and Kemal (2005) observed bi-directional causality between real exchange rate and economic growth. Ojo and Allege (2014) observed bi-directional causality between nominal exchange rate and trade openness, inflation and interest rate. Rehman (2014) observed bi-directional causality between exchange rate and total reserves. Madesha et al. (2013) observed bi-directional causality between exchange rate and inflation.

Identification of the Research Gap

- The literature provides limited evidence on the determinants of exchange rate volatility that has utilized multiple panel data sets and conducted a comparative analysis of the determinants of exchange rate level and exchange rate volatility covering the group of the economies segregated by income.
- The exchange rate disconnect puzzle questioned the role of macroeconomic indicators in deriving the exchange rate behaviour. However none of the study has tried to investigate whether the questioned link between exchange rate and macroeconomic variables is sensitive to the choice of exchange rate level and exchange rate volatility as explained variable.
- In application of cross country panel econometric analysis some studies assume the coefficient homogeneity (for example application of GMM estimators and panel Granger Causality) while others assume coefficient heterogeneity (for instance panel cointegration techniques) but there are very limited studies which have examined the said relationship in both referred contexts.

Research Methodology

Model Specification

The objective of this study is to identify the relationship between the fundamental macroeconomic indicators and exchange rate volatility as well as exchange rate level. Thus, an open economy macroeconomic model of exchange rate determination is devised. The functional form of the model is given as:

EXRV = f(GDPC, CAB, FDI, FDEV, GEXP, INF, RESERV ,TRADE) …… (1)
EXRL = f(GDPC, CAB, FDI, FDEV, GEXP, INF, RESERV ,TRADE) ……. (2)
Where,

EXRV = Exchange rate volatility (Volatility series generated by GARCH Model)

EXRL = Exchange rate level (Official Exchange Rate level measured as local currency units per US Dollars

GDPC = Economic Growth (Measured by GDP per capita)

CAB = Current Account Balance

FDI = Foreign Direct Investment (Percentage of GDP)

FDEV = Financial Development (Credit to Private Sector)

GEXP = Government Expenditures (Percentage of GDP)

INF = Inflation Rate (Consumer Price Index represented in annual %)

RESERV = Total Reserves (Current US Dollars.)

TRADE = Trade Openness (Net Trade in goods and services. Data are in current US Dollars)

Measuring Volatility

Different kinds of distortions like political instability, economic interdependence, rise or fall in oil prices, supply or demand boom or crises, disasters, global or national financial crises and technological advancements caused widespread effects on the financial indicators, such as exchange rates. Thus intensity of these elements is better explained by the volatility in the exchange rate time series rather than that of exchange rate values at current level. The process of capturing the

shocks and understanding the behaviour of series through driving the variance series is technically called volatility. Through GARCH process the exchange rate series include lagged dependent variable (say EXRt-1) in the model to capture the elements of heteroskedasticity and autocorrelation and follow the above referred conditionality. In this way GARCH process generate the variance series of exchange rate that is called exchange rate volatility. The exchange rate volatility has been measured by simple GARCH (1,1) model in this study[1].

Estimation Techniques

The current research study has selected three distinct panel data sets of high income countries, middle income countries and low income countries to estimate the connotation of the said relationship further Panel Auto Regressive Distributive Lag (ARDL) and Panel Granger Causality test have been applied for the analysis. Now a days, it has become a tradition to apply the cross country panel data frame work to different theoretical propositions. Panel data estimation, technically, helped to tackle more complex issues that cannot be considered by purely time series analysis. Panel data application allow individual heterogeneity among different units of the data set, moreover, it can remove the effects of omitted variables which are particular to the individual cross section units but remain constant over time. Another advantage of panel data application is that the combination of time series and cross section dimensions in panel data lead to increase the degree of freedom that lead to resolve the issues of multicollinearity.

Panel Cointegration

The dynamic time series analysis cannot ignore the issue of non stationarity. Three distinct types of unit root tests being differentiated on the basis of their statistical procedure, namely Im, Pesaran and Shin test (IPS), Hadri Langrange Multiplier test (HLM) and Levin, Lin and Chu test (LLC) are applied to check the stationarity.

Modeling the Panel Cointegration

The long run information in time series can be intact through the process of cointegration. Cointegration not only facilitate in the course of

1. It is followed from the studies (Ebaidalla, 2014; Supaat et al., 2003; Udoh et al., 2012; Yunana et al., 2016).

analysis of long run association among the considered integrated variables, moreover, it reparameterize the relationship into Error Correction Model. This idea was formulized by Granger (1981) and later on by Engle and Granger (1987) along with the estimation procedure and specification test.

Panel ARDL Approach

Pesaran, Shin and Smith. (1999) incorporated the dynamic heterogeneous panel regression into the error correction model by applying the Auto Regressive Distributive Lag, ARDL (p,q) methodology. Specifically, in cross country analysis where the long run coefficients and the speed of convergence towards the long run are parameters of interest, the panel ARDL methodology is assumed as best choice. An important advantage of the Panel ARDL cointegration methodology is that it can be applied even if the selected variables have different order of integration. In other words, whether variables under consideration are I(0) or I(1). Moreover, both the short run and long run relationship among the selected variables can be estimated simultaneously from the panel data set with large time dimensions and large cross sections.

Causal Relationship

In addition to understanding the exchange rate behaviour in response to its macroeconomic factors, the potential causal association between exchange rate and macroeconomic factors may be important to cover the scope of the research. In this respect application of Granger Causality test is considered to test the direction of causality among the selected variables.

Data Source

The annual data set for the panels of high income countries, middle income countries and low income countries covering the time period from 1995 to 2015 is taken from World Development Indicators (WDI) and OECD Countries Data. The countries having gross national per capita income 12376 dollars or more are taken as high income countries. The countries with GNI per capita between 1026 and 12375 dollars are classified as middle income countries and the countries with GNI per

capita 1025 dollars or less have been selected as low income countries. Further in order to fill the missing values, the data have been retrieved from the official websites of the selected countries, especially websites of concerned country's central banks and statistical bureaus.

Results and Discussions

Estimation Results for Panel Data Set of High Income Countries

Panel ARDL Results for High Income Countries

The result of three panel unit root tests for panel data set of high income countries have been represented in Table 1. The test results indicate that some variables are stationary at level while some are stationary at first difference. The situation allows the application of panel ARDL only. The results of Panel ARDL estimation are shown in Table 2. This technique has an advantage that it does not assume homogeneity of the coefficients. Further it allows the short run parametric coefficients to differ across the cross-sections, however it computes common long run coefficients.

The estimation results of exchange rate volatility function for the high income countries shown in table 2 established that there exists a strong long run relationship between exchange rate volatility and the selected set of macroeconomic indicators. Whereas error correction term shows the speed of adjustment which shows value of the coefficient of convergence is -0.1731, that is statistically significant and negative, which, clearly indicates no omitted variable bias. The long run results explain that GDPC, CAB, FDI, FDEV and GEXP have negative impact on exchange rate volatility. Further impact of INF, RESERV and TRADE has been observed positive on EXRV in long run (the findings are in line with Bobai et al., 2013; Devereux & Lane, 2003; Esquivel & Larrain, 2002; Grydaki & Fountas, 2009). Further RESERV and TRADE are found to have positive contribution in EXRV in long run and direction of relationship is not as expected. Most probable justification of the positive long run relationship between total reserves and exchange rate volatility is that high income countries maintained a high level of total reserves and further increase in total reserves causes increase in exchange rate volatility (see for instance, Grossmann, Love & Orlov, 2014). Likewise increase in trade openness also results increase in exchange rate volatility in long run (Ebaidalla, 2014; Kilicarslan, 2018).

Table. 1

Results of Panel Unit Root Tests for High Income Countries

Variables	Im, Peseran and Shin (IPS)		Levin, Lin and Chu (LLC)		Hadri Z-Statistics	
	Level	First Diff.	Level	First Diff.	Level	First Diff.
LEXRV	-6.299 (0.000)	- 12.361 (0.000)	-6.281 (0.000)	- 15.973 (0.000)	8.434 (0.009)	3.335 (0.000)
LEXRL	-1.357 (0.087)	-2.519 (0.005)	-0.477 (0.000)	-8.631 (0.316)	7.856 (0.000)	13.464 (0.000)
LGDPC	4.389 (1.000)	-4.889 (0.000)	4.502 (0.000)	- 11.326 (0.000)	8.994 (1.000)	12.977 (0.000)
LCAB	-1.743 (0.041)	- 17.988 (0.000)	-3.168 (0.001)	- 19.591 (0.000)	8.373 (0.000)	10.761 (0.000)
LFDI	- 10.561 (0.000)	- 23.674 (0.000)	-9.293 (0.000)	- 23.291 (0.000)	4.573 (0.462)	49.664 (0.000)
LFDEV	-0.904 (0.183)	- 10.821 (0.000)	-3.627 (0.000)	- 13.720 (0.000)	9.848 (0.000)	22.767 (0.000)
LGEXP	-1.183 (0.118)	- 12.843 (0.000)	-2.149 (0.015)	- 16.781 (0.000)	12.329 (0.000)	13.230 (0.000)
LINF	-7.406 (0.000)	- 19.522 (0.000)	-9.579 (0.000)	- 21.051 (0.000)	8.582 (0.000)	25.246 (0.000)
LRESERV	0.411 (0.659)	- 13.149 (0.000)	-0.338 (0.367)	- 17.022 (0.000)	11.470 (0.000)	6.600 (0.000)
LTRADE	-0.257 (0.397)	- 14.218 (0.000)	-1.981 (0.023)	- 15.955 (0.000)	12.660 (0.000)	7.317 (0.000)

Note: Values in parentheses are estimated p values. The options used are: individual trend and intercept, lag length chosen by Schwarz automatic selection (Schwarz, 1978), Kernel method of Bartlett (Bartlett, 1948) obtained by special estimation and Bandwidth selection by automatic Newey-West (Newey & West, 1994)

Table. 2

Results of Pooled Mean Group Regression of ARDL for Exchange Rate Behaviour in High Income Countries

Independent Variables	**Dependent Variable LEXRV**		**Dependent Variable LEXRL**	
	Coefficient	**Z Statistics**	**Coefficient**	**Z Statistics**
Long Run Results				
LGDPC	-0.0406	-4.85* (0.000)	-0.8731	-15.38* (0.000)
LCAB	-0.0196	-5.02* (0.000)	0.0633	3.84* (0.000)
LFDI	-0.0119	-5.99* (0.000)	0.0882	7.53* (0.000)
LFDEV	-0.0317	-1.66*** (0.098)	0.0035	0.14 (0.886)
LGEXP	-0.3244	-3.81* (0.000)	-0.7850	-6.13* (0.000)
LINF	0.0503	5.75* (0.000)	0.1258	6.06* (0.000)
LRESERV	0.0265	4.93* (0.000)	0.4193	11.72* (0.000)
LTRADE	0.0032	5.53* (0.000)	0.0136	7.50* (0.000)
Short Run Results				
ECT	-0.1732	-4.93* (0.000)	-0.0141	-1.27 (0.205)

Independent Variables	Dependent Variable LEXRV		Dependent Variable LEXRL	
	Coefficient	Z Statistics	Coefficient	Z Statistics
LGDPC	-0.4759	-1.79*** (0.074)	-0.6523	-12.95* (0.000)
LCAB	-0.0185	-0.28 (0.782)	0.0011	0.21 (0.832)
LFDI	0.0281	0.98 (0.327)	0.0012	0.70 (0.483)
LFDEV	0.0958	0.45 (0.656)	0.0216	0.76 (0.450)
LGEXP	-0.2822	-0.34 (0.735)	-0.2055	-4.90* (0.000)
LINF	-0.0234	-0.92 (0.355)	0.0094	3.35* (0.001)
LRESERV	0.0145	0.17 (0.867)	-0.0107	-1.12 (0.264)
LTRADE	-0.0392	-0.41 (0.679)	0.0084	1.32 (0.188)
Number of Groups	44	44		
No. of Observations	880	880		
Log Likelihood	2078.526	2791.97		

Note:

*, ** and *** represent 1, 5 and 10 percent level of significance respectively. Values in parentheses are estimated p values.

The results represented on right hand side in Table 2 are the panel ARDL estimates for exchange rate level function. The results show strong long run association between the exchange rate level and macroeconomic indicators as all the independent variables are significant at level of one percent except financial development.

Table. 3

Panel Granger Causality Test Results for Exchange Rate Volatility (High Income Countries)

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LGDPC does not Granger Cause LEXRV	836	5.24671	0.0054	Reject	Unidirectional
LEXRV does not Granger Cause LGDPC		0.64414	0.5254	Accept	
LCAB does not Granger Cause LEXRV	836	1.89551	0.1509	Accept	No Causality
LEXRV does not Granger Cause LCAB		0.62291	0.5366	Accept	
LFDI does not Granger Cause LEXRV	836	0.95645	0.3847	Accept	No Causality
LEXRV does not Granger Cause LFDI		0.53669	0.5849	Accept	
LFDEV does not Granger Cause LEXRV	836	0.09725	0.9073	Accept	No Causality
LEXRV does not Granger Cause LFDEV		0.09906	0.9057	Accept	
LGEXP does not Granger Cause LEXRV	836	2.05246	0.1291	Accept	No Causality
LEXRV does not Granger Cause LGEXP		0.04025	0.9605	Accept	
LINF does not Granger Cause LEXRV	836	7.57219	0.0006	Reject	Bidirectional
LEXRV does not Granger Cause LINF		4.25401	0.0145	Reject	
LRESERV does not Granger Cause LEXRV	836	2.25428	0.1056	Accept	Unidirectional
LEXRV does not Granger Cause LRESERV		4.32820	0.0135	Reject	
LTRADE does not Granger Cause LEXRV	836	0.42516	0.6538	Accept	No Causality
LEXRV does not Granger Cause LTRADE		0.71823	0.4879	Accept	

However the effect of GDPC and GEXP on EXRL observed negative and effect of CAB, FDI, INF, RESERV and TRADE observed positive (Calderon, Chong & Loayza, 2002; Eichengreen, 2007; Rashidin, Ullah & Jehangir, 2017; Saeed, Awan, Sial, & Sher, 2012). However negative relationship between EXRL and GDPC and GEXP, whereas, positive relationship between EXRL and INF in high income countries is against the theory (the findings of the study are in line with, Cavallo, Cottani & Kahn, 1990; Ojo & Allege, 2014; Ramasamy & Abar, 2015). One of the main reasons of this theoretical deviation might be the peculiar nature of panel data set of high income countries. All the countries in this group of countries contained high level of per capita income more than 12376 dollars.

Panel Granger Causality Test Results for Exchange Rate Volatility (High Income Countries)

The results of pair wise granger causality test are given in Table 3. It is observed that there exists bidirectional causality between EXRV and INF (Ali, Mahmood, & Bashir, 2015). However GDPC observed to affect EXRV but EXRV does not granger cause the GDPC. Further RESERV does not granger cause EXRV but EXRV granger cause the total reserves. The results have established that there exists a weak relationship between exchange rate volatility and the macroeconomic indicators.

The Results of Panel Granger Causality Test for Exchange Rate Level (High Income Countries)

The Table 4 shows the pair wise panel granger causality estimates of exchange rate level function for the panel date set of high income countries. The results indicate bidirectional causation between EXRL and CAB and RESERV (Rehman, 2014).

There exists unidirectional causality between EXRL and GEXP. Likewise, TRADE granger cause the exchange rate level but exchange rate level does not cause the changes in trade openness (Vijayakumar, 2014; Yaya & Lu, 2012). The results show the possibility of cause and effect relationship between exchange rate level and macroeconomic indicators in high income countries but the relationship did not seem stronger.

Table. 4

Panel Granger Causality Test Results for Exchange Rate Level (High Income Countries)

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LGDPC does not Granger Cause LEXRL LEXRL does not Granger Cause LGDPC	836	2.13804 1.36063	0.1185 0.2571	Accept Accept	No Causality
LCAB does not Granger Cause LEXRL LEXRL does not Granger Cause LCAB	836	5.09020 3.24792	0.0064 0.0393	Reject Reject	Bidirectional
LFDI does not Granger Cause LEXRL LEXRL does not Granger Cause LFDI	836	1.71862 0.15544	0.1800 0.8561	Accept Accept	No Causality
LFDEV does not Granger Cause LEXRL LEXRL does not Granger Cause LFDEV	836	0.17425 0.72136	0.840 0.486	Accept Accept	No Causality
LGEXP does not Granger Cause LEXRL LEXRL does not Granger Cause LGEXP	836	1.80705 2.57080	0.164 0.077	Accept Reject	unidirectional
LINF does not Granger Cause LEXRL LEXRL does not Granger Cause LINF	836	0.54338 1.64994	0.581 0.192	Accept Accept	No Causality
LRESERV does not Granger Cause LEXRL LEXRL does not Granger Cause LRESERV	836	14.2037 6.17514	0.000 0.002	Reject Reject	Bidirectional
LTRADE does not Granger Cause LEXRL LEXRL does not Granger Cause LTRADE	836	3.13850 2.07803	0.043 0.125	Reject Accept	unidirectional

Estimation Results for Panel Data Set of Middle Income Countries

Panel ARDL Results for Middle Income Countries

The results of Panel unit rest tests are represented in Table 5 for middle income countries. The results show that some variables have unit root in the time series at level while others have unit root in the time series at the first difference.

Table. 5

Results of Panel Unit Root Tests for Exchange Rate Volatility (Middle Income Countries)

Variables	Im, Peseran and Shin (IPS)		Levin, Lin and Chu (LLC)		Hadri Z-Statistics	
	Level	First Diff.	Level	First Diff.	Level	First Diff.
LEXRV	0.705 (0.759)	-22.337 (0.000)	0.023 (0.509)	-19.417 (0.000)	14.994 (0.000)	11.283 (0.000)
LEXRL	-4.237 (0.000)	-13.493 (0.000)	-2.593 (0.004)	-41.041 (0.000)	16.622 (0.000)	16.314 (0.000)
LGDPC	0.829 (0.796)	-8.106 (0.000)	-0.743 (0.228)	-14.374 (0.000)	11.207 (0.000)	15.776 (0.000)\
LCAB	-5.038 (0.000)	-21.747 (0.000)	-6.775 (0.000)	-20.877 (0.000)	13.091 (0.000)	12.032 (0.000)
LFDI	-7.518 (0.000)	-27.920 (0.000)	-7.497 (0.000)	-27.860 (0.000)	10.415 (0.000)	11.223 (0.000)
LFDEV	1.182 (0.881)	-16.813 (0.000)	-0.341 (0.366)	-19.506 (0.000)	15.321 (0.000)	9.859 (0.000)
LGEXP	-3.295 (0.000)	-25.3452 (0.000)	-2.795 (0.002)	-26.364 (0.000)	13.517 (0.000)	16.119 (0.000)

LINF	-14.333 (0.000)	-28.292 (0.000)	-17.367 (0.000)	-27.993 (0.000)	16.659 (0.000)	20.370 (0.000)
LRESERV	2.251 (0.987)	-18.826 (0.000)	2.767 (0.997)	-21.899 (0.000)	11.771 (0.000)	13.783 (0.000)
LTRADE	-0.501 (0.691)	-18.864 (0.000)	1.949 (0.974)	-19.768 (0.000)	10.628 (0.000)	11.677 (0.000)

Note:

Values in parentheses are estimated p values. The options used are: individual trend and intercept, lag length chosen by Schwarz automatic selection (Schwarz, 1978), Kernel method of Bartlett (Bartlett, 1948) obtained by special estimation and Bandwidth selection by automatic Newey-West (Newey & West, 1994)

The long run and short run results of Pooled Mean Group (PMG) regression with dependent variable exchange rate volatility are given in Table 6 on left hand side. The long run results explain that the exchange rate volatility in middle income countries is entirely determined by the macroeconomic indicators. The macroeconomic variables GDPC and INF have positive effect on EXRV whereas CAB, FDEV, FDI, GEXP and RESERV have negative long run impact on the exchange rate volatility (The findings are in line with Ali et al., 2015; Arabi, 2012; Calderon, 2004; Hviding, Nowak & Ricci, 2004; Kilicarslan, 2018; Serven, 2003). The results of Pooled Mean Group (PMG) estimation of exchange rate level function for panel data set of middle income countries are given on right hand side in table 6. The long run results show strong influence of macroeconomic variables in determination of exchange rate level. The results show that CAB, GEXP and INF have negative impact on the exchange rate movements in the long run. On the other hand impact of GDPC, FDEV and RESERV have been observed statistically significant and positive on the exchange rate level (Chowdhery & Hossein, 2014; Eichengreen, 2007; Iavorschi, 2014; Ojo & Allege, 2014; William & Parsad, 2019). However negative impact of CAB and GEXP on EXRL in middle income countries is against the theory. One of the major reason of this theoretical deviation is that middle income countries are facing persistent current account deficits further governments in these countries are spending more on non-tradable goods (see for instance, Cakrani et

al., 2013; William & Parsad, 2019). Further, the short run analysis shows that impact of GDPC, FDEV and GEXP is negative on exchange rate level and impact of inflation observed positive on exchange rate level.

Table. 6

Results of Pooled Mean Group Regression of ARDL for Exchange Rate Behaviour in Middle Income Countries

Independent Variables	**Dependent Variable LEXRV**		**Dependent Variable LEXRL**	
	Coefficient	**Z Statistics**	**Coefficient**	**Z Statistics**
Long Run Results				
LGDPC	1.9799	10.75* (0.000)	0.5240	7.05* (0.000)
LCAB	-0.0769	-2.41** (0.016)	-0.3308	-9.01* (0.000)
LFDI	-0.0893	-1.65*** (0.098)	0.0246	0.73 (0.466)
LFDEV	-0.5446	-4.60* (0.000)	0.2356	4.35* (0.000)
LGEXP	-1.1526	-4.33* (0.000)	-0.1383	-2.17** (0.030)
LINF	0.2837	5.34* (0.000)	-0.3016	-10.38* (0.000)
LRESERV	-1.2648	-13.07* (0.000)	0.1442	3.51* (0.000)
LTRADE	0.0075	1.26 (0.208)	-0.0063	-1.20 (0.231)
Short Run Results				
ECT	-0.2414	-5.68* (0.000)	0.0000	0.14 (0.891)
LGDPC	-1.3417	-1.90** (0.057)	-0.6381	-14.15* (0.000)

Independent Variables	Dependent Variable LEXRV		Dependent Variable LEXRL	
	Coefficient	Z Statistics	Coefficient	Z Statistics
LCAB	-0.1361	-1.60 (0.109)	0.0047	0.87 (0.385)
LFDI	0.0517	0.44 (0.658)	0.0015	0.46 (0.648)
LFDEV	-0.4440	-0.98 (0.326)	-0.0881	-3.50* (0.000)
LGEXP	-0.2535	-0.25 (0.799)	-0.1260	-3.73* (0.000)
LINF	-0.0181	-0.23 (0.819)	0.0192	2.90* (0.004)
LRESERV	-0.2804	-1.24 (0.217)	-0.0186	-1.33 (0.183)
LTRADE	0.3587	1.63 (0.103)	0.0010	0.13 (0.897)
Number of Groups	68	68		
No. of Observations	1360	1360		
Log Likelihood	-488.1488	3088.973		

Note:

*, ** and *** represent 1, 5 and 10 percent level of significance respectively. Values in parentheses are estimated p values.

Panel Granger Causality Test Results for Exchange Rate Volatility (Middle Income Countries)

The estimation results of pair wise panel granger causality test are given in Table 7. The results indicate existence of bidirectional causality between EXRV and GDPC (the findings are in line with Aliyu, 2009; Morana, 2009). The results show government expenditure does not cause the exchange rate volatility while exchange rate volatility granger cause the government expenditures.

Table. 7

Panel Granger Causality Test Results for Exchange Rate Volatility (Middle Income Countries)

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LGDPC does not Granger Cause LEXRV	1292	7.07957	0.0009	Reject	Bidirectional
LEXRV does not Granger Cause LGDPC		2.74529	0.0646	Reject	
LCAB does not Granger Cause LEXRV	1292	0.19462	0.8232	Accept	No Causality
LEXRV does not Granger Cause LCAB		0.14831	0.8622	Accept	
LFDI does not Granger Cause LEXRV	1292	1.03883	0.3542	Accept	No Causality
LEXRV does not Granger Cause LFDI		0.65360	0.5203	Accept	
LFDEV does not Granger Cause LEXRV	1292	1.87629	0.1536	Accept	No Causality
LEXRV does not Granger Cause LFDEV		0.89030	0.4108	Accept	
LGEXP does not Granger Cause LEXRV	1292	1.16678	0.3117	Accept	Unidirectional
LEXRV does not Granger Cause LGEXP		4.93765	0.0073	Reject	
LINF does not Granger Cause LEXRV	1292	0.52850	0.5896	Accept	No Causality
LEXRV does not Granger Cause LINF		0.34561	0.7079	Accept	
LRESERV does not Granger Cause LEXRV	1292	1.94341	0.1436	Accept	No Causality
LEXRV does not Granger Cause LRESERV		0.47213	0.6238	Accept	
LTRADE does not Granger Cause LEXRV	1292	0.40221	0.6689	Accept	No Causality
LEXRV does not Granger Cause LTRADE		1.52973	0.2170	Accept	

Thus in case of panel data set of middle income countries the causality analysis provides the evidence of poor relationship between exchange rate volatility and macroeconomic variables.

Panel Granger Causality Test Results for Exchange Rate Level (Middle Income Countries)

The results of pair wise panel granger causality test have been given in Table 8. The results indicate evidence of bidirectional causality between EXRL and CAB, FDEV, INF, RESERV and TRADE. Further FDI and GEXP do not granger cause EXRL however EXRL cause the changes in FDI and GEXP.

Table. 8

Panel Granger Causality Test Results for Exchange Rate Level (Middle Income Countries)

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LGDPC does not Granger Cause LEXRL	1292	0.28030	0.7556	Accept	No Causality
LEXRL does not Granger Cause LGDPC		1.53020	0.2169	Accept	
LCAB does not Granger Cause LEXRL	1292	17.8314	0.0000	Reject	Bidirectional
LEXRL does not Granger Cause LCAB		11.4508	0.0000	Reject	
LFDI does not Granger Cause LEXRL	1292	0.48296	0.6171	Accept	Unidirectional
LEXRL does not Granger Cause LFDI		3.44935	0.0321	Reject	
LFDEV does not Granger Cause LEXRL	1292	10.46953	0.0000	Reject	Bidirectional
LEXRL does not Granger Cause LFDEV		1.6480	0.0000	Reject	
LGEXP does not Granger Cause LEXRL	1292	0.27709	0.7580	Accept	Unidirectional
LEXRL does not Granger Cause LGEXP		3.20341	0.0409	Reject	

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LINF does not Granger Cause LEXRL	1292	11.5110	0.0000	Reject	Bidirectional
LEXRL does not Granger Cause LINF		16.2884	0.0000	Reject	
LRESERV does not Granger Cause LEXRL	1292	40.0037	0.0000	Reject	Bidirectional
LEXRL does not Granger Cause LRESERV		0.84273	0.0000	Reject	
LTRADE does not Granger Cause LEXRL		2.81594	0.0602	Reject	Bidirectional
LEXRL does not Granger Cause LTRADE		6.01955	0.0025	Reject	

Thus the causality analysis provides the evidence of strong cause and effect relationship between the exchange rate level and selected set of macroeconomic indicators (Azid et al., 2005; Khan, Sattar & Rehman, 2012; Ojo & Allege, 2014; Rehman, 2014; Sekmen, 2007)

Estimation Results for Panel Data Set of Low Income Countries

Panel ARDL Results for Low Income Countries

The Panel unit root test results for panel data set of low income countries are given in Table 9. It is the case where selected variables have order of integration I(0) and I(1) thus preferred technique of cointegration is the Panel ARDL.

The results of panel ARDL cointegration are given in Table 10. The long run results of the panel ARDL show that exchange rate volatility in long run in low income countries is derived by macroeconomic indicators. The macroeconomic variables CAB, FDI and RESERV effect EXRV negatively while GDPC, GEXP, INF and TRADE influence the volatility positively in long run for panel data set of low income countries (Arabi, 2012; Arratibel et al., 2011; Bobai et al., 2013; Domac & Mendoza., 2004; Hviding et al., 2004). However results indicate weak relationship between exchange rate volatility and macroeconomic indicators in short run.

Table. 9

Results of Panel Unit Root Tests for Exchange Rate Volatility (Low Income Countries)

Variables	Im, Peseran and Shin (IPS)		Levin, Lin and Chu (LLC)		Hadri Z-Statistics	
	Level	First Diff.	Level	First Diff.	Level	First Diff.
LEXRV	-2.163 (0.015)	-18.110 (0.000)	-2.302 (0.011)	-20.220 (0.000)	8.519 (0.000)	10.860 (0.000)
LEXRL	-5.947 (0.000)	-8.083 (0.000)	-13.364 (0.004)	-13.310 (0.000)	10.736 (0.000)	4.341 (0.000)
LGDPC	-2.677 (0.004)	-7.702 (0.000)	-2.779 (0.003)	-9.794 (0.000)	7.575 (0.000)	7.796 (0.000)
LCAB	-3.912 (0.000)	-15.972 (0.000)	-4.191 (0.000)	-17.691 (0.000)	2.993 (0.001)	1.461 (0.072)
LFDI	-5.519 (0.000)	-15.362 (0.000)	-4.865 (0.000)	-13.788 (0.000)	4.796 (0.000)	4.131 (0.000)
LFDEV	-3.304 (0.000)	-12.521 (0.000)	-2.752 (0.003)	-12.765 (0.000)	7.691 (0.000)	4.918 (0.000)
LGEXP	-5.266 (0.000)	-14.286 (0.000)	-5.637 (0.000)	13.918 (0.000)	8.025 (0.000)	13.201 (0.000)
LINF	-8.823 (0.000)	-15.955 (0.000)	-9.294 (0.000)	-17.094 (0.000)	2.831 (0.033)	43.762 (0.000)
LRESERV	0.763 (0.987)	-14.432 (0.000)	0.919 (0.821)	-16.644 (0.000)	6.357 (0.000)	9.892 (0.000)
LTRADE	-2.446 (0.007)	-12.880 (0.000)	-1.177 (0.119)	-7.696 (0.000)	10.976 (0.000)	4.755 (0.000)

Note:

Values in parentheses are estimated p values. The options used are: individual trend and intercept, lag length chosen by Schwarz automatic selection (Schwarz, 1978), Kernel method of Bartlett (Bartlett, 1948) obtained by special estimation and Bandwidth selection by automatic Newey-West (Newey & West, 1994)

Table. 10

Results of Pooled Mean Group Regression of ARDL for Exchange Rate Behaviour in Low Income Countries

Independent Variables	**Dependent Variable LEXRV**		**Dependent Variable LEXRL**	
	Coefficient	**Z Statistics**	**Coefficient**	**Z Statistics**
Long Run Results				
LGDPC	4.6048	7.00* (0.000)	-1.1011	-3.32* (0.001)
LCAB	-0.9513	-5.79* (0.000)	-0.1519	-2.04** (0.041)
LFDI	-0.7053	-2.87* (0.004)	-0.3104	-3.57* (0.000)
LFDEV	0.1986	0.54 (0.587)	-0.2174	-1.21 (0.225)
LGEXP	5.1545	5.60* (0.000)	-2.3254	-5.07* (0.000)
LINF	0.9355	5.45* (0.000)	-0.3146	-4.43* (0.000)
LRESERV	-0.6769	-2.01** (0.044)	0.6040	3.69* (0.000)
LTRADE	0.3118	3.67* (0.000)	-0.0111	-0.86 (0.389)
Short Run Results				
ECT	-0.420	-6.67* (0.000)	-0.0249	-1.38 (0.169)
LGDPC	-4.3478	-2.97* (0.003)	-0.4633	-6.37* (0.000)
LCAB	0.3978	0.71 (0.479)	-0.0135	-1.85*** (0.064)

Independent Variables	Dependent Variable LEXRV		Dependent Variable LEXRL	
	Coefficient	Z Statistics	Coefficient	Z Statistics
LFDI	0.2036	1.64 (0.101)	0.0033	0.65 (0.514)
LFDEV	-0.4985	-0.80 (0.424)	-0.060	-1.57 (0.116)
LGEXP	-2.1872	-1.69*** (0.092)	0.0072	0.06 (0.952)
LINF	0.320	0.21 (0.836)	0.0241	3.24* (0.001)
LRESERV	0.333	0.45 (0.653)	-0.0098	-0.41 (0.679)
LTRADE	-0.2395	-0.45 (0.651)	0.0402	2.94* (0.003)
Number of Groups	23	23		
No. of Observations	460	460		
Log Likelihood	-704.5	801.28		

Note:

*, ** and *** represent 1, 5 and 10 percent level of significance respectively. Values in parentheses are estimated p values.

The estimation results of panel ARDL of functional equation of exchange rate level for panel data set of low income countries are given in Table 10. The long run results show strong influence of macroeconomic variables in determination of exchange rate level in low income countries. The results indicate GDPC, CAB, FDI, GEXP and INF have negative impact while total reserves have positive impact on exchange rate level in long run (Acemoglu, Johnson, Thaicharoen & Robinson, 2003; Aizenman & Riera-Crichton, 2008; Gala, 2007; Kamin & Rogers, 2000; Ojo & Allege, 2014; William & Parsad, 2019).

Even though except trade and financial development all the macroeconomic indicators have statistically significant impact on exchange

rate level but surprisingly direction of the relationship is against the theory for majority of the indicators, like GDP per capita, current account balance, foreign direct investment and government expenditures posed negative relationship with exchange rate level in long run for panel data set of low income countries. The low income countries contained deteriorated situation of macroeconomic indicators. These countries have low per capita income as low as less than 1026 dollars, high current account deficits, very low foreign direct investment inflows, backward and underdeveloped financial system, high inflation, low exports, high imports, low level of output and inadequate government expenditures. This is the reason that macroeconomic indicators i.e. GDP per capita, current account balance, foreign direct investment, government expenditures posed to have negative relationship with exchange rate level in low income countries.

Panel Granger Causality Test Results for Exchange Rate Volatility (Low Income Countries)

The estimation results of pair wise panel granger causality test are given in Table 11. The results indicate that there is no causality between EXRV and FDEV, GEXP and TRADE.

Table. 11

Panel Granger Causality Test Results for Exchange Rate

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LGDPC does not Granger Cause LEXRV	437	1.92324	0.1474	Accept	Unidirectional
LEXRV does not Granger Cause LGDPC		3.58848	0.0285	Reject	
LCAB does not Granger Cause LEXRV	437	2.42596	0.896	Accept	No Causality
LEXRV does not Granger Cause LCAB		0.8062	0.9226	Accept	
LFDI does not Granger Cause LEXRV	437	2.71282	0.0675	Reject	Unidirectional
LEXRV does not Granger Cause LFDI		0.53075	0.5885	Accept	

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LFDEV does not Granger Cause LEXRV	437	0.00671	0.9933	Accept	No Causality
LEXRV does not Granger Cause LFDEV		1.56828	0.2096	Accept	
LGEXP does not Granger Cause LEXRV	437	0.68491	0.5047	Accept	No Causality
LEXRV does not Granger Cause LGEXP		0.16380	0.8490	Accept	
LINF does not Granger Cause LEXRV	437	1.81294	0.1644	Accept	Unidirectional
LEXRV does not Granger Cause LINF		2.35491	0.0961	Reject	
LRESERV does not Granger Cause LEXRV	437	1.01964	0.3616	Accept	Unidirectional
LEXRV does not Granger Cause LRESERV		2.53429	0.0805	Reject	
LTRADE does not Granger Cause LEXRV	437	0.70876	0.4928	Accept	No Causality
LEXRV does not Granger Cause LTRADE		0.90158	0.4067	Accept	

Further causality between exchange rate volatility and GDP per capita, current account balance, foreign direct investment, inflation and total reserves is unidirectional. Thus in case of panel data set of low income countries the causality analysis provides the evidence of poor relationship between exchange rate volatility and macroeconomic variables.

Panel Granger Causality Test Results for Exchange Rate Level (Low Income Countries)

The results of pair wise panel granger causality test for exchange rate level function are given in Table 12. The results explain that here exist no causality between EXRL and CAB, FDI and TRADE.

The results show unidirectional causality between EXRL and GEXP, INF and reserves (Kasman & Ayhan, 2008; Narayan & Smyth, 2004). Further analysis indicates there exist bidirectional causality between EXRL and GDPC and FDEV (Ojo & Allege, 2014; Sekmen, 2007).

Table. 12

Panel Granger Causality Test Results for Exchange Rate Level Low Income Countries

Null Hypothesis	Obser-vations	F-Stat	Probability	Decision	Causality
LGDPC does not Granger Cause LEXRL	437	23.8829	0.0000	Reject	Bidirectional
LEXRL does not Granger Cause LGDPC		4.00942	0.0188	Reject	
LCAB does not Granger Cause LEXRL	437	0.35372	0.7023	Accept	No Causality
LEXRL does not Granger Cause LCAB		0.71560	0.4895	Accept	
LFDI does not Granger Cause LEXRL	437	0.67921	0.5076	Accept	No Causality
LEXRL does not Granger Cause LFDI		1.87044	0.1553	Accept	
LFDEV does not Granger Cause LEXRL	437	5.81599	0.0032	Reject	Bidirectional
LEXRL does not Granger Cause LFDEV		5.71254	0.0036	Reject	
LGEXP does not Granger Cause LEXRL	437	7.02454	0.0010	Reject	Unidirectional
LEXRL does not Granger Cause LGEXP		0.58566	0.5572	Accept	
LINF does not Granger Cause LEXRL	437	2.065461	0.1280	Accept	Unidirectional
LEXRL does not Granger Cause LINF		0.1887	0.0000	Reject	
LRESERV does not Granger Cause LEXRL	437	3.57594	0.0288	Reject	Unidirectional
LEXRL does not Granger Cause LRESERV		0.67188	0.5113	Accept	
LTRADE does not Granger Cause LEXRL	437	0.75667	0.4698	Accept	No Causality
LEXRL does not Granger Cause LTRADE		0.48644	0.6151	Accept	

The causality analysis provides the evidence of cause and effect relationship between exchange rate level and macroeconomic indicators for panel data set of low income countries.

The Main Line of Arguments and Findings

Ø There exists strong long run relationship between exchange rate volatility and macroeconomic indicators (Arize, Osang & Slottje, 2008; Calderon, 2004; MacDonald, 1999; Morana, 2009; Udoh et al., 2012). However the overall causality analysis provides the evidence of feeble link between exchange rate volatility and macroeconomic indicators.

Ø The study provides the evidence of strong relationship between the exchange rate level and selected macroeconomic variables in long run, short run and causality analysis as well (The findings are in line with Engel & West, 2005; Kim & Mo, 1995; Mark & Sul, 2001; Ojo & Alege, 2014; Ramasamy & Abar, 2015; Ricci et al., 2013).

Ø In long run period of time exchange rate volatility and exchange rate level both are substantially influenced by the selected set of fundamental macroeconomic indicators. Thus it is quite justified to say that relationship between exchange rate behaviour (in terms of volatility and at level) and macroeconomic indicators is a long run relationship (The findings are in line with Diamandis et al., 2014; Lee-Lee & Hui-Boon, 2007; MacDonald, 1999; Morana, 2009; Vygodina et al., 2008).

Ø The pair wise causality analysis also provide the evidence of missing link between exchange rate volatility and macroeconomic variables, however, the study proved the evidence of the existence of cause and effect relationship between exchange rate level and macroeconomic indicators. (see Ahmad & Ali, 1999; Engel & West, 2005; Dlamini, 2014).

Ø The study has proved the validity of fundamentals based macroeconomic models of exchange rate determination and negated the possibility of exchange rate disconnect in the current global analysis not only in case of exchange rate level but also for exchange rate volatility.

Ø The direction of the relationship between exchange rate and macroeconomic indicators (both in terms of volatility and level) found sensitive to the income groups (high income countries, middle income countries and low income countries) (The results are in line with Aydin, 2010; Bravo-Ortega & Giovnni, 2006; Christiansen et al., 2009; Devereux & Lane, 2003; Dhasmana, 2012; Diallo, 2015; Santacreu, 2015; Serven, 2003; Senadza & Diaba, 2017).

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