Asian Journal of Economic Modelling
ISSN(e): 2312-3656
ISSN(p): 2313-2884
DOI: 10.18488/journal.8.2021.92.166.178
Vol. 9, No. 2, 166-178.

URL: www.aessweb.com

DYNAMICS OF RELATIONSHIP BETWEEN MACROECONOMIC FUNDAMENTALS AND EXCHANGE RATE: A COMPARISON OF ADVANCED AND LEAST DEVELOPED COUNTRIES

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Article History
Received: 14 December 2020
Revised: 8 March 2021
Accepted: 13 April 2021
Published: 5 May 2021

Keywords
Exchange rate
Exchange rate volatility
Macroeconomic fundamentals.

JEL Classification:
F11; F31; F41.

ABSTRACT

The exploration of relationship between macroeconomic fundamentals and exchange rate is needed in the perspective of economic structure of the economies. The focus of current study is to inquire the dynamics of exchange rate behavior in response to macroeconomic fundamentals for advanced and least developed countries. The Pooled Mean Group regression based on panel ARDL and Panel Granger Causality Test are employed on annual panel data sets for the time period 1995-2015. The results evidence a strong relationship between macroeconomic fundamentals and exchange rate volatility in advanced countries and a moderate relationship in least developed countries. The exchange rate level has been observed entirely governed by the selected set of macroeconomic fundamentals in both group of countries. The results validate the fundamental macroeconomic models of exchange rate determination as the macroeconomic fundamental indicators play an important role in the determination of exchange rate volatility as well as exchange rate level. It may be concluded that the relationship between fundamental macroeconomic indicators and exchange rate behavior is sensitive to the economic structure of the countries.

Contribution/ Originality: Six major puzzles in international economics have been identified by Obstfeld and Rogoff (2000). One of them is disconnect puzzle. The current study has attempted to solve this puzzle and seen whether the economic structure of the economies matter for disconnect puzzle.

1. INTRODUCTION

Theories of exchange rate established relationship between macroeconomic indicators and exchange rate behavior but empirically the role of macroeconomic indicators in exchange rate dynamics lacked general consensus. The theories of exchange rate proposed several structural models which assume that the patterns of exchange rate movements are influenced by various macroeconomic indicators. They are the portfolio balance models and monetary exchange rate models. The most influential and frequently used models of exchange rate determination are the monetary models which are based on the principles of purchasing power parity (PPP) and interest rate parity. These models are designed to understand the exchange rate behavior in response to macroeconomic fundamentals so they are called fundamental exchange rate models.

However, Meese and Rogoff (1983a); Meese and Rogoff (1983b) empirically established that the models which deal with fundamental macroeconomic indicators had been failed to exhibit the random walk of exchange rate. The missing relationship between macroeconomic variables and exchange rate identified by Meese and Rogoff (1983a);

Meese and Rogoff (1983b) got fame as exchange rate disconnect puzzle. Obstfeld and Rogoff (2000) identified six puzzles of exchange rate and numbered six to the "exchange rate disconnect puzzle". They argued that in most of the economies, the relative price generally and exchange rate particularly respond immediately to a variety of transactions, even though the potential links are direct and obvious but surprisingly they are not strong. Withal, the exchange rate theory clearly suggests that macroeconomic fundamentals are driving force behind the exchange rate movements. It is worth mentioning that the perceived role of the macroeconomic fundamentals in derivation of exchange rate fluctuations is undoubtedly an open issue and controversial in the international macroeconomics.

The theory along with empirical evidences argues that the relationship between macroeconomic fundamentals and exchange rate may be sensitive to economic structure of the economies. The theory of exchange rate determination asserted that sound and stable economic structure has the capability to absorb the waves of change in exchange rate (Devereux & Lane, 2003; Ganguly & Breuer, 2010; Karras, Lee, & Stokes, 2005). On the other hand the least developed countries being backward in technology, institutional setup, productivity, international trade and economic structure may be more vulnerable to exchange rate fluctuations. So they lack the capacity to absorb the drives of changes in exchange rate (Arize, Osang, & Slottje, 2000; Grossmann, Love, & Orlov, 2014).

In the current study the relationship between macroeconomic fundamentals and exchange rate behavior is analyzed through the utilization of two different panel data sets categorized on the basis of economic structure of the country (advanced vs least developed economies). The comparison of behavior of exchange rate in response to fundamental macroeconomic indicators for the advanced and least developed economies would enhance exposure about the policies related with exchange rate behavior by providing the evidence whether the economic structure influences the exchange rate behavior.

The study proves the originality based on three points, i.e. (i) incorporation of the exchange rate volatility to the conventional open economy macroeconomic models of exchange rate determination, (ii) a comparative analysis of the determinants of exchange rate volatility and determinants of exchange rate level in cross country perspectives, and (iii) overcoming the econometric issues of application of panel data methodology by application of two econometric techniques of different econometric assumptions.

2. LITERATURE REVIEW

A plethora of studies is available in empirical literature designated to test the empirical cogency of the theories of exchange rate determination by using data for different time periods, approaches and estimation techniques. In the perspective of naive random walk hypothesis these studies produced mixed results. However it is observed that empirical evidences in some specific time period show somehow similarities in applications, techniques and results. Based on these similarities the relevant literature is divided into three periods.

2.1. First Period of Investigation

Depending on the similar trends in results produced by empirical studies, the first period is described starting from general promulgation of floating exchange rate system to the 1980s. Majority of the empirical literature during this period established the validity of the structural models used for the assessment of exchange rate behavior, which supports the notion of association between macroeconomic indicators and exchange rate behavior. In this regard, Frenkel (1976) for the first time attempted to check the cogency of the monetary model of flexible price for exchange rate between Mark (German) and Dollar during the time period of hyperinflation. The study incorporated the German hyperinflation in the analysis and attempted to isolate its effect and see the key relationship based on the theory of exchange rate determination. The study confirmed the price level, money stock and expectations as determinants of exchange rate. It also provided the evidence of the validity of monetary model in terms of efficiency and significance of the estimates. Likewise, Bilson (1978) analyzed the functioning of the structural models in estimation of exchange rate. The study estimated the price equation for the flexible exchange rate between the currencies of the UK and Holland and endorsed the prophecy of the models.

Dornbusch (1979) investigated the role of freely moving exchange rates in relation to the macroeconomic context. The study analyzed the case of exchange rate of Mark and Dollar and supported the performance of asset market approach. Putnam and Woodbury (1979) also proved the role of monetary factors in determination of exchange rate in the case of monthly and quarterly exchange rate of Dollar and Pound and suggested the validity of PPP hypothesis for both kinds of data (See also, (Frenkel, 1976; Hodrick, 1978)).

2.2. Second Period of Investigation

In the early years of flexible exchange rate there was an optimistic impression of the structural models for exchange rate behavior, but by the passage of time the charisma of structural models was collapsed by the empirical studies extended beyond 1980. For instance, Dornbusch and Fischer (1980) observed poor performance of the real interest rate differential model in estimation of the exchange rate (see also, Haynes and Stone (1981)). In this context most famous and most cited work is of Meese and Rogoff (1983a) who analyzed the twelve month horizon for four currencies' exchange rates, i.e. Pound, Mark, trade weighted Dollar and Yen for the time period of March 1973 to June 1981 by applying three techniques, like GLS, OLS and Instrumental Variables technique. The results explained that structural models about the determination of exchange rate did not outperform the random walk hypothesis. The researchers also attempted to adjust their specification by adding domestic and foreign price levels as regressors and estimated separate coefficients on real income and money supplies but it yielded no benefits in forecasting accuracy. The results of this study gave birth to major puzzle of exchange rate theory, i.e. the exchange rate disconnect puzzle. The puzzle explained the weak association between exchange rate and its macroeconomic factors, that is confirmed by a number of empirical evidences later on (Backus, 1984; Frankel & Rose, 1995; Rose, 1996).

A number of other studies applying cointegration testing procedure developed by Engle and Granger (1987) also failed to find the cointegration association between exchange rate and its macroeconomic fundamentals. For example, Meese and Rogofp (1988) failed to find cointegration association between exchange rate and real rate of interest and differentials (see also, (Baillie & Selover, 1987; Kearney & MacDonald, 1990)).

2.3. Third Period of Investigation

After findings the poor cogency of structural models in exchange rate determination in the second period of investigation, the researchers' opted new methods of estimation which were comprised of long time periods and panel data measurement of long run dimensions of the relationship. Mark and Sul (2001) estimated the possibility of long run association between exchange rates and monetary indicators. They analyzed the quarterly panel data set of nineteen countries and estimated the long-run cointegration between the exchange rate and a set of macroeconomic monetary indicators. They also tried to test the forecasting power of the set of fundamentals to predict the future exchange rates by applying Least Square Dummy Variable (LSDV) estimators. The study divided macroeconomic fundamentals into monetary fundamentals and PPP fundamentals. The results found the evidence of long run cointegration both in case of monetary fundamentals and PPP fundamentals, however, only monetary fundamentals were found significant in determining the future exchange rate returns.

Engel and West (2005) estimated present value model of exchange rate determination based on the rational expectations theory. They applied Granger Causality approach and found the evidence of association between exchange rates and selected set of macroeconomic variables. Similarly, Chang and Su (2014) tried to see the short-run and long-run properties of the said relationship for the panel data set of Pacific Rim countries. They observed inability of the cointegration test to establish the long-run association between exchange rate and macroeconomic variables but cointegration test with structural breaks observed this relationship significant for some countries.

Furthermore, the results of VECM and time varying causality found the evidence of association between exchange rate and selected macroeconomic indicators. Rapach and Wohar (2002) analyzed the long-run model of monetary exchange rate for the panel data set of fourteen developed countries. They concluded that monetary models are validated in determining the exchange rate in long run for most of the countries, however, the countries where monetary models did not hold in long run have instable association between monetary indicators and price levels.

After going through the literature on exchange rate determination in three periods it can be concluded that the recent work has rekindled the hope in the theory of exchange rate determination (Cheikh, Zaied, Bouzgarrou, & Nguyen, 2018; Kilicarslan, 2018; Ojo & Alege, 2014; Williams & Prasad, 2019) although overall evidence in this respect is still found mixed. In this perspective the current study will attempt to see the examination of application of fundamental macroeconomic model for the determination of exchange rate in two economic structure groups of economies, i.e. advanced economies and least developed economies.

3. METHODOLOGY

3.1. 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 in Equation 1 and 2.

$$EXRV = f\,(GDPP, CAB, FDI, FDEV, GEXP, INF, RESER, TRADE) \qquad (1)$$

$$EXRL = f\,(GDDP, CAB, FDI, FDEV, GEXP, INF, RESER, TRADE) \qquad (2)$$

Where,

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

EXRL = Exchange rate level (Official exchange rate --- local currency units per US Dollars).

GDPP = GDP per capita.

CAB = Current account balance.

FDI = Foreign direct investment (Percentage of GDP).

FDEV = Financial development (Credit to private sector as ratio of total credit).

GEXP = Government expenditures (Percentage of GDP).

INF = Inflation (Consumer Price Index).

RESER = Reserves (Foreign reserves as percentage of GDP).

TRADE = Trade openness (Net trade in goods and services percentage of GDP).

3.2. Estimation Techniques

The study has selected two distinct panel data sets of advanced countries and least developed countries to estimate the connotation of the said relationship. Two econometric estimation techniques, i.e. Pooled Mean Group regression based on panel Autoregressive Distributive Lag (ARDL) and Panel Granger Causality test are employed. Applying more than one technique on the same data-set is evidenced in the literature (Aydin, 2010; Ojo & Alege, 2014). 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 procedures are applied to check the stationarity. They are Im, Pesaran and Shin test (IPS) (Im, Pesaran, & Shin, 2003) Hadri Langrange Multiplier test (HLM) (Hadri, 2000) and Levin, Lin and Chu test (LLC) (Levin, Lin, & Chu, 2002).

The long-run information in time series can be intact through the process of cointegration. Cointegration not only facilitate in the course of analysis of long-run association among the under-consideration integrated variables, but it reparameterize the relationship into Error Correction Model. This idea was formulized by Granger (1981) and later by Engle and Granger (1987) along with the estimation procedure and specification test. Pesaran, Shin, and Smith (1999) incorporated the dynamic heterogeneous panel regression into error correction model by applying the Autoregressive 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 the best choice. An important advantage of the Panel ARDL cointegration 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. Pesaran et al. (1999) developed Pooled Mean Group (PMG) estimation that used both pooling and averaging during estimation. The dynamic nature of PMG regression helped to deal with heterogeneity and to avoid the average estimator's bias. Panel Mean Group estimators based on panel ARDL has relative importance in theoretical and empirical literature. In the current analysis Pooled Mean Group regression based on Panel ARDL is applied. In addition to understanding the exchange rate behavior in response to macroeconomic factors, the potential causal association between exchange rate and macroeconomic factors may be important to cover the scope of this research. In this respect application of Granger Causality test originally formulated by Granger (1969) but later on modified as per analysis requirements is employed to test the direction of causality among the selected variables.

3.3. Data Source

The annual data-set for the panels of 27 advanced and 37 least developed economies covering the time period 1995 to 2015 is taken from World Development Indicators (WDI) and OECD countries data-sets[1]. 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.

Table-1. Results of panel unit root test for advanced 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	-9.194 (0.000)	-26.189 (0.000)	26.351 (1.000)	-16.402 (0.000)	2.365 (0.009)	29.091 (0.000)
LEXRL	0.204 (0.581)	-0.895 (0.185)	0.894 (0.814)	-6.063 (0.000)	5.586 (0.000)	10.468 (0.000)
LGDPP	4.654 (1.000)	-3.650 (0.000)	5.154 (1.000)	-9.030 (0.000)	6.979 (0.000)	11.364 (0.000)
LCAB	1.353 (0.912)	-14.822 (0.000)	-0.935 (0.174)	-15.847 (0.000)	11.807 (0.000)	5.524 (0.000)
LFDI	-9.143 (0.000)	-20.164 (0.000)	-6.951 (0.000)	-20.039 (0.000)	0.0947 (0.462)	4.389 (0.000)
LFDEV	0.645 (0.740)	-9.725 (0.000)	-0.007 (0.496)	-11.963 (0.000)	6.691 (0.000)	26.294 (0.000)
LGEXP	-0.344 (0.365)	10.205 (0.000)	-1.260 (0.103)	-13.330 (0.000)	11.456 (0.000)	16.280 (0.000)
LINF	-6.753 (0.000)	-15.374 (0.000)	-8.024 (0.000)	-16.604 (0.000)	6.030 (0.000)	13.022 (0.000)
LRESER	-0.682 (0.247)	-10.169 (0.000)	-1.107 (0.133)	-13.181 (0.000)	9.381 (0.000)	6.115 (0.000)
LTRADE	0.832 (0.797)	-11.374 (0.000)	-0.496 (0.309)	-11.507 (0.000)	8.560 (0.000)	-3.191 (0.999)

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 (1948) obtained by special estimation and Bandwidth selection by automatic (Newey & West, 1994).

[1]First time, the list of advanced countries was issued by IMF. IMF published World Economic Outlook in 1980 where in country classification system was given in IFS. In 1980 IMF listed 21 countries as industrial countries and later on in 1977 these industrial countries were renamed as advanced countries (Nielsen, 2011).

Least Developed Countries are classified by United Nations. These are the countries which have lowest HDI rating, lowest socioeconomic development and high vulnerability to economic shocks.

4. RESULTS AND DISCUSSION

4.1. Results of Panel ARDL for Advanced Countries

Firstly, the results of panel unit root tests namely Im, Peseran and Shin (IPS), Levin, Lin and Chu (LLC) and Hadri LLM test for the sample of advanced countries are presented in Table 1. The results show that some variables have order of integration I(0) and others have order of integration I(1). None of the variable is stationary at second difference. This situation allows the application of panel ARDL cointegration technique.

Table-2. Results of pooled mean group regression on panel ARDL for exchange rate behavior in advanced countries.

Independent Variables	Dependent Variable LEXRV		Dependent Variable LEXRL	
	Coefficient	Z Statistics (Probability)	Coefficient	Z Statistics (Probability)
Long-Run Results				
LGDPP	0.4965	-1.17 (0.243)	0.1008	1.29 (0.199)
LCAB	4.0127***	1.69 (0.091)	0.5255**	2.56 (0.010)
LFDI	0.0159	0.08 (0.940)	-1.1244*	-5.13 (0.000)
LFDEV	0.0889	0.21 (0.830)	0.6441*	5.79 (0.000)
LGEXP	-5.9527*	-3.28 (0.001)	0.5617*	4.07 (0.000)
LINF	-13.2346*	-3.36 (0.001)	-0.5977	-0.96 (0.339)
LRESER	0.4363***	1.91 (0.057)	-0.0385	-1.41 (0.157)
LTRADE	-12.8069*	-5.38 (0.000)	0.5017**	1.99
Short-Run Results				
ECT	-0.8322*	-10.63 (0.000)	-0.0569	-1.30 (0.193)
LGDPP	-3.4702**	-2.58 (0.010)	-0.5064*	-2.81 (0.005)
LCAB	-15.4427	-1.24 (0.214)	0.3396	0.75 (0.451)
LFDI	5.4040***	1.66 (0.096)	0.2520	0.91 (0.363)
LFDEV	-4.1743	-1.53 (0.127)	0.0224	0.51 (0.610)
LGEXP	17.5808**	2.86 (0.004)	-0.0540	-0.27 (0.791)
LINF	21.1625*	4.83 (0.000)	0.5393**	1.90 (0.057)
LRESER	0.1258	0.16 (0.877)	-0.0284	-1.35 (0.178)
LTRADE	113.1444	1.50 (0.135)	-10.0666	-1.13 (0.260)
Number of Groups	27		29	
No. of Observations	540		580	
Log Likelihood	-390.775		1660.671	

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

The results of Pooled Mean Group regression based on panel ARDL for exchange rate volatility and exchange rate level in developed countries are shown in Table 2.

For the exchange rate volatility in developed countries, the long-run results show that five variables, i.e. CAB, government expenditures, inflation, reserves and trade have statistically significant effect on exchange rate volatility. It established that there is a strong association between selected fundamental macroeconomic indicators and exchange rate volatility in developed countries. The findings are in line with the findings of Ahn and Oh (2001); Devereux and Lane (2003) and Ganguly and Breuer (2010). The results further show that out of eight selected variables five macroeconomic indicators are explaining the short-run behavior of exchange rate volatility.

For the exchange rate level in developed countries the Pooled Mean Group regression on ARDL estimates indicate that in the long run the current account balance, financial development, government expenditures and trade expansion have positive impact on the changes in the level of exchange rate (Chowdhury & Hossain, 2014; Galstyan & Lane, 2009; Williams & Prasad, 2019) while FDI has negative impact on exchange rate level. It explains that in advanced countries increase in net inflows of foreign direct investment leads to depreciation of the exchange rate level in the long run. The results are justified by the literature (Aizenman & Riera-Crichton, 2008; Gharaibeh, 2017). However, in the short run two variables, i.e. GDP per capita growth and inflation show negative and positive impact on exchange rate level respectively.

The analysis clearly establishes that the fundamental macroeconomic indicators strongly explain the movements of exchange rate level in advanced countries as five out of eight macroeconomic variables influence the exchange rate level.

4.2. Results of Panel Granger Causality for Advanced Countries

The results of pair wise granger casually test for the exchange rate volatility in advanced countries are shown in Table 3.

Table-3. Results of panel granger causality for exchange rate volatility in advanced countries.

Null Hypothesis	Obs.	F-Stat	Probability	Decision	Causality
LGDPP does not Granger Cause LEXRV LEXRV does not Granger Cause LGDPP	532	12.8700 0.84819	0.0000 0.4288	Reject Accept	Uni-directional
LCAB does not Granger Cause LEXRV LEXRV does not Granger Cause LCAB	532	0.30687 5.52380	0.7359 0.0042	Accept Reject	Uni-directional
LFDI does not Granger Cause LEXRV LEXRV does not Granger Cause LFDI	532	0.00836 0.28338	0.9917 0.7533	Accept Accept	No Causality
LFDEV does not Granger Cause LEXRV LEXRV does not Granger Cause LFDEV	532	0.25725 2.37276	0.7733 0.0942	Accept Reject	Uni-directional
LGEXP does not Granger Cause LEXRV LEXRV does not Granger Cause LGEXP	532	0.88933 4.64802	0.4115 0.0100	Accept Reject	Uni-directional
LINF does not Granger Cause LEXRV LEXRV does not Granger Cause LINF	532	0.96415 1.50558	0.3820 0.2228	Accept Accept	No Causality
LRESER does not Granger Cause LEXRV LEXRV does not Granger Cause LRESER	532	1.92441 5.89943	0.1470 0.0029	Reject Reject	Bi-directional
LTRADE does not Granger Cause LEXRV LEXRV does not Granger Cause LTRADE	532	0.02772 0.00717	0.9727 0.9929	Accept Accept	No Causality

The results in Table 3 show that there exists bidirectional casually between exchange rate volatility and reserves. However, due to unidirectional causality it is concluded that GDP per capita affects exchange rate volatility while exchange rate volatility affects current account balance, financial development as well as government expenditures but not the vice versa at all. Furthermore, there exists no causality between exchange rate volatility and FDI, inflation as well as trade openness.

The results established that for advanced countries there exists a weak relationship between exchange rate volatility and the selected set of macroeconomic fundamentals as only a single variable, i.e. reserves has bidirectional causality with exchange rate volatility and a single variable has unidirectional causality, i.e. GDP per capita affects the exchange rate volatility.

The pair wise panel granger causally estimates of exchange rate level for the panel of advanced countries are shown in Table 4.

Table-4. Results of panel granger causality for exchange rate level in advanced countries.

Null Hypothesis	Obs.	F-Stat	Probability	Decision	Causality
LGDDP does not Granger Cause LEXRL LEXRL does not Granger Cause LGDDP	551	3.14367 3.75054	0.044 0.024	Reject Reject	Bi-directional
LCAB does not Granger Cause LEXRL LEXRL does not Granger Cause LCAB	551	2.33998 3.85511	0.097 0.021	Reject Reject	Bi-directional
LFDI does not Granger Cause LEXRL LEXRL does not Granger Cause LFDI	551	1.32231 0.19725	0.267 0.821	Accept Accept	No Causality
LFDEV does not Granger Cause LEXRL LEXRL does not Granger Cause LFDEV	551	0.68074 1.51275	0.506 0.221	Accept Accept	No Causality
LGEXP does not Granger Cause LEXRL LEXRL does not Granger Cause LGEXP	551	1.02481 0.94763	0.359 0.388	Accept Accept	No Causality
LINF does not Granger Cause LEXRL LEXRL does not Granger Cause LINF	551	0.72191 1.03885	0.486 0.354	Accept Accept	No Causality
LRESER does not Granger Cause LEXRL LEXRL does not Granger Cause LRESER	551	6.60380 2.69243	0.001 0.068	Reject Reject	Bi-directional
LTRADE does not Granger Cause LEXRL LEXRL does not Granger Cause LTRADE	551	0.04775 0.00105	0.953 0.999	Accept Accept	No Causality

The results in Table 3 indicate a bidirectional causation between exchange rate level and GDP per capita, current account balance as well as total reserves. There is no causality between exchange rate level and FDI, financial development, government expenditures, inflation as well as trade openness. It explains that in the advanced countries where economic structure is independent, stable and developed the exchange rate level is determined by GDP per capita, current account balance and total reserves. These three indicators not only influence the exchange rate level but in return they are also effected by exchange rate changes. So the results express weak relationship between macroeconomic indicators and exchange rate level in advanced countries.

4.3. Results of Panel ARDL for Least Developed Countries

The results of panel unit rest tests for the sample of least developed countries are shown in Table 5 which explain that variables have order of integration I(0) or I(1) thus preferred technique of cointegration is the Panel ARDL.

Table-5. Results of panel unit root test for least developed countries.

Variable	Im, Peseran and Shin (IPS)		Levin, Lin and Chu (LLC)		Hadri Z-Statistics	
	Level	First Diff.	Level	First Diff.	Level	First Diff.
LEXRV	-3.984 (0.000)	-24.092 (0.000)	-6.933 (0.000)	-28.375 (0.000)	9.438 (0.000)	21.229 (0.000)
LEXRL	-4.364 (0.000)	-9.892 (0.000)	-11.173 (0.000)	-17.153 (0.000)	13.665 (0.000)	10.415 (0.000)
LGDPP	-0.774 (0.219)	-7.922 (0.000)	-1.256 (0.104)	-11.137 (0.000)	9.984 (0.000)	11.618 (0.000)
LCAB	-5.267 (0.000)	-18.604 (0.000)	-6.893 (0.000)	-17.523 (0.000)	9.502 (0.000)	22.66 (0.000)
LFDI	-5.193 (0.000)	-19.044 (0.000)	-5.247 (0.000)	-14.986 (0.000)	8.243 (0.000)	8.262 (0.000)
LFDEV	-0.245 (0.402)	-15.112 (0.000)	-0.403 (0.343)	-17.770 (0.000)	5.195 (0.000)	10.724 (0.000)
LGEXP	-5.315 (0.000)	-18.052 (0.000)	-6.269 (0.000)	-18.062 (0.000)	11.896 (0.000)	9.265 (0.000)
LINF	-11.480 (0.000)	-21.695 (0.000)	-12.004 (0.000)	-21.566 (0.000)	15.174 (0.000)	41.406 (0.000)
LRESER	2.692 (0.996)	-12.774 (0.000)	1.573 (0.942)	-12.506 (0.000)	10.276 (0.000)	8.733 (0.000)
LTRADE	-3.890 (0.000)	-11.746 (0.000)	-3.395 (0.000)	-7.506 (0.000)	13.026 (0.000)	17.668 (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 (1948) obtained by special estimation and Bandwidth selection by automatic (Newey & West, 1994).

For least developed countries the ARDL estimations of exchange rate volatility and exchange rate level is shown in Table 6.

Table-6. Results of pooled mean group regression on panel ARDL for exchange rate behavior in least developed economies.

Independent Variables	Dependent Variable LEXRV		Dependent Variable LEXRL	
	Coefficient	Z Statistics (Probability)	Coefficient	Z Statistics (Probability)
Long-run Results				
LGDPP	0.1019	0.35 (0.729)	-0.0613	-0.46 (0.647)
LCAB	-4.1904	-3.52 (0.000)	-2.2012	-2.07 (0.039)
LFDI	1.0258	0.52 (0.601)	2.6626	1.73 (0.083)
LFDEV	-0.9159	-4.54 (0.000)	0.3747	3.44 (0.001)
LGEXP	0.8115	1.27 (0.203)	-0.4644	-2.29 (0.022)
LINF	2.6948	4.78 (0.000)	23.4214	6.33 (0.000)
LRESER	0.5512	1.24 (0.217)	-1.4266	-4.43 (0.000)
LTRADE	-0.1289	-0.13 (0.898)	-2.5697	-1.52 (0.128)
Short-run Results				
ECT	-0.6452	-8.69 (0.000)	-0.0253	-3.42 (0.001)
LGDPP	-5.9521	-3.56 (0.000)	-0.6167	-11.49 (0.000)
LCAB	0.5811	0.10 (0.921)	0.0733	0.95 (0.344)
LFDI	9.9408	1.61 (0.108)	0.1048	0.66 (0.511)
LFDEV	-0.3901	-0.28 (0.782)	-0.0662	-2.88 (0.004)
LGEXP	-0.8077	-0.33 (0.744)	0.0335	1.68 (0.092)
LINF	3.5219	0.49 (0.626)	0.2024	1.41 (0.159)
LRESER	3.1291	0.71 (0.478)	-0.0272	-0.37 (0.715)
LTRADE	97.1195	1.58 (0.115)	1.2068	1.15 (0.251)
Number of Groups	34		34	
No. of Observations	680		680	
Log Likelihood	-1206.542		1602.355	

Notes: Values in parentheses are estimated p values.

The results in Table 6 express that in the long run CAB and financial development negatively while inflation positively influence exchange rate volatility. There is support in the literature for CAB (Arabi, 2012) financial development (Ganguly & Breuer, 2010) and inflation (Bobai, Ubangida, & Umar, 2013). The short run dynamics of the model shows that only a single variable that is GDP per capita influence exchange rate volatility negatively. The error correction term is significant which reflects the speed of adjustment. It may be inferred that link between fundamental macroeconomic indicator and exchange rate volatility is weak in least developed economies. The results of Pooled Mean Group ARDL regression for exchange rate level depicted in Table 6 explains that in the long run there is strong influence of fundamental macroeconomics indicators in determination of exchange rate level. The CAB, government expenditures and total reserves have negative (Aizenman & Riera-Crichton, 2008; Ojo & Alege, 2014; Williams & Prasad, 2019) while FDI, financial development and inflation have positive impact on exchange rate level (Aizenman & Riera-Crichton, 2008; Gharaibeh, 2017; Kamin & Rogers, 2000). In the short run GDP per capita and financial development has negative but government expenditures have positive impact on exchange rate level. The error correction term that is statistically significant shows the speed of adjustment. It may be inferred that there exists a strong relationship between selected macroeconomic fundamentals and exchange rate level.

4.4. Results of Panel Granger Causality for Least Developed Countries

For least developed economies, the results of pair wise panel granger causality test for exchange rate volatility are shown in Table 7.

Table-7. Results of panel granger causality for exchange rate volatility in least developed countries.

Null Hypothesis	Obs.	F-Stat	Probability	Decision	Causality
LGDPP does not Granger Cause LEXRV LEXRV does not Granger Cause LGDPP	684	0.219 1.824	0.803 0.162	Accept Accept	No Causality
LCAB does not Granger Cause LEXRV LEXRV does not Granger Cause LCAB	665	0.985 1.176	0.373 0.308	Accept Accept	No Causality
LFDI does not Granger Cause LEXRV LEXRV does not Granger Cause LFDI	684	0.499 2.945	0.607 0.053	Accept Reject	Uni-directional
LFDEV does not Granger Cause LEXRV LEXRV does not Granger Cause LFDEV	684	0.019 1.124	0.980 0.325	Accept Accept	No Causality
LGEXP does not Granger Cause LEXRV LEXRV does not Granger Cause LGEXP	665	0.745 1.441	0.471 0.237	Accept Accept	No Causality
LINF does not Granger Cause LEXRV LEXRV does not Granger Cause LINF	684	0.322 1.083	0.724 0.339	Accept Accept	No Causality
LRESER does not Granger Cause LEXRV LEXRV does not Granger Cause LRESER	684	0.363 2.357	0.695 0.095	Accept Reject	Uni-directional
LTRADE does not Granger Cause LEXRV LEXRV does not Granger Cause LTRADE	684	0.652 1.179	0.521 0.308	Accept Accept	No Causality

The results in Table 7 indicate that there is no causality between exchange rate volatility and GDP per capita, CAB, financial development, government expenditures, inflation as well as trade openness. The foreign direct investment and total reserves cause the exchange rate volatility in unidirectional causality.

It may be concluded that for least developed economies the causality analysis provides a weak relationship between exchange rate volatility and fundamental macroeconomic indicators.

Table-8. Results of panel granger causality for exchange rate level in least developed countries.

Null Hypothesis	Obs.	F-Stat	Probability	Decision	Causality
LGDDP does not Granger Cause LEXRL LEXRL does not Granger Cause LGDPP	684	5.82040 0.89345	0.003 0.409	Reject Accept	Unidirectional
LCAB does not Granger Cause LEXRL LEXRL does not Granger Cause LCAB	665	10.5324 1.43139	0.000 0.239	Reject Accept	Unidirectional
LFDI does not Granger Cause LEXRL LEXRL does not Granger Cause LFDI	684	0.67606 1.17064	0.509 0.311	Accept Accept	No Causality
LFDEV does not Granger Cause LEXRL LEXRL does not Granger Cause LFDEV	684	9.60356 0.68241	0.000 0.505	Reject Accept	Unidirectional
LGEXP does not Granger Cause LEXRL LEXRL does not Granger Cause LGEXP	665	9.38851 0.80999	0.000 0.445	Reject Accept	Unidirectional
LINF does not Granger Cause LEXRL LEXRL does not Granger Cause LINF	684	2.82567 7.43345	0.060 0.000	Reject Reject	Bidirectional
LRESER does not Granger Cause LEXRL LEXRL does not Granger Cause LRESER	684	13.4976 0.50563	0.000 0.603	Reject Accept	Unidirectional
LTRADE does not Granger Cause LEXRL LEXRL does not Granger Cause LTRADE	684	0.77538 0.86476	0.461 0.422	Accept Accept	No Causality

The pair wise panel granger causally estimates of exchange rate level for the panel of least developed countries are shown in Table 8. The results in Table 8 show that there exists bidirectional causality only between exchange rate level and inflation. In the case of unidirectional causality, the economic growth, CAB, financial development, government expenditures and total reserves cause the level of exchange rate. The results further indicate that there exists no causality between exchange rate level and fundamental macroeconomic indicators like FDI and trade openness. It may be concluded that there exists a strong relationship between exchange rate level and fundamental macroeconomic indicators in least developed countries.

5. CONCLUSION

There exists strong relationship between macroeconomic fundamentals and exchange rate volatility in advanced countries, however, in least developed countries the role of macroeconomic fundamentals in determination of exchange rate volatility has been observed moderate. Thus the relationship between macroeconomic fundamentals and exchange rate volatility is highly dependent on the economic structure of the countries (Bravo-Ortega & Di Giovanni, 2006; Devereux & Lane, 2003).

The behavior of exchange rate level is entirely governed by the selected fundamental macroeconomic variables in advanced countries and least developed countries. The current study provides the evidence of strong relationship between the selected macroeconomic variables and exchange rate level via cointegration and causality analysis.

The direction of the relationship between fundamental macroeconomic variables and exchange rate (both in terms of volatility and level) is also found sensitive to the economic structure (advanced vs least developed).

The current study proves the validity of fundamentals based macroeconomic models of exchange rate determination and negates the possibility of exchange rate disconnect not only in case of exchange rate volatility but also for exchange rate level for panel data sets of advanced and least developed countries.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Acknowledgement: All authors contributed equally to the conception and design of the study.

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