Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 6): pp. 6674-6693
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.06.650

Is Money Demand Function Stable In Developing Economies? Evidence From Panel Data Study

Peerzada Gh Mohammad Research Scholar, Department of Economics, Baba Ghulam Shah Badshah University, Rajouri- 185234 (Jammu and Kashmir)

Sajad Ahmad Rather Assistant Professor[2], Department of Economics, Baba Ghulam Shah Badshah University, Rajouri- 185234 (Jammu and Kashmir)
*Email of the Corresponding author: gmpir16eco@bgsbu.ac.in

ABSTRACT

This study evaluates money demand in a sample of developing countries by analysing annual data spanning from 1990-2019. This study employs a dynamic Panel ARDL model and a suite of stability and causality tests to explore the key issues surrounding the money demand function. The findings provide substantial empirical support for a statistically significant and enduring association within the specified function of demand for money. Moreover, the results indicate that the estimated values of all variables, except for the real interest rate, are both rational and consistent with the economic theory. Nevertheless, the inclusion of the real interest rate as a proxy variable for opportunity cost in a given sample of developing economies has been criticised as inadequate because of its failure to accurately capture prevailing financial market conditions. The application of the Dumitrescu and Hurlin (2012) test verifies the notion that money demand is influenced by income, interest rate, and inflation rate, in line with the theoretical framework of monetary transmission mechanisms.

Keywords
Open economy, Money Demand, Developing economies, Panel ARDL.

JEL Codes: F41, E41, E50, E52

I. Introduction.

In light of the evolutionary nature of emerging economies and integration with the globalized world economy, the stability of the money demand function (MDF from now) and the framework of monetary policy thereof bear an adjacent examination. The framing of an effective monetary policy depends on the magnitude of a stable money demand function in an economy. Being the fundamental models of macroeconomic strands, the incremental use of MDF received considerable attention as an effective instrument of monetary policy formulation for empirical analysis (Adil et al., 2020). As mentioned by (Goldfeld, 1989), the money demand relationship with its key determinants is an important building block in macroeconomic literature and is a crucial component in the conduct of monetary policy. Even in the regime of inflation targeting, a well-specified money demand functional form is a crucial component for the effective implementation of monetary policy especially to trace both, the interest rate and the stock of money—to evaluate the impact of monetary policy on the economy. (Singh & Pandey, 2010)mentioned (Reddy, 2004) "The monetary management in terms of framework and instruments have undergone significant changes, reflecting broadly the transition of the economy from a regulated to a liberalized and deregulated one". The stability of the demand for money is one of the most important and recurring issues in macroeconomic policy

analysis. A monetary policy that seeks to limit the supply of money to its demand facilitates the tasks of demand management and contributes to the achievement of price stability. The rate of growth in the money supply should conform with the desired rate of output growth and thus constrain the price increases to an acceptable level. Stable demand for money implies a stable money multiplier and, therefore, stability makes it easier to predict the effect of a given money supply on the aggregate money income.

Under different economic situations, the probable holding of money by the public is a precondition for an effective monetary policy formulation of an economy. It is so because the nature and quantum of interaction between the monetary and real sectors of a country are reflected by the demand for money and its components. (Muralikrishna Bharadwaj & Pandit, 2010), "the relationship between the stock of money and the level of output, interest rate, price level, and other important financial series such as stock prices must be stable if it has to be of any use for policy purposes. It is only then, that policymakers can effectively target the ultimate objectives like price stability, capital formation, unemployment reduction, and economic growth through intermediate variables such as interest rates and liquidity." The significance of MDF to be stable holds paramount importance in the formulation and smooth functioning of monetary policy since it has a functional relationship with the targeted macroeconomic variables (Laidler 1977). The implications of stable MDF are as: Firstly, a stable money demand equation suggests a stable money multiplier, leading to predictability in assessing how a specific money supply affects total money income. (Pradhan and Subramanian, 2003). Secondly, understanding the causes and consequences of stable MDF can provide useful insights in formulating monetary policy decisions, while conversely, the instability of MDF is a major determinant of liquidity preference. (Kumar, Webber, et al., 2013a). Third one is a stable money demand shows how effective the use of monetary aggregates is in the conduct of monetary policy and to what extent money helps forecast inflation. (Albulescu & Pepin, 2018)

Therefore, a great deal of money demand studies has been undertaken to provide empirical evidence of its stability. An important shortcoming of the related literature[a], however, is that it generally focuses on developed countries rather than developing countries. Moreover, the available literature[b] implies that vast attention has been received in the country-specific time series studies. There is scant evidence of literature on developing countries as a whole[c]. Thus, we can deduct from the given literature that the studies on MDF have taken two directions viz; country-by-country basis and panel testing procedures.(Narayan et al., 2009) The later approach of the study is at a nascent stage. However, among the later approaches of studies, most of them are related to regional groups like The Association of Southeast Asian Nations (ASEAN), South Asian Association for Regional Cooperation (SAARC) and Organization of the Petroleum Exporting Countries (OPEC) etc, thus the concern over the stability of MDF has been increased in the recent past. The central banks, policymakers and researchers around the world are more concerned due to moving towards flexible exchange rate regimes, openness and integration of evolutionary economies to the world economies. All these changes bear the question of the stability of money demand in emerging and developing economies The whole strand of literature on MDF is based on the controversy over the role of money demand in monetary policy. In this context the whole literature is bifurcated into two perspectives, that is, new Keynesian and new monetarist perspectives. Both perspectives share a mixture of MDF issues[d]. (Knell & Stix, 2003) raised the concern towards achieving the primary goal of price stability, exploring options such as pure inflation targeting, monetary targeting, nominal income targeting, or a combination of strategies. Their meta-analysis, drawing from over 500 individual studies on money demand estimation, did not strongly endorse monetary or nominal income targeting strategies, primarily due to the stability observed in the Money Demand Function (MDF).

Table 1: Empirical studies on money demand function in developing countries

Study	Money	Country/period	Method	Findings
(Wesso, 2002)	M3	South Africa 1971(Q1)-2000(Q4	JML	M3 demand is unstable in South Africa

(Bahmani-Oskooee* & Rehman, 2005)	M1 or M2	Asian developing countries	ADL, ECM	M1 monetary aggregate is cointegrated with its determinants in India, Indonesia and Singapore, and the estimated elasticities are stable over time, in the remaining countries (Malaysia, Pakistan, and the Philippines), it is the M2 aggregate that is cointegrated and stable.
(James, 2005)	M2	Indonesia	ARDL Bounds test approach	Financial liberalization plays a key role in determining money demand and its fluctuations.
(Nair et al., 2008)	M2	1986(Q1-2001(Q4) Malaysia	JML	M1, M2 and M3 demand functions are stable in Malaysia.
(Lee & Chien, 2008)	M1 or M2	China (1977 to 2002).	Johansen's maximum likelihood cointegrating tests, Gregory and Hansen's (1996) tests for regime shift	The estimated long-run income and interest elasticity are respectively 1.01 (1.11) and -0.14 (-0.08)
(Bahmani & Kutan, 2010a)	M2	Emerging economies of Eastern Europe	ECM	Money demand is stable in all seven Eastern European countries in the sample
(Basutkar, 2016)	M1 or M2	India	OLS, Ericsson (1998)	M3 is more significant as compared to M1
(Adil et al., 2018a)	RM1, RM3	India	Gregory–Hansen Cointegration with Structural Break, ARDL, Cointegration, (UECM), OLS Method, F-test, Psarian and Psarian (1997) tests, CUSUM and CUSUMQ	Existence of a well-specified money demand function in India. LnRM3 smoothly accommodated the structural breaks and volatility.
(Ahad, 2017b)	M2	Pakistan	Bayer–Hanck-combined cointegration, Johansen cointegration, ECM and Engle-Granger approach. ADF, PP	Financial development and industrial production have a positive significant impact on money demand. While income and exchange rate have a negative insignificant impact on money demand. It means that to control money demand in the short run, we need to control financial development.
(Nepal & Paija, 2020)	M2	SAARC Region (1986-2017)	Panel ARDL	Stable long-run MDF
(Asiedu et al., 2020)	RM2	Sixteen (16) West Africa Countries (1982 to 2019)	ARDL, CUSUM and CUSUMQ	Evidence of stability and partial stability for underlying countries.

Source: The authors

Notes: M0 is reserve money, M1 is narrow money and M2 and M3 are broad measures of money. ARDL, JML, ECM and GH are time series techniques that denote autoregressive distributed lag, Johansen maximum likelihood, error correction method and Gregory–Hansen, respectively.

Given the large strand of literature in this backdrop, we only review some key studies mostly related to developing and emerging economies. For convenience, we tabulated the major findings of some of these studies in Table 1.

Reviewing the literary work on money demand function, there is a strand of mixed results on the stability of MDF. Most of the studies pertaining to developing countries support the view that the money demand is stable even after various economic reforms (e.g., (Adil et al., 2020); (Arora & Osatieraghi, 2016), 2016; (Muralikrishna Bharadwaj & Pandit, 2010); Padhan, 2011). Conversely, some studies support unstable money demand after reform e.g.(Aggarwal, 2016); (Singh & Pandey, 2010) Thus, there is a need to look at this issue afresh and consider the limitations of these studies along with new policy changes. In this respect, our study would differ: First, we estimate the MDF in a panel framework by taking a set of developing countries and drawing on recent developments

in panel cointegration and panel estimation techniques. Second, we estimate the correlation between MDF and its determinants and the causality thereof. And lastly, the stability tests on the money demand function are examined using a suit of tests.

Dataset and Research Methodology

Model Specification

The theoretical underpinnings motivating an empirical assessment of the stability of money demand, our study followed the approach of (Hossain, 1993) which is consistent with the recent studies on the stability of money demand function (Asongu et al., 2019). The macro theory postulates that two important determinants of demand for money in any country are a measure of economic activity; First, the Scale variable and second, the opportunity cost variable. The scale variable is used as a measure of transactions relating to economic activity. For this purpose, our study uses GDP to represent the scale variable as it poses little measurement problem. Opportunity cost variable includes the interest rate and inflation rate[e]. Due to the lack of well-developed financial markets in many of the emerging economies, (Bahmani & Kutan, 2010) and others employed the inflation rate as the opportunity cost of holding money because the use of interest rate as an opportunity cost variable could be misleading in the context of developing countries see (Bahmani-Oskooee et al., 2013). Robert Mundell (1963) proposed that money demand can also depend upon the exchange rate and also (Arango & Nadiari, 1981) elaborated on the rationale of the exchange rate as the determinant of MDF that foreign exchange constitutes a part of a portfolio of economic agents. Depreciation in the exchange rate may result in further depreciation of the currency, which will force individuals to hold money as foreign currency to avoid possible losses. Similarly, expectations of currency depreciation may reduce money demand either due to the substitution effect or the wealth effect. Hence, the study also incorporates an exchange rate into the estimation. The money demand thus specified is as:

$$M/P = f(Y, R, \mathrm{P}, E), \quad (1)$$

Where, M/P = Real Money stock, Y = Real GDP at constant prices ($US 2015), R= Real rate of interest, E= exchange rate, and P=inflation rate.

Equation (1) can be re-represented in a log form as:

$$\ln (M/p)_t = \beta_0 + \beta_1 \ln\, y_t + \beta_2 R_t + \beta_3 INF_t + \beta_4 \ln\, E_t + \varepsilon_t \quad (2)$$

where ln is the natural logarithm, βs are the coefficients of the variables, ε is the residual term, and subscript t is the time. All variables, except for real interest rate, are log-transformed by taking their natural logarithms. Where equation (2) represents the long-run money demand function for the sample set of developing countries. For the panel money demand function, equation (2) can be re-written as:

$$\ln (M/p)_{it} = \beta_0 + \beta_{i1} \ln\, y_{it} + \beta_{i2} R_{it} + \beta_{i3} INF_{it} + \beta_{i4} \ln\, E_{it} + \varepsilon_{it} \quad (3)$$

where i and t are country and time subscripts, respectively and $\varepsilon_{it} \sim N(0, \sigma)$ for all i and t. The present study follows a three-step procedure to examine the determinants of MDF and its stability under the sample period. The first step is to check whether there is a long-run relationship between real money balances and their covariates. The second and third steps depend on the first step to establish the long- and short-run elasticities.

The Data

The broad methodology employed in this study is empirical in nature. The data employed in the study is entirely secondary. The period of the sample data ranges from 1990 to 2019. The researcher took a sample set of developing countries by incorporating the criteria set by international institutions like the World Bank and IMF. The study is based on panel data i.e. both the time series data as well as cross-section data or the same cross-sectional units are surveyed over time. The variables used in the study are consistent with the recent literature (Asongu et al., 2019) and include real broad money M3, real gross domestic product (GDP), inflation, real interest rate and real effective exchange rate. The following Table 2 lists the complete variable definitions and corresponding sources.

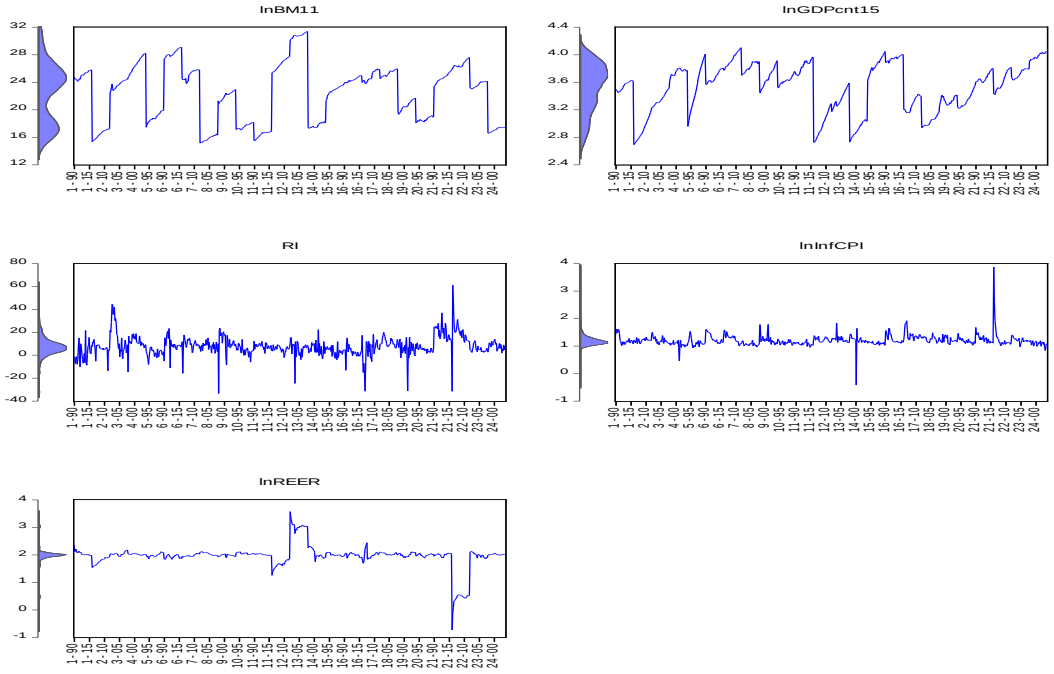
Table 2: Variable definitions and sources

Variables	Full name	Definition	Sources
BM	Broad money constant local currency units.	Broad money current local currency units divided by GDP deflator.	International Monetary Fund, International Financial Statistics and data files, World Bank
GDP	GDP per capita (constant 2015 US$)	GDP per capita is gross domestic product divided by midyear population	International Monetary Fund, International Financial Statistics, World Bank
RI	Real interest rate (%)	The lending interest rate is adjusted for inflation as measured by the GDP deflator.	International Monetary Fund, International Financial Statistics., World Bank
INF	Consumer price index (2010 = 100)	Changes in the cost to the average consumer of acquiring a basket of goods and services may be fixed or changed at specified intervals, such as yearly.	International Monetary Fund, International Financial Statistics, World Bank
REER	Real effective exchange rate index (2010 = 100)	The nominal effective exchange rate is divided by a price deflator or index of costs.	International Monetary Fund, International Financial Statistics, World Bank

Source: The authors
Note: The annual data set used for the study spans from 1990 to 2019.

Table 3: Sample of developing countries

Country	Country Code	Country	Country Code
Algeria	DZA	Indonesia	IDN
Bangladesh	BGD	Lesotho	LSO
Belize	BLZ	Malaysia	MYS
Bolivia	BOL	Mexico	MEX
India	IND	Nigeria	NGA
China	CHN	Pakistan	PAK
Colombia	COL	Papua New Guinea	PNG
Costa-Rica	CRI	Paraguay	PRY
Dominica	DMA	Philippines	PHL
Dominica Republic	DOM	Peru	PER
Fiji	FJI	South Africa	ZAF
Grenada	GRD	St. Lucia	LCA



Source: The authors

Figure 1. Plots of underlying panel variables for the period 1990-2019

Panel estimation is chosen in this study to control for individual heterogeneity, to identify unobservable characteristics and to give more information on reliable estimation, see Baltagi (2005). The empirical analysis is carried out using annual data from a set of 26 developing economies over the period spanning from 1990 to 2019. However, the choice of a sample of developing countries is dictated by the availability of data and the choice of sample period for its relevance in light of the issues under scrutiny. The list of countries with country-specific codes specified by IFS (International Financial Statistics) is tabulated in Table 3***Unit root tests***

Before performing the main estimations, the conductance of unit root tests in both the time series and panel data is important to avoid any potential misspecification.(Smeekes & Wijler, 2020). To that end, for the panel data analysis we used LLC (Levin et al., 2002) IPS (Im et al., 2003), ADF (Dickey & Fuller, 1979) and PP unit root tests (Phillips & Perron, 1988). The equations used to test the null of non-stationarity for LLC, ADF, PP, and IPS are respectively as:

$$\Delta y_{it} = \mu_i + \rho y_{it-1} + \sum_{i=1}^{m} \alpha_j \Delta y_{it-j} + \delta_{it} + \theta_t + \varepsilon_{it} \quad (4)$$

$$\Delta \ln\, y_t = \lambda_1 + \lambda_2 t + \delta \ln\, y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta \ln\, y_{t-i} + \varepsilon_t, \quad (5)$$

$$\ln\, y_t = \lambda_1 + \lambda_2 t + \alpha \ln\, y_{t-1} + \varepsilon_t, \quad (6)$$

$$\Delta y_{it} = \mu_i + \rho_i y_{it-1} + \sum_{j=1}^{m} \alpha_j \Delta y_{it-j} + \delta_{it} + \theta_t + \varepsilon_{it} \quad (7)$$

where Δ is the first difference operator, *m* is the lag length, in the equation (4) and (7) μ_i and θ_t are unit-specific fixed and time effects, respectively. λ_1 = intercept and λ_2 =trend regressor in equations (5) and (6) respectively. The LLC test assumes non-heterogeneity of the autoregressive parameter (ρ). However, cross-sectional units can have a different speed of adjustment process towards the long-run equilibrium. In this context, the IPS test allows heterogeneity (i.e. allows the ρ to carry across all cross-sectional units). The selection optimal lag length is based on the automatic selection, using the AIC (Akaike Information Criterion), SIC (Schwarz Information Criterion), and HIC (Hanna-Quinn Information Criterion) frameworks that are estimated in the unrestricted vector auto-regressive environment. In the context of globalization and economic integration, there may arise a question of cross-sectional dependence among the sample set. However, the sample units of the study differ from the previous studies as they do not belong to the same economic region or group but rather belong to a sample of overall developing countries. Thud, for the sake of simplicity, we restricted our study to the independence of cross-sectional units.

The next step to be followed is the specification of dynamic panel data methodology. However, the specification of the model is based on the order of integration of the variables under study. When all the variables are stationary, the estimation can be carried out with fixed effects or random effects models. If all the variables are non-stationary at level but are stationary at the first difference, the (FMOLS) fully modified ordinary least square (Pedroni, 2001) and (DOLS) are to be specified (Mark & Sul, 2003). For the mixture of order of integration of the variables i.e., I(0) and I(0), the panel ARDL method is appropriate (Pesaran & Shin, 1999)

Dynamic panel ARDL model

On account of the order of integration of the variables, the Panel Autoregressive Distributed Lag model (ARDL) is specified. The Panel ARDL is superior regardless of the order of integration of underlying regressors i.e., I (0), I (1) or a mixture of both. In addition, the problem of serial auto-correlation can be corrected simultaneously. The benefit of using panel ARDL with sufficient lags is a reduction of the problem of endogeneity. In panel ARDL proposed by (Pesaran & Smith, 1995) and (Pesaran & Shin, 1999) there are two estimators viz; the MG (mean group) and PMG (pooled mean group). With the panels having large cross-section and time dimensions, the MG and PMG can produce consistent estimates. The main difference between these estimators is that, while both estimators allow for their intercepts, short-run coefficients, and error variances to differ freely across cross-section units, only the PMG constrains the long-run coefficients to be the same. That is, under the assumption of long-run slope homogeneity, both PMG and MG are consistent estimators, but only PMG is efficient. To that end, (Pesaran & Shin, 1999) suggested employing a joint Hausman test statistic, the null of which is long-run homogeneity. In this context, our study applied several estimators to assess the relation between the money demand and its determinants. The estimators include Mean Group (MG), Pooled Mean Group (PMG), and Dynamic Two-Way Fixed Effect (DFE) estimators (Pesaran and Smith 1995; Pesaran et al. 1999). The DFE estimator allows for intercept heterogeneity but no homogeneity of all other parameters across individual countries in the sample (Hsiao et al. 2002). Finally, the Hausman test is applied to compare the consistency and efficiency properties of these three estimators.

The panel ARDL model of order (p, q) is formulated below:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} x_{i,t-j} + \mu_i + \varepsilon_{i,t} \qquad (8)$$

where $x_{i,t-j}$ and δ_{ij} denote the k×1 vector of independent variables and the coefficients of independent variables, respectively, and y_{it} denotes the dependent variable λ_{ij} is a vector of scalars, μ_i is the country-specific time-invariant fixed effect, and $\varepsilon_{i,t}$ are the residuals.

Reparametrizing the equation (8) to arrive at the error correction model:

$$\Delta y_{i,t} = \varphi_i\left(y_{i,t-1} - \theta_{a,i} - \theta_i x_{i,t}\right) + \sum_{j=1}^{p-1} \lambda_{i,j}^{*} \Delta y_{i,t-j} + \sum_{j=1}^{q-1} \delta_{i,j}^{*} \Delta x_{i,t-j} + \eta_i + \varepsilon_{i,t} \qquad (9)$$

Where, $x_{i,t-j}$ = GDP, real interest rate, price and REER as represented in equation (8) above, φ_i= $-\left(1 - \sum_{j=1}^{p} \lambda_{i,j}\right), \theta_i = -\frac{\sum_{j=0}^{q} \delta_{i,j}}{\varphi_i}, \lambda_{i,j}^{*} = -\sum_{m=j+1}^{p} \lambda_{i,m}, \delta_{i,j}^{*} = -\sum_{m=j+1}^{q} \delta_{i,m}$

Re-writing the equation (9) as:

$$\Delta \ln BM_{it} = -\mu_i + \varphi_i(\ln BM_{it-1} - \lambda_1 \ln Y_{it-1} - \lambda_2 \ln P_{it-1} - \lambda_3 IR_{it-1} - \lambda_4 \ln EX_{it-1}) + \sum_{j-1}^{p-1} \gamma_j^i (\Delta \ln BM_i)_{t-j} + \sum_{j-0}^{q-1} \delta_{1j}^i \Delta \ln Y_{it-j} + \sum_{j-0}^{q-1} \delta_{2j}^i \Delta \ln P_{it-j} + \sum_{j-0}^{q-1} \delta_{3j}^i \Delta IR_{it-j} + \sum_{j-0}^{q-1} \delta_{4j}^i \Delta \ln EX_{it-j} + \varepsilon_{it} \qquad (10)$$

The equation (10) thus formulated captures the long-run relationship between money demand and its determinants based on the term $\varphi_i\left(y_{i,t-1} - \theta_{a,i} - \theta_i x_{i,t}\right)$, where θ_t is the vector of the corresponding long-term coefficients. A fundamental characteristic of co-integration is the presence of temporary deviations from equilibrium that gradually diminish at a rate of φ_i towards the long-term equilibrium, assuming the series is integrated at most to the first order I (1) or not integrated I (0). We anticipate φ_i to be both statistically significant and negative.

Causality test approach

Considering the causality test, two methods are there to check the causality. The first approach works under the assumption that all the coefficients are the same across all the cross-sections. On the contrary, the second approach suggested by Dumitrescu and Hurlin (2012)- (DH test) now onwards assumes that all the coefficients are different across all the cross-sections. The null hypothesis of the DH test is that the dependent variable does not Granger-cause independent variable against the alternate hypothesis that the independent variable does Granger-cause dependent variable for at least one panel variable. The DH-test can be used when N is growing and T is constant. Moreover, it can also be used when T>N and when N>T. The test, which is based on VAR, assumes that there is no cross-sectional dependency. Yet, the Monte Carlo simulations show that even under the conditions of cross-sectional dependency, this test can produce strong results. This test is used for balanced and heterogeneous panels. There are two different distributions in this test: asymptotic and semi-asymptotic. Asymptotic distribution is used when T>N, while semi-asymptotic distribution is used when N>T. (Dumitrescu and Hurlin (2012, p. 1453). Therefore, the DH test has been applied to discern the nature of causal relationships among the variables.

However, the DH test is an extension of Granger's (1969) causality test to detect causality in panel data. The underlying regression is as:

$$y_{it} = \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \qquad \text{with i = 1,, N and t = 1,…., T} \qquad (11)$$

Where K stands for the lag length. $\gamma_i^{(k)}$, which is an autoregressive parameter, and $\beta_i^{(k)}$, which is the regression coefficient varying across the cross sections but is assumed time-invariant. The lag order K is assumed to be identical for all cross sections and the panel must be balanced.

As in Granger (1969), the procedure to determine the existence of causality is to test for significant effects of past values of x on the present value of y. The null hypothesis is therefore defined as:

$$H_0: \beta_{i1} = \cdots = \beta_{iK} = 0 \forall i = 1, \ldots, N \quad (12)$$

Which indicates the absence of causality for all the individuals in the panel. However, the DH-test assumes the causality for some individuals of the panel but not necessarily for all. Thus, the alternative hypothesis writes;

$$H_1: \quad \begin{array}{ll} \beta_{i1} = \cdots = \beta_{iK} = 0 & \forall i = 1, \ldots, N_1 \\ \beta_{i1} \neq 0 \text{ or } \ldots \text{ or } \beta_{iK} \neq 0 & \forall i = N_1 + 1, \ldots, N \end{array} \quad (13)$$

Where $N_1 \in [0, N-1]$ is unknown. If N1 = 0, there is causality for all individuals in the panel. N1 must be strictly smaller than N, otherwise, there is no causality for all individuals and H1 reduces to H0.

In contrast, the DH-test proposes to run the N induvial regressions implicitly for equation (11), perform F-tests of the K linear hypotheses $\beta_{i1} = \cdots = \beta_{iK} = 0$ to retrieve the individual Wald statistic Wi, and finally the average Wald statistic $\bar{W}$:

$$\bar{W} = \frac{1}{N} \sum_{i=1}^{N} W_i$$

II. The Empirical Results and Discussion

Descriptive Statistics

Before analysing the variables of the study, the characterization of the data is of vital importance. Following Table 4 summarizes the characteristics of the variables. It includes average, standard deviation, minimum, and maximum. The average per capita GDP measured in U.S. dollars (USD $) of the sample countries is (3.529). A minimum of (2.693) and a maximum of (4.103) correspond to the countries of Bangladesh and Costa Rica in the years 1990 and 2019 (Fig 2). For the inflation rate measured as the consumer price index (annual percentage), the minimum of (-0.416) and a maximum of (3.875) correspond to the countries of Lesotho and the Philippines in the year 2001 and 1990 (Fig 2). However, the high variability in the inflation rate is associated with political and economic instability. It is to be noted that the values are given in logarithmic terms. The (Fig 2) is extracted from Table 4 and depicts the minimum and maximum values of the variables corresponding to the specific country and year. The maximum and minimum of RI measured as the real rate of interest annual percentage is (61.186) and (-33.36) corresponding to the Philippines and the Dominica Republic in the year 1991 respectively.

Table 4: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lnBM	720	22.483	4.207	15.155	31.373
lnGDP	720	3.529	.343	2.693	4.103
RI	720	7.818	8.471	-33.357	61.186
lnInfCPI	720	1.205	.198	-.416	3.875

lnREER	720	1.961	.412	-.726	3.572

Source: The authors

Correlation matrix

The strong correlation between variables can lead to multicollinearity, which in turn complicates the interpretation of coefficients. However, the decision to address multicollinearity depends on its severity and whether it occurs between the dependent and independent variables. Notably, the correlation matrix indicates a moderate correlation (± 30 & ±70) between the dependent variable (BM) and the independent variable (GDP), with a coefficient of (0.032), suggesting a medium level of correlation. Conversely, the correlation between BM and INF is very low and negative (-0.077). Further analysis of the correlation matrix reveals predominantly low to medium correlations between dependent variables (BM) and other variables, as well as medium correlations (± 30 & ±70) between independent variables (GDP) and control variables. Moreover, there is no high correlation (±70 & ±1) among the variables under study, allowing for straightforward interpretation of the experimental variables due to their low correlation.

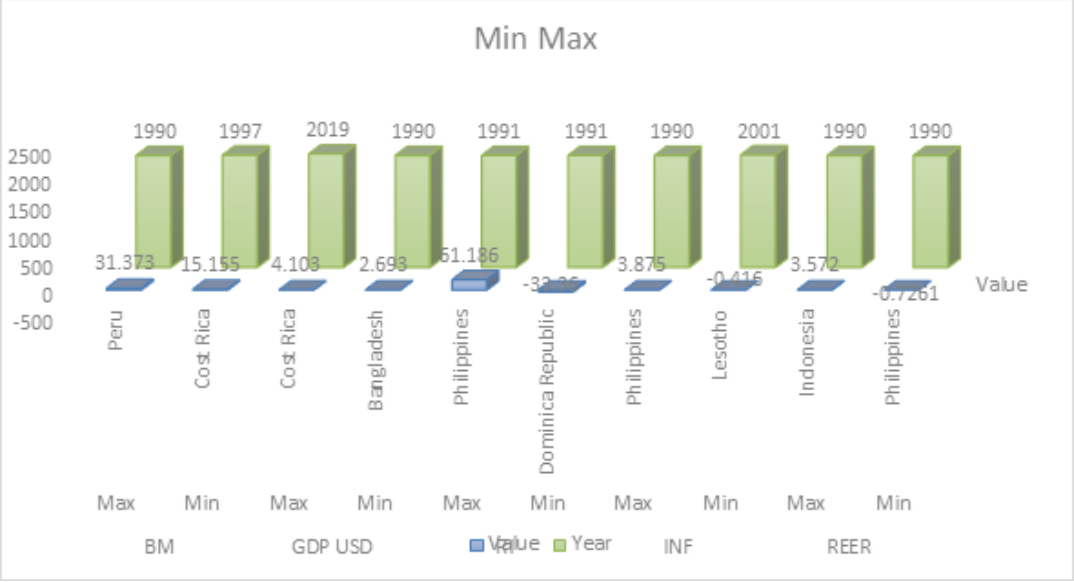
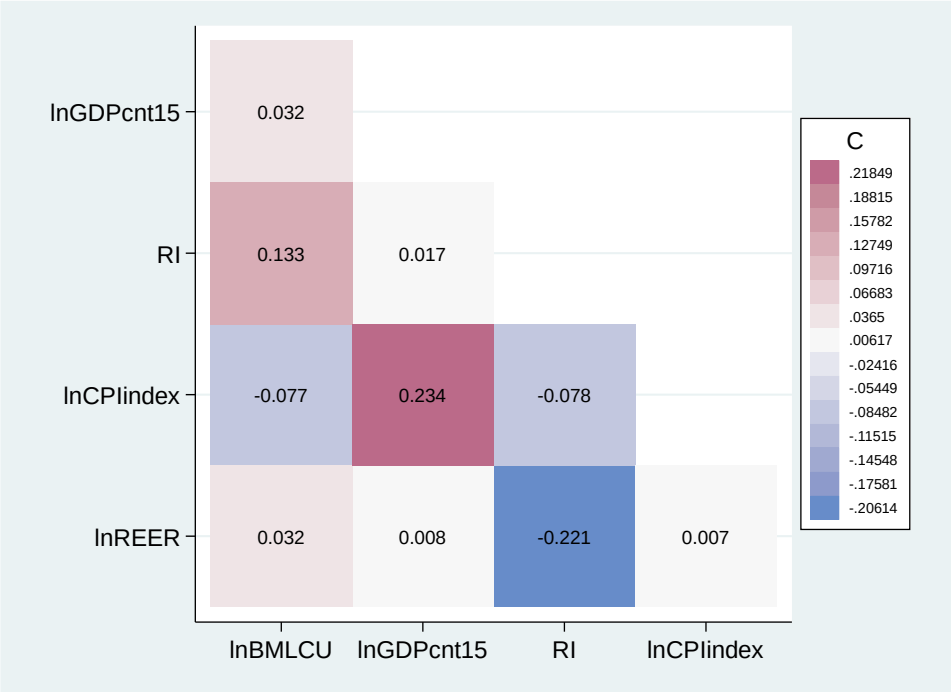


Figure 2: Maximum and Minimum

Panel unit root analysis

The analysis of this study begins with testing the order of integration of the variables. In other words, we can say that these tests detect the unit roots in the underlying variable of the panel data. The results of these are reported in Table 5. The results show that the variables are of mixed order of integration i.e. broad money (lnBM), real rate of interest (RI) is stationary at a level with 1% level of significance and income(lnGDP), inflation rate (lnCPI), real exchange rate (lnREER) are stationary at first difference. However, the inflation (lnCPI) is stationary at a level as per the LLC test. Moreover, for the robustness of the study, (Im et al., 2003) unit root test has been applied as shown in Table 4. The results of the IPS test are more or less similar to ADF and PP tests. This observation shows that the variables under study are of mixed order of integration, i.e., I (0) and I (1) order of integration. (see, inter alia,(Menegaki, 2019); (Asteriou et al., 2021).

The results of panel unit root tests lead the study to apply the dynamic panel auto-regressive distributed lag (ARDL) model. The appropriateness of the dynamic panel ARDL is based on the integration properties of the variables i.e. I (0) and I (1).



Source: The authors **Figure 3. Correlation Matrix**

Table 5: Panel unit root test

variables	LLC	IPS	ADF-Fisher X^2	PP-Fisher x^2
Level				
lnBM	-4.87***	1.73	44.84	51.34
lnGDPCnst15$	11.82	15.14	4.59	2.56
lnREER	-0.70	-1.64**	65.75**	101.68***
RI	-9.77***	-11.96***	250.73***	313.005***
INF	6.63	12.16	21.25	12.76
Ist difference				
ΔlnBM	--	-16.63***	535.10***	535.10***
ΔlnGDP	-19.65***	-19.62***	640.46***	640.46***
ΔGDPdfltr	-11.78***	-12.86***	354.94***	354.94***
ΔlnREER	-16.80***	--	--	--
ΔRI	--	--	--	--

*Notes: ***, ** and * indicate the rejection of the null at 1%,5% and 10% level of significance, respectively.*

Source: The authors

Dynamic panel ARDL model

In this section, we estimated the equation (10) using three different estimators: PMG, MG and DFE as shown in Table 5. The Hausman tests (Hausman 1978) are also reported to compare an efficient model against a more efficient model that also provides consistent results. The result of the Hausman test thus performed signifies that the PMG estimator is appropriate for the model. This is because the null hypothesis of homogeneity in long-run parameters is not rejected at the 5% level of significance. i.e. Ho: difference in coefficients not systematic, is accepted as the Hausman test statistic p-value is (Prob>chi2 = 0.385). Also, the Hausman test is performed between PMG and DFE as a result, the p-value of the test statistic is (Prob>chi2 = 1.00). So, no supporting evidence to reject the null hypothesis that PMG is a consistent and efficient estimator leads to employing PMG estimator.

Table 6 provides the results of the Panel ARDL estimation which consists of PMG, MG, and DFE, with the dependent variable Money demand (lnBM). The results confirm the presence of a co-integrated relationship. Based on the results of the Hausman test, the null hypothesis of long-run parametric restriction at the 5% level of significance is not rejected. So, the results of the PMG estimator are efficient for the model. As from the results of ECT, or the adjustment coefficient, (φ_i), is significantly negative in all three cases viz; PMG MG and DFE, thus denotes the converging long-run relationship between demand for money, real income, real interest rate, real exchange rate and inflation and denotes the short-run deviations as well. The long-run relation signifies that the broad money as an instrument of monetary policy in the sample of developing countries impacts the given determinants significantly. As can be seen from Table 5, the income elasticity (β_1), is greater than one ($\beta_1>1$) i.e. 3.79

The results of the full panel i.e. the underlying 24 developing countries are not displayed here for the cause of space brevity[f]. However, interpreting the long-run results, all estimates of the coefficients of the variables under study except interest rate are quite reasonable and correctly signed, in line with economic theory. The coefficient of lnGDP indicates that the 1% increase in income (lnGDP) causes money demand (lnBM) to increase by 3.79% in the sample of developing countries. Therefore, during the specified sample period, the velocity of money for these developing countries shows a declining trend. The determinant of inflation is augmented in the model to reflect the market conditions of the financial markets in these countries as well. The results are consistent with the empirical literature and indicate an inverse relation with money demand. Following the macro theory, the estimate of λ_4 in equation (10) above could be positive or negative. Given that REER is defined as a measure of domestic currency units against a weighted average of several foreign currencies, an increase in EX or depreciation of the domestic currency raises the value of the foreign assets in terms of domestic currency. If this increase is perceived as an increase in wealth, then the demand for domestic money increases yielding a positive estimate of λ_4. However, if an increase in EX induces an expectation of further depreciation of the domestic currency, the public may hold less of domestic currency and more of foreign currency. In this case an estimate of λ_4 is expected to be negative. Since the latter case corroborates with our results of the negative estimate of REER[g]. For the case of real interest rates, the results show a significant and positive impact. Although positive, but of a very low value which is in contrast with the theoretical literature. As elaborated in the methodology part, we have taken two opportunity cost variables for the given sample of developing countries i.e. inflation and interest rate. However, the results of our study imply that the use of interest rate as an opportunity cost variable in the given sample set is inappropriate. This is justified on several grounds. However, more importantly, the given sample set pertains to developing countries and is characterised by less developed financial markets. So, the use of interest rate as an opportunity cost variable cannot appropriately measure the market conditions. see Bahmani-Oskooee and Gelan (2009). The same argument is in line with Bahmani-Oskooee and Rehman (2005) and Folarin and Asongu (2019).

Table 6: Panel ARDL estimation

	ARDL		
	(1) PMG	(2) MG	(3) DFE
Adjustment coefficients	-0.085***	-0.313***	-0.055***
	(0.00)	(0.00)	(0.00)
Long-term coefficients			
lnGDPCnst15$	3.792***	-0.021	2.483***
	(0.00)	(0.996)	(0.001)
RI	0.048***	0.010	0.039**
	(0.00)	(0.463)	(0.015)
lnREER	-0.769***	1.979	-1.606*
	(0.01)	(0.631)	(0.076)
INF	-1.364***	1.459	-2.456***
	(0.00)	(0.376)	(0.001)
Short-term coefficients			
lnGDPCnst15$			
D1	-0.281	-0.797**	0.413
	(0.672)	(0.013)	(0.193)
RI	0.0012	0.0007	0.001***
D1.	(0.037)	(0.465)	(0.001)
lnREER			
D1.	0.292	0.211	0.087
	(0.078) *	(0.301)	(0.354)
INF			
D1.	0.110***	0.037	0.068**
	(0.004)	(0.543)	(0.034)
Constant	1.03***	2.39***	1.13***
	(0.00)	(0.001)	(0.00)
	(0.849)		
Number of observations	696	696	696
Number of countries	24	24	24
Hausman test	(PMG vs. MG) [a]		(PMG vs.GFE) [b]
Chi^2	4.15		0.00
Prob.>Chi^2	0.385		1.00

*(Notes): (i) ***, **, and *, indicate the significance at 1%,5%, and 10% levels respectively. The estimated ARDL is of order (1 1 1 1 1), and the order variable is lnBM, lnGDPCnst15$, RI, lnREER and INF.*
(ii) [a](H_0): PMG is more efficient than MG estimation. *(iii)*
[b] (H_0: PMG is efficient than DFE estimation
Source: The Authors

Panel Granger Causality Tests

The PMG ARDL result of the money demand function demonstrates that the underlying variables are significant at 1%,5% and 10% levels of significance. This statistical significance indicates that the variables have a long-run relationship with each other. However, in the short run, the variable inflation is significant at the 3 per cent level depicting a short-run causal relationship with other variables. In contrast, the short-run insignificant variables do not have a causal impact on other variables. Further, the ECT term is significant at a 1 per cent level, depicting joint long-run causality among the variables.

Table 7: Dumitrescu and Hurlin (2012) panel causality test

Source: The Authors

	lnBM		lnY		RI		lnREER		INF	
	W-stat	Z-stat	W-stat	Z-stat	w-stat	Z-stat	Z-stat	Z-stat	w-stat	Z-stat
lnBM	---	---	9.48	14.83 (0.00) ***	3.92	3.52 (0.00)***	2.82	1.29 (0.19)	9.75	15.83 (0.00)***
lnY	4.01	3.69 (0.00) ***	---	---	3.83	3.84 (0.00)***	3.87	3.42*** (0.00)	6.31	8.39*** (0.00)
RI	4.50	4.70 (3.E-06)	4.98	5.68 (1.E-08)	---	---	3.17	1.99 (0.46)	5.33	6.39 (2.E-10)
lnREER	4.11	3.90 (9.E-05)	4.87	5.45 (5.E-08)	3.03	1.70* (0.08)	---	---	3.22	2.10** (0.03)
INF	6.50	8.77 (0.00) ***	5.05	5.81 (6.E-09)	2.51	0.66 (0.50)	3.83	3.33*** (0.00)	---	---

*Note: ***, ** and * denote statistical significance at the 1%,5% and 10% levels, respectively*

Although the long-run equilibrium relationship cannot determine the direction of causation. Therefore, the causality test is justifiable to examine the nature of the casual relationships among the cointegrated variables. The results are reported in Table 7. There is evidence of a feedback relationship (bi-directional relationship) between money demand and Income, money demand and inflation, and inflation and exchange rate at 1 per cent and 5 per cent levels of significance. While as exchange rate and real rate of interest have bi-directional causality at 5 per cent and 10 per cent levels of significance respectively. The unidirectional relationship is evident from the real interest rate and money demand like Kumar et al., (2009), real interest rate and income, inflation rate and income, exchange rate and income. However, no Granger causality is evident from money demand to real rate of interest, money demand to exchange rate, income to inflation, income to exchange rate, and inflation to interest rate.

An important finding from the DH test is that the money demand is linked with income, interest rate and inflation as is evident from the second row of Table 6. Thus, the results seem to be consistent with the monetary transmission mechanism theories (see, inter alia, Friedman and Schwartz 1963; Laidler (1980).

Parametric stability test

To uphold the validity and to deliver a coherent and dependable conclusion, it is imperative to examine the stability of the parameters. In this context, the study employs a method of recursive estimate of the CUSUM and CUSUMSQ recommended by (Brown et al., 1975). This is because in the case of the money demand function, the variables- broad money, income, real interest rate, inflation and exchange rate likely to have experienced shocks over the sample time. While performing the CUSUM and CUSUMQ statistics two aspects of the results have been found; First, countries which conform the CUSUM and CUSUMQ test stability results and, Second, the countries which conform the results otherwise. The results are depicted from Fig. 4 to 13, for only the first case[h]. The countries in which the plots of the CUSUM and CUSUMSQ statistics fall inside the critical bands of the 5 per cent confidence intervals are Dominica Republic, Grenada, Indonesia, Nigeria, Lesotho, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, South Africa and St. Lucia. On the other hand, the countries which show the results otherwise are Algeria, Bangladesh, Belize, Bolivia, India, China, Colombia, Costa Rica, Dominica, Fiji, Malaysia and Mexico. This shows that out of 24 sample

developing counties, 12 countries have stability and 12 do not support the stability of MDF parameters. The confirmation of the parametric test stability in the given 12 countries shows that the MDF is stable. This stability of MDF in these countries can be attributed to numerous factors specifically; less developed financial markets (Narayan et al., 2009).

Figure 4: Indonesia, Cusum and Cusum of

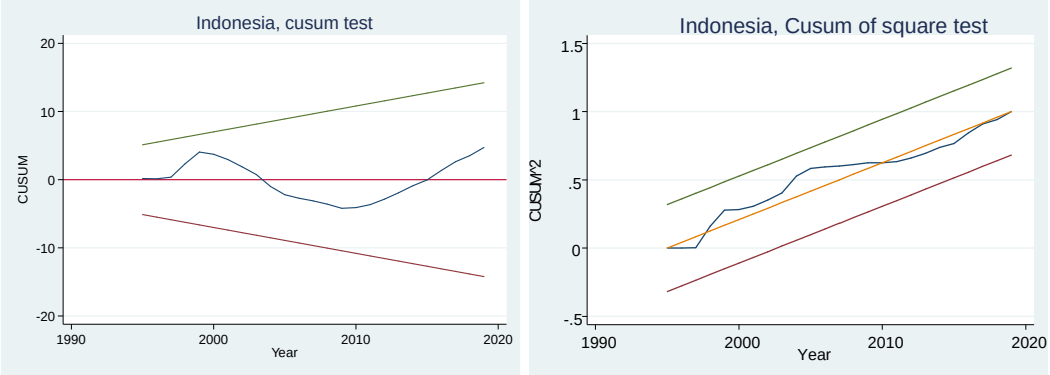


Figure 5: Nigeria, Cusum and Cusum of

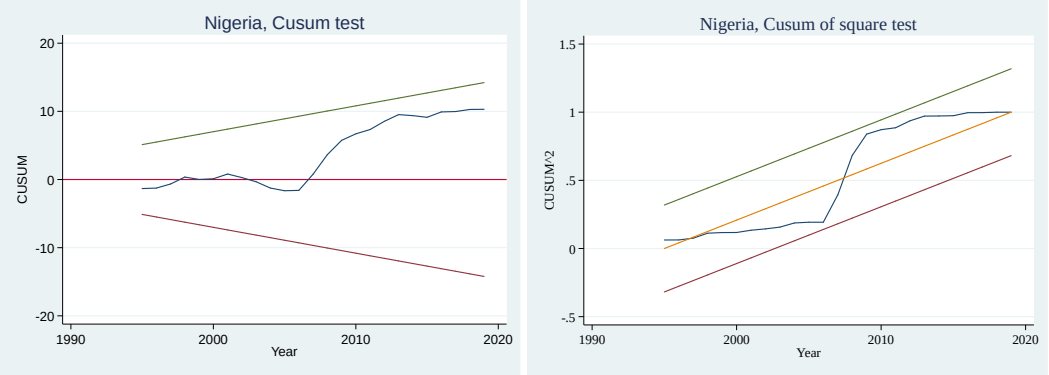


Figure 6: Lesotho, Cusum and Cusum

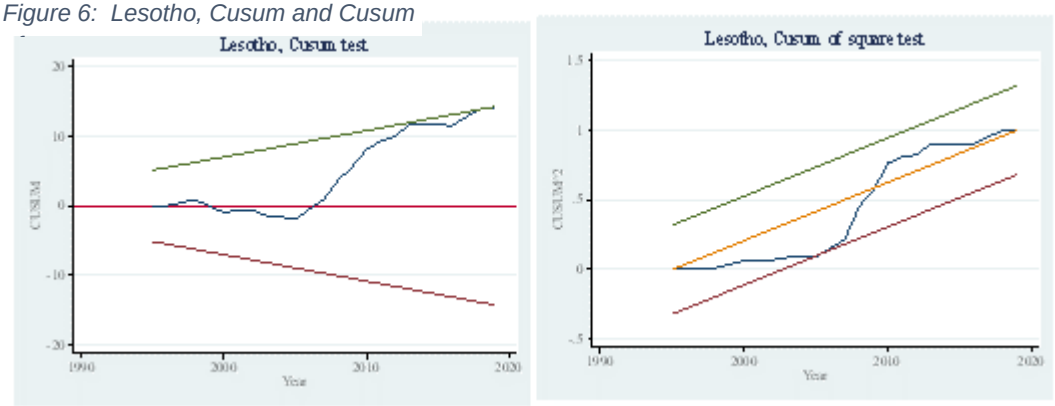


Figure 7:Pakistan, Cusum and Cusum

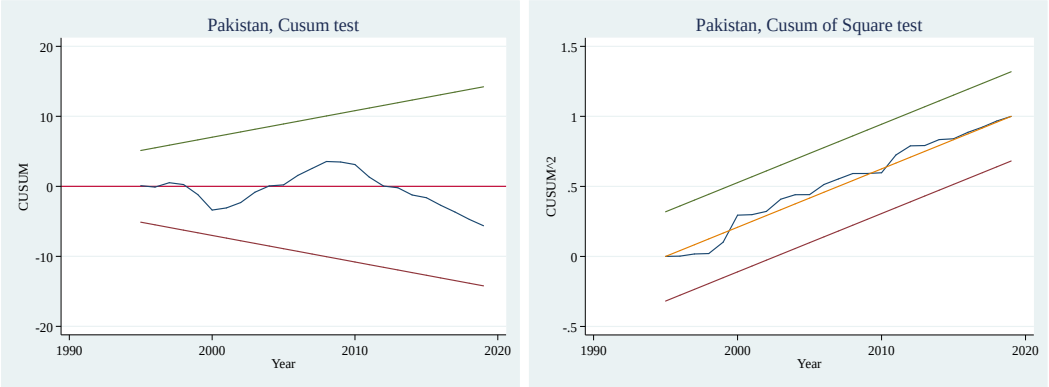


Figure 8: Papua New Guinea, Cusum and Cusum of square test

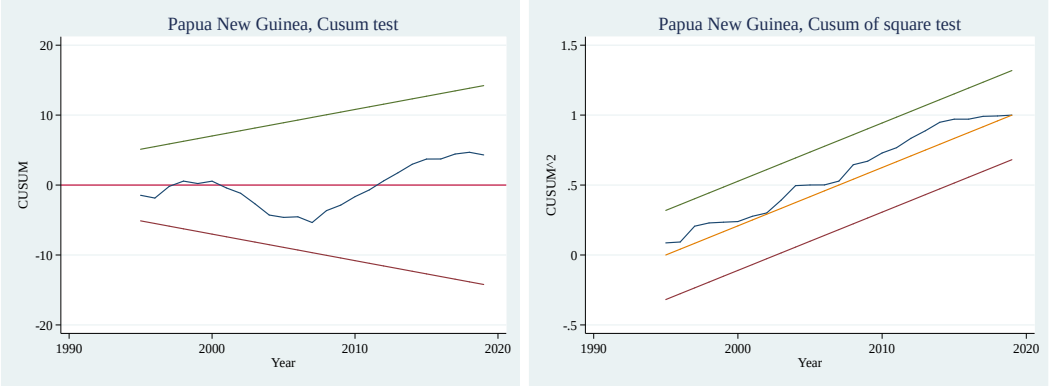


Figure 9: PARAGUAY

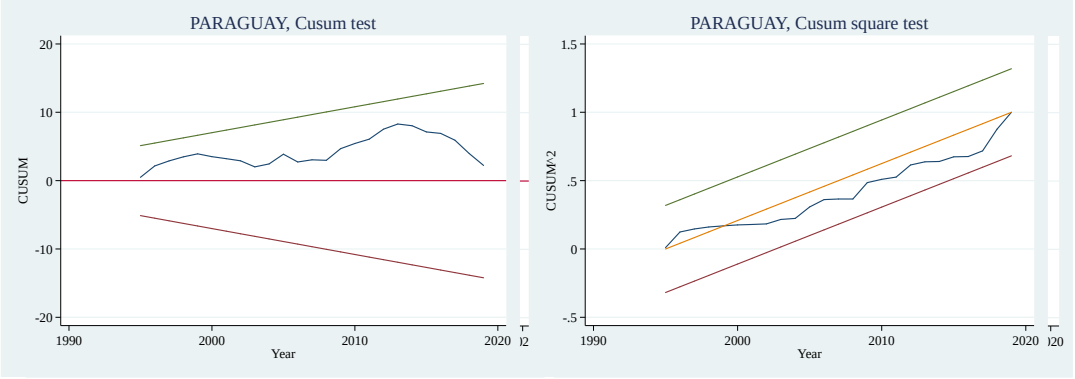


Figure 10: PERU. Cusum and Cusum

Figure 11: Philippines, Cusum and

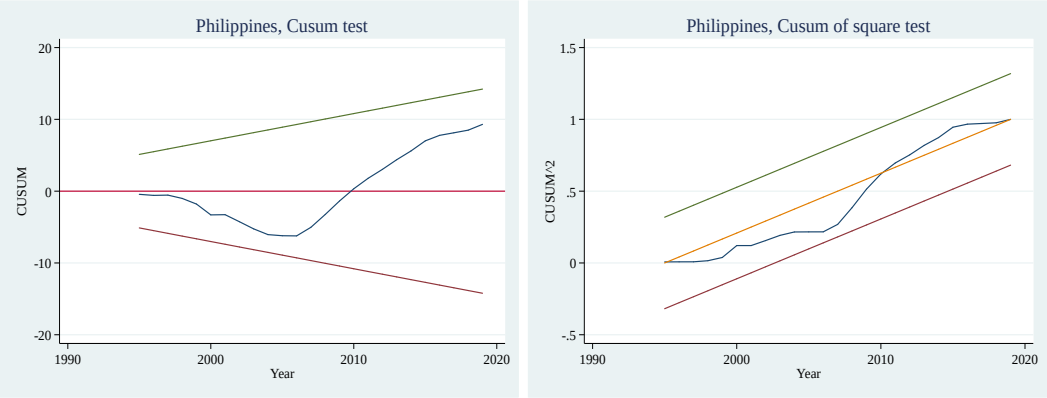


Figure 12: SOUTH AFRICA, Cusum

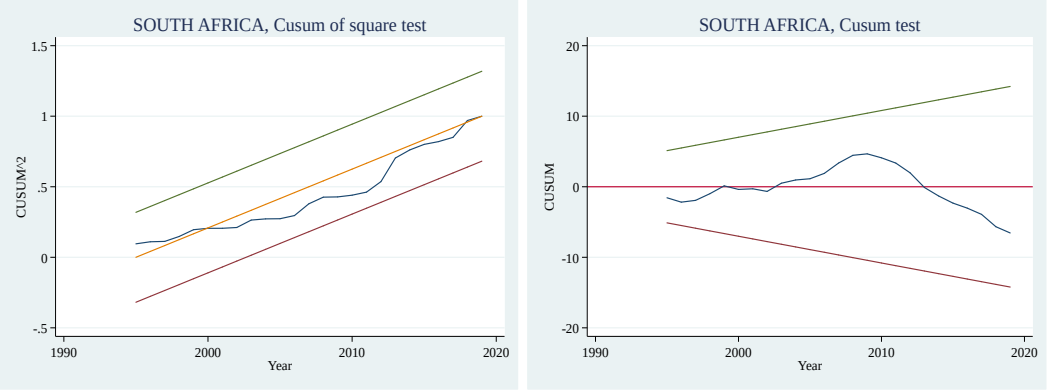
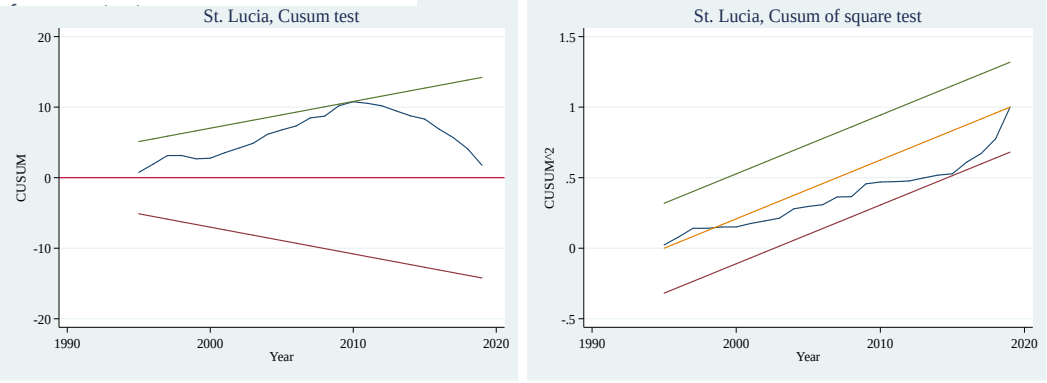


Figure 13:St. Lucia, Cusum and Cusum



Concluding Remarks

As the relationship between money demand with its key determinants is an important building block in macroeconomic literature, its stability bears optimal policy prescriptions for underlying economies. Targeting the monetary economic issues with the help of stable intermediate MDF variables like monetary aggregates and interest rates, a plethora of literature has been mounted on the stability of MDF. However, in the context of globalized world economies and integration of developing economies to the world economies remained a limitation to the amounted literature. Against this backdrop, the present study attempts to answer the question of whether the *money demand function*

is stable in sample developing countries. Thus, the study empirically verifies the MDF in the context of stability and cointegrating relationships by taking the sample of developing countries from 1990 to 2019. The methodological framework is in the context of panel analysis which has the advantages and capability to control for individual-specific effects. It accounts for individual heterogeneity and allows researchers to isolate the impact of time-varying factors while controlling individual characteristics that remain constant over time.

Based on model specification and integrating properties of the underlying determinants, the study employed the dynamic panel ARDL model. The results are as: For all the selected developing countries, there is substantial evidence of a long-run and statistically significant relationship between the money demand and its determinants. However, the stability test reveals that out of 24 developing countries, 12 countries [i] resulted in a stable money demand function. Focusing on the long-run elasticities of MDF, the results reveal that all estimates of the coefficients of the variables under study except interest rate are quite reasonable and correctly signed, in line with economic theory. Interestingly, the estimation coefficient of income is above one and is statistically positive. A one per cent increase in income causes money demand to increase by (3.79) per cent in the given sample of developing countries. However, the study reveals that the use of interest rate as an opportunity cost variable in the given sample set cannot appropriately measure the market conditions. So, the use of interest rate as an opportunity cost variable is inappropriate. Moreover, the study ascertained the panel causality by employing the Dumitrescu and Hurlin (2012) test. The test findings are that money demand is linked with income, interest rate and inflation as consistent with the monetary transmission mechanism theories.

The policy implications of the study can be summarized as: Firstly, the central banks of countries; Dominica Republic, Grenada, Indonesia, Nigeria, Lesotho, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, South Africa and St. Lucia, have viable option of broad monetary aggregate targeting in their monetary policy framework. Secondly, the inflation rate rather than the interest rate captures the financial market conditions of these underlying countries and is used as an opportunity cost for holding money balances. Third, following (Poole, 1970), the study findings support the useful policy recommendation for the central banks of the countries for which there is strong evidence of stability; targeting the monetary aggregates as the preeminent strategy for monetary policy implementation for the central banking authorities' endeavour to mitigate inflationary pressures and mitigate the amplitude of output fluctuations. Utilization of interest rates as a conduit for monetary policy would merely serve to amplify the volatility inherent in output dynamics.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The authors received no financial support for the research, authorship and/or publication of this article.

References

Adil, M. H., Haider, S., & Hatekar, N. R. (2018). Revisiting money demand stability in India: some post-reform evidence (1996–2016). *The Indian Economic Journal*, *66*(3–4), 326–346.

Adil, M. H., Hatekar, N., & Sahoo, P. (2020). The impact of financial innovation on the money demand function: an empirical verification in India. *Margin: The Journal of Applied Economic Research*, *14*(1), 28–61.

Aggarwal, S. (2016). Determinants of money demand for India in presence of structural break: An empirical analysis. *Business and Economic Horizons*, *12*(4), 173–177. https://doi.org/10.15208/beh.2016.13

Ahad, M. (2017). Financial Development and Money Demand Function: Cointegration, Causality and Variance Decomposition Analysis for Pakistan. *Global Business Review*, *18*(4), 811–824. https://doi.org/10.1177/0972150917692209

Albulescu, C. T., & Pepin, D. (2018). Monetary integration, money-demand stability, and the role of monetary overhang in forecasting inflation in CEE countries. *Journal of Economic Integration*, *33*(4), 841–879.

Arora, N., & Osatieraghi, A. (2016). Does India have a stable demand for money function after reforms? A macroeconometric analysis. *Прикладная Эконометрика*, *4 (44)*, 25–37.

Asiedu, M., Opoku, P., AbdElghaffar, A. M., Bimpong, P., & Yeboah, F. (2020). Long-Run Money Demand Function and Stability among Sixteen (16) West Africa Countries. *Journal of Financial Risk Management*, *9*(04), 390.

Asongu, S. A., Folarin, O. E., & Biekpe, N. (2019). The long-run stability of money demand in the proposed West African monetary union. *Research in International Business and Finance*, *48*, 483–495. https://doi.org/10.1016/j.ribaf.2018.11.001

Asteriou, D., Pilbeam, K., & Pratiwi, C. E. (2021). Public debt and economic growth: panel data evidence for Asian countries. *Journal of Economics and Finance*, *45*(2), 270–287. https://doi.org/10.1007/s12197-020-09515-7

Bahmani, S., & Kutan, A. M. (2010). How stable is the demand for money in emerging economies? *Applied Economics*, *42*(26), 3307–3318. https://doi.org/10.1080/00036840802112406

Basutkar, T. (2016). *Money Demand in India*.

Haider, S., Ganaie, A. A., & Kamaiah, B. (2017). Asymmetric exchange rate effect on money demand under open economy in case of India. *Economics Bulletin*, *37*(1), 168–179.

James, G. A. (2005). Money demand and financial liberalization in Indonesia. *Journal of Asian Economics*, *16*(5), 817–829.

Knell, M., & Stix, H. (2003). *How robust are money demand estimations? A meta-analytic approach*. Working paper.

Kumar, S., Chowdhury, M. B., & Rao, B. B. (2013). Demand for money in the selected OECD countries: A time series panel data approach and structural breaks. *Applied Economics*, *45*(14), 1767–1776. https://doi.org/10.1080/00036846.2011.637897

Kumar, S., Webber, D. J., & Fargher, S. (2013). Money demand stability: A case study of Nigeria. *Journal of Policy Modeling*, *35*(6), 978–991. https://doi.org/https://doi.org/10.1016/j.jpolmod.2013.03.012

Lee, C.-C., & Chien, M.-S. (2008). Stability of the money demand function revisited in China. *Applied Economics*, *40*(24), 3185–3197.

Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1–24.

Muralikrishna Bharadwaj, B., & Pandit, V. (2010). Policy reforms and stability of the money demand function in India. *Margin: The Journal of Applied Economic Research*, *4*(1), 25–47.

Narayan, P. K., Narayan, S., & Mishra, V. (2009). Estimating money demand functions for South Asian countries. *Empirical Economics*, *36*(3), 685–696. https://doi.org/10.1007/s00181-008-0219-9

Nepal, R., & Paija, N. (2020). Stability of money demand function in the SAARC region. *Journal of Economic Integration*, *35*(1), 111–128.

Padhan, P. C. (2011). Stability of demand for money in India: Evidence from monetary and liquidity aggregates. *International Journal of Economics and Finance*, *3*(1), 271–282.

Payne, J. E. (2003). Post stabilization estimates of money demand in Croatia: error correction model using the bounds testing approach. *Applied Economics*, *35*(16), 1723–1727.

Singh, P., & Pandey, M. K. (2010). Financial innovation and stability of money demand function in post–reform period in India. *Economics Bulletin*, *30*(4), 2895–2905.

Notes

[a] Mehra (1997), Sriram (2001), Calza and Joao (2003) and (Bahmani-Oskooee et al., 2015) provide a review of empirical money demand studies.

[b] (Pradhan & Subramanian, 2003), (Royal et al., 2005), (Muralikrishna Bharadwaj & Pandit, 2010) (Adil et al., 2018) Mehra (1997), Sriram (2001), Calza and Joao (2003) and (Bahmani-Oskooee et al., 2015) provide a review of empirical money demand studies.

[c] . (Arize, 1994), (Arrau et al., 1995), (Bahmani & Kutan, 2010), (Kumar, 2011), (Asiedu et al., 2020), (Benati et al., 2021) provide empirical study on either regional or a group of developing countries.

[d] The new Keynesians did not take money as explicitly in conducting monetary policy due to unstable MDF under the new economic policy regime. In contrast to this the monetarists were much more concerned about the diminishing role of money while conducting monetary policy under the inflation targeting framework (see (Adil et al., 2018b))

[e] (Kumar, Chowdhury, et al., 2013) have employed both the interest and the inflation rates.

[f] The results may be available upon the request to authors.

[g] For more on the expected sign of d see (Arango & Nadiri, 1981) and (Bahmani-Oskooee & Pourheydarian, 1990)

[h] For the second case, the results are not shown on the account of space brevity. However, these results are available upon request to authors.

[i] These countries are: *Dominica Republic, Grenada, Indonesia, Nigeria, Lesotho, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, South Africa and St. Lucia.*