WP-2021-005

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February 2021

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Keywords: Narrow money demand, broad money demand, simple-sum monetary aggregates, Divisia monetary aggregates, ARDL cointegration approach

JEL Code: C23, E41, E52

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February 1, 2021

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Abstract:

We revisit the issue of stable demand for money, using quarterly data for the European Monetary Union, India, Israel, Poland, the UK, and the US. We use the same linear modeling and specification approach that had previously cast doubt on money demand stability. Autoregressive distributed lag (ARDL) cointegration models are used in the study to establish a long-term relationship between real money balances and real output, interest rate, and real effective exchange rate. For all the countries analyzed, evidence of the existence of stable demand for money is found. Broad money in general is better at capturing a stable demand for money than narrow money. The stability results are especially strong, when broad Divisia money is used instead of its simple sum counterpart.

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1. Introduction

Stability of the money demand function has been one of the most researched topics in the monetary policy literature in the past five decades. Money began to play a minor role in policy after a series of papers indicated that demand for central banks' official simple-sum monetary aggregates was unstable in some countries during the 1970s.[1] For example, the "missing money" puzzle raised concerns, since conventional linear demand for money functions, using simple-sum monetary aggregates, consistently over-predicted the demand for money. Moreover, those linear demand for money functions seemed to be unstable, displaying frequent shifts. The *ad hoc* models used in that research were not directly derived from microeconomic theory but widely used in policy design. The empirical irregularities encountered in that literature were mainly attributed to financial innovation and institutional/regulatory changes (James (2005), Adil et al. (2020,a)). As a result, money was largely abandoned under the New Keynesian tradition.

In contrast, from the start, research using Divisia monetary aggregates, derived from microeconomic aggregation theory, has never confirmed any of those findings of "missing money" or unstable demand for money. See, e.g., Barnett (1980, 1983, 1997), Barnett, Offenbacher, and Spindt (1984), and Barnett, Fisher, and Serletis (1992). A table of relevant empirical tests is available in Barnett (1982, Table 1).

[1] See, e.g., Goldfeld, Fand, and Brainard (1976) and Roley (1985) in the case of the US and Darrat (1986) in the case of four Latin American countries.

Our research in this study is based on the conventional linear time series approach to modeling the demand for money in applied macroeconomics, not the approach derived from microeconomic theory with user cost pricing of the aggregates, scale variable based on the budget constraint, and nonlinear specifications that are integrable to a utility function, assuring rational behavior of decision makers. The systems-theoretic demand modeling approach, using models directly derived from microeconomic theory, have never found that the demand for money is any more unstable than the demand for any other goods in the economy. Nevertheless, we use the conventional linear time-series approach to specification, since that approach produced the influential literature on unstable demand for money. We are not advocating that approach over the rigorously micro-founded approach, but rather investigating the literature on unstable demand for money on its own methodological grounds, although with a newer linear time series inference approach, with extension to open economy modeling, and with data from many more countries.

Most central banks around the world currently work with monetary policy models having no demand for money function, with the interest rate serving as the main instrument of monetary policy. The interest rate, however, lost its credibility as a reliable monetary policy instrument during the 2008 Great Financial Crisis (GFC), when it hit its lower bound of zero. In monetary policy research after the GFC, there has been a consequent resurgence of research in the role of money, particularly Divisia money. The recent literature on aggregation theoretic Divisia monetary aggregates (e.g., Belongia and Ireland (2016), Ghosh and Parab (2019), Hendrickson (2014), Keating et al. (2019) and Serletis and Gogas (2014)) are casting increasing doubt on the lack of attention paid to money in monetary policy in the post-GFC era.

The literature on aggregation-theoretic measurement of money has found the empirical failure of money demand primarily to have been caused by using simple-sum monetary measures. Simple sum and arithmetic average aggregation, disreputable in index number and aggregation theory since Fisher (1922), assume that all components of the money stock are perfect substitutes. Divisia monetary aggregates, however, place weights on the growth rates of the various components of money to reflect, at the margin, their relative contributions to monetary service flows. In accordance with the principles of aggregation and index number theory, the resulting Divisia quantity indexes adjust to changes in the economy's liquidity as new instruments are introduced (Barnett (1980), Belongia and Binner (2001)). The index prices the components' monetary services at their opportunity costs (user cost price).

As explained above, research using Divisia monetary aggregates did not confirm the "missing money" paradox or other early findings of unstable money demand. Nevertheless, many researchers have continued investigating those early controversies with more recent data. For example, Hendrickson (2014) estimated a stable Divisia money demand equation for the US with a cointegrated vector-autoregressive model and concluded that the information content of Divisia money qualifies it as an appropriate intermediate target for US monetary policy. Belongia and Ireland (2016) similarly identified a cointegrating money demand. They found that Divisia money dominates simple sum in their tests and found that stability of demand for Divisia money was retained throughout the financial innovations of 1980s, as well as during the Great Recession of 2008. The authors emphasized that the perceived instability of money demand was caused by the mismeasurement of money, rather than any dysfunctional relationship between money, real income, and interest rate. Serletis and Gogas (2014) have also found stable long-run money demand relationships for U.S. Divisia monetary aggregates, while the simple sum demand for money was found to be largely unstable.

Using the modern autoregressive distributed lag (ARDL) cointegration technique, this paper further examines the nature of the demand for money in the Euro Area, India, Israel, Poland, the UK, and the U.S. The presence of a combination of stationary and non-stationary variables in our data causes the ARDL cointegration technique to be particularly suitable for the analysis. In capturing the long-run demand for money, we compare the merits of correctly measured (Divisia) money with those of simple sum measures, as well as the merits of narrow money with those of broad money. In earlier studies, the effectiveness of Divisia money in capturing stable demand for money was mostly based on U.S. data. We broaden the analysis to include five more countries along with the U.S. While the earlier studies were based on a closed economy version of demand for money, we estimate a theoretically more appropriate open economy version for these economies. In addition, for both simple sum and its Divisia counterpart, we compare narrow money with broad money to explore whether narrow money or broad money more accurately characterizes the demand for monetary services of each country.

Our results establish the existence of stable demand for broad money for all the countries analyzed. Divisia money delivers superior results compared to its simple sum counterpart, with Divisia M3 providing the best outcome among all the models evaluated. We find the existence of a long-run cointegrating relation between real money balances, real income, interest rate, and the real effective exchange rate. We also find statistically significant and economically meaningful long-run and short-run coefficients of the three explanatory variables in the demand for money equations. The results hold across the six countries and are robust to use of different lag selection criteria. Money, especially broad Divisia money, can be a useful tool in monetary policy decision-making. A complete abandonment of money from policy, as has become common in many countries currently, could be potentially harmful.

The rest of the paper is organized as follows. Section 2 reviews the previous literature over stability issues. Section 3 defines the dataset, model specification, and empirical methodology. Section 4 discusses the empirical results. Section 5 summarizes the results and provides robustness check of the models under study. Section 6 is the conclusion.

2. Literature Review

The demand for money function had been a cornerstone of monetary policy design for decades. After the GFC, interest rates have lost their appeal as the sole instruments or intermediate targets of monetary policy. As a result, it has become important to reassess stability of the money demand function. However, the European Central Bank (ECB) is the only major central bank to assign a special role to money as part of its "two-pillar strategy," consistent of "economic analysis" and "monetary analysis." If these two pillars are to be merged in the future, there will need to be a larger pillar in which money will play a prominent role in guiding the ECB's monetary policy decisions. It becomes necessary for demand for the monetary aggregate to remain stable after structural changes associated with financial innovation.[2] Then adequacy of the monetary aggregates can be examined under the ECB's "monetary analysis" procedure. Because of the wave of "inflation targeting" that has arisen across many major economies, monetary aggregates that are significant predictors (or intermediate targets) in inflation targeting

[2] According to Lewis and Mizen (2000), "…financial innovation can be categorized in the form of a new product, or a new process for supplying an already existing product or be in terms of market arrangements."

are needed, with stable demand.[3] Some of the important empirical studies on short-run and long-run demand for money and stability of those demand functions are summarized in Table 1 below.[4] The studies indicate mixed results.

Table 1: Literature Review

Studies	Countries and sample covered	Methodology	Conclusion
Barnett (1980)	US, 1968:Q1-1978:Q4	CES demand system	Stable Divisia M2
Barnett (1983)	US, 1959(1)-1980(3)	Laurent series demand system	Stable Divisia M3
Barnett, Offenbacher, and Spindt (1984)	US, 1959(3)-1982(4)	Chow test, Swamy and Tinsley test	Unstable M3, stable Divisia M3
Millar (1991)	US, 1959:Q1-1987:Q4	Unit root tests, EG and AEG cointegration tests	Stable M2 monetary aggregate
Baba et al. (1992)	US, 1960-1988	Error correction mechanism	Stable M1 money demand
Barnett, Fisher, and Serletis (1992)	US, 1970Q1-1985Q2	Translog and Fourier demand system	Unstable M2, stable Divisia M2 demand
Moosa (1992)	India, 1972:Q1-1990:Q4	Unit root tests, EG, AEG, CRDW and JJ cointegration tests	Stable M1 and unstable M2 monetary aggregates
Orden and Fisher (1993)	New Zealand, 1965:Q2-1989:Q4	Unit root tests and cointegration test	No cointegration in M3 for full sample but for 1965:Q2-1984:Q2
Arrau and Gregorio (1993)	Chile, 1975:Q1-1989:Q4 and Mexico, 1980:Q1-1989:Q3	Unit root test and cointegration test	Unstable M1 money demand

[3] As mentioned in the report of the Reserve Bank of India (RBI, 2014), inflation targeting in advanced economies include Australia since 1993, Canada since 1990-91, Japan since 2013, New Zealand since 1989-90 and Norway since 2001. In emerging market economies, some of the many countries moving towards inflation targeting include Chile since 1999, Brazil since 1999, Hungary since 2001, Indonesia since 2005, and South Africa since 2000.

[4] A useful source of recent research on the subject of stability of money demand is the library online at the Center for Financial Stability at www.centerforfinancialstability.org/amfm_library.php

Table 1: Literature Review

Studies	Countries and sample covered	Methodology	Conclusion
Drake and Chrystal (1994)	UK, 1976:Q2-1990:Q3	Unit root tests and cointegration tests	Stable Divisia M1, M2, and M3 monetary aggregates
Yashiv (1994)	Israel, 1965-1989	Unit root test, cointegration test	Stable M1 money demand
Arrau et al. (1995)	Ten emerging countries: Argentina, Brazil, Chile, India, Israel, Korea, Malaysia, Mexico, Morocco and Nigeria, Used different time periods.	Unit root tests, EG cointegration and OLS	Stable M1 and M2 monetary aggregate
Barnett (1997)	US, Jan 1970-Jan 1996	Velocity stability	Unstable M2, stable Divisia M2
Funke (2001)	Euro area, 1980:Q1-1998:Q4	Error correction mechanism	M1 unstable and M3 stable
Ball (2001)	US, 1946-1987	SOLS, NNLS, DOLS, DGLS, Phillips, Phillips-Hansen, and Johansen's cointegration test	Stable M1 money demand
Buch (2001)	Hungary and Poland, 1991-1998	Error correction mechanism	Stable M1 and M2 money demand
Wesso (2002)	South Africa, 1971:Q1-2000:Q4	Johansen maximum likelihood	Unstable M3 demand
Ramachandran (2004)	India, 1951-52 to 2000-01	Gregory-Hansen cointegration and ECM	Stable M3 money demand
Brand and Cassola (2004)	Euro area, 1980:Q1-1999:Q3	Structural VAR and cointegration analysis	Stable M3 money demand
Bahmani-Oskooee and Rehman (2005)	Seven Asian countries: India, Indonesia, Malaysia, Pakistan, Phillippines, Singapore and Thailand; 1973-2000 Quarterly data	ARDL cointegration test and ECM	Stable M1 and M2 monetary aggregates
Bae and Jong (2007)	US, 1946-1997	NCLS, SOLS, DOLS and FMOLS	Stable long run M1 money demand

Table 1: Literature Review

Studies	Countries and sample covered	Methodology	Conclusion
Narayan (2008)	Fiji, 1971-2002	OLS and Bounds test	Unstable M1 money demand
Hamori and Hamori (2008)	11 European Union: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain, 1999:M1-2006:M3	Panel cointegration test, FMOLS	Stable M1, M2, and M3 monetary aggregates
Drama and Yao (2010)	Côte d'Ivoire, 1980-2007	Johansen maximum likelihood	Unstable M2 money demand
Gaurisankar and Kwie-Jurgens (2012)	Suriname, 1981-2010	Unit root test, EG cointegration and VECM	Unstable Real base money, M1, and M2 demand
Ball (2012)	US, 1959-1993	Partial adjustment model and cointegration test	Stable short-and long-run M1 money demand
Kumar and Weber (2013)	Australia and New Zealand, 1960-2009	Unit root test with and without break, Gregory-Hansen cointegration test	Unstable M1 for 1984-1998, thereafter stable money demand
Serletis and Gogas (2014)	US, 1967 to 2011	Johansen maximum likelihood approach	Stable Divisia money demand at M2M, M2, and MZM level
Bahmani-Oskooee et al. (2015)	UK, 1997:Q1-2013:Q3	Unit root test and ARDL cointegration test	Stable M2 monetary aggregate
Aggarwal (2016)	India, 1996-2013	Unit root test with and without break, DOLS	No long run relationship for M1
Haider et al. (2017)	India, 2004:M4-2015:M11	Unit root test and NARDL cointegration tests	Stable M1 and M3 money demand
Jadidzadeh and Serletis (2019)	US, 1974:M6-2017:M5	Full information maximum likelihood	CFS Divisia M4 concluded as the broadest and consistent measure of money
Belongia and Ireland	US, 1967:Q1-2019:Q1	Unit root test, ARDL	Stable Divisia M3

Table 1: Literature Review

Studies	Countries and sample covered	Methodology	Conclusion
(2019)		cointegration test	and MZM money demand
Adil et al. (2020,a)	India, 1996:Q2-2016:Q3	Unit root tests and ARDL cointegration tests	Stable M1 and M3 money demand
Adil et al. (2020,b)	India, 1996:Q2-2016:Q3	Unit root test and NARDL cointegration tests	Stable M3 demand
Fuente et al. (2020)	US, 1990:Q1-2017:Q2	Unit root test, OLS and ECM	Stable CFS Divisia M3 aggregate, Unstable simple sum M3

3. Dataset, model specification, and econometric methodology

3.1 Dataset and model specification:

Table 2 outlines the countries, variables, data sources, and time periods under study.

Table 2: Data description

Country	Variable	Database	Time period
Euro Area	M1, M3, GDP, 3IR, LTIR Div M1, Div M3 REER, CPI	OECD Bruegel BIS	2001: Q1 - 2018: Q2
India	M1, M3, GDP Div M2[5], Div M3 TB-364, G-Sec 10 REER, CPI CMR	OECD Ramachandran et al. (2010) EPWRF BIS HSIE	1996: Q2 - 2008: Q2
Israel	M1, M3, GDP, 3IR Div M1	OECD Bank of Israel	1995: Q1 - 2014: Q3

[5] As the narrow-Divisia (Div M1) is unavailable for India, we begin with Divisia M2 denoted by Div M2.

	REER, CPI	BIS	
Poland	M1, M3, GDP, OIR, 3IR Div M1, Div M3 REER, CPI	OECD Narodowy Bank Polski BIS	1997: Q1 - 2018: Q4
UK	M1, M3, GDP, 3IR, LTIR Div M3 REER, CPI	OECD Bank of England BIS	1994: Q1 - 2019: Q1
US	M1, M3, GDP, 3IR, LTIR Div M1, Div M3 REER, CPI	OECD Center for Financial Stability BIS	1994: Q1 - 2019: Q1

Notes: (a) OECD denotes Organisation for Economic Co-operation and Development; EPWRF denotes Economic and Political Weekly Research Foundation; BIS denotes Bank for International Settlement; HSIE denotes Handbook of Statistics on Indian Economy; (b) M1 denotes simple sum monetary aggregate M1; M3 denotes simple sum monetary aggregate M3; GDP denotes gross domestic product; 3IR denotes 3 month interbank rate; LTIR denotes long term interest rate; Div M1 denotes Divisia monetary aggregate M1; Div M3 denotes Divisia monetary aggregate M3; REER denotes real effective exchange rate; CPI denotes consumer price index; TB-364 denotes 364 Day Treasury Bill rate; G-Sec 10 denotes 10 year government securities; CMR denotes weighted average call money rate; OIR denotes overnight interbank rate; (c) All series are quarterly and seasonally adjusted; (d) The time period differs in case of different countries depending on the availability of the data; (e) For India and the UK, narrow-Divisia (Div M1) is unavailable and for Israel broad-Divisia (Div M3) is unavailable.

Laidler (1982) suggested that a “stable demand for money function” implies, at the very least, that money holdings can be explained, to conventionally acceptable levels of statistical significance, by functional relationships including a relatively small number of arguments. Further, he mentioned: “In practice a ‘small’ number of arguments has meant three or four—typically including a scale variable such as income, permanent income or wealth, an opportunity cost variable such as a nominal interest rate or some measure of the expected inflation rate, and, if the nominal balances have been the dependent variable, the general price level.”[6] In addition to the scale and opportunity cost variables, Mundell (1963) proposed that demand for money might also be dependent on the exchange rate. An open economy money demand specification would therefore incorporate foreign interest rates and the exchange rate, in order to take into account the wealth-holders’ portfolio-adjustment responses to changes in returns on domestic and foreign assets (Hossain (2012), Bahmani-Oskooee (2001)).

[6] See Laidler (1982, pp. 39-40).

This study specifies an open economy version of the specification for money demand, rather than the closed economy version used in most prior studies. An open economy money demand specification has performed well in several countries (see Bahmani-Oskooee & Malixi (1991)). An objective is to capture the financial liberalization that occurred in the late 1980s and 1990s across the globe. A scale variable, an opportunity cost variable, and the exchange rate are included in the present analysis.

The log-linearized version of a conventional long-run money demand function is specified and applied with simple sum and Divisia monetary aggregates:

$$ln\, M_{jt} = \alpha_0 + \alpha_1 ln\, Y_t + \alpha_2 R_t + \alpha_3 ln\, E_t \; . \qquad (1)$$

With ln being the natural logarithm operator, we define M_{jt} to be real money balances for time period t, with j=N designating narrow simple-sum money, j=B designating broad simple-sum money, j=DN designating narrow Divisia money, and j=BN designating broad Divisia money.[7] We define "narrow" to be M1 and "broad" to be M3, while Y_t stands for real GDP during period t, R_t stands for interest rate during period t,[8] and E_t stands for the real exchange rate (REER)[9] during period t. The structural parameters are α_n, for n = 0,1,2,3.

[7] The log of real money balances are calculated by subtracting the log of the CPI from the log of nominal money balances.

[8] Belongia and Ireland (2016) advocate the use of user cost as the opportunity cost variable in the demand for Divisia money instead of the interest rates. That choice would be consistent with the literature on microeconomic foundations for money demand, as mentioned above and summarized in Barnett (1997). However, official data sources on user cost are available for very few countries in our analysis and are not used in the conventional approach to modeling money demand addressed in our paper. To obtain comparability to the conventional literature arguing for unstable money demand, we use the standard interest rates as the opportunity cost variable. We are not thereby advocating the conventional specification, but rather investigating its conclusions on its own grounds. Our study uses various interest rate proxies, depending on the availability of the data in different countries. Usually demand for narrow-money (simple M1 and Divisia M1) is estimated using a short-term interest rate, while demand for broad-money (simple M3 and Divisia M3) is estimated using a long-term interest rate. The conventional rationale for that choice is the fact that many components of broad money are associated with long-term interest rates, such as time deposits.

All series are at quarterly frequency and seasonally adjusted. The equation above depicts the long run relationship. The goal of this study is to examine the short-and long-run dynamic relationship between real money balances and their determinants/covariates, including real income, interest rate, and exchange rate. We also explore the stability of each relationship, including its elasticity of real money balances with respect to real income, its elasticity of real money balances with respect to the interest rate, and its elasticity of real money balances with respect to the exchange rate.

Rule-based monetary policies focus not so much on the short-run demand for money specification, but rather on the long-run equation (Laidler (1993)). The present study attempts to check whether the long run money demand is sufficiently stable for each model to be used to predict output gaps or inflation gaps under an inflation targeting framework.

In the specified money demand equation, economic theory indicates that scale and opportunity cost variables should be positively and negatively related, respectively, to real money balances. The sign of the coefficient of exchange rate is ambiguous (Arango and Nadiri (1981)). It may have a positive or negative relationship with respect to real money balances, indicating whether a currency substitution effect or a wealth effect outweighs the other in management of wealth-holder portfolios of domestic and foreign assets. The wealth effect reflects the fact that domestic currency depreciation increases the value of foreign currency-denominated assets held by domestic residents. If the result is an increase in wealth, the demand for domestic money will increase through the wealth effect (Arango and Nadiri (1981)). But if the expectation of further depreciation of domestic currency dominates, then the domestic agent will substitute foreign currencies for domestic currency, thereby decreasing demand for domestic

[9] An increase in the REER value denotes an appreciation of the currency of the country against the currencies of its trading partners.

currency. The result is known as the *currency substitution effect*. In short, demand for money can move in either direction, depending on the dominance between these two effects.

3.2 Econometric Methodology

In time series econometrics, there are two frequently used cointegration techniques to establish the long-run equilibrium relationship among variables: the Engle-Granger two-step residual-based procedure (Engle and Granger (1987)) and Johansen's system-based reduced rank regression approach (Johansen (1988); Johansen and Juselius (1990)). These two approaches are based on the assumption that the variables under consideration are I(1); that is, they have unit roots. However, the restrictive nature of that assumption, which needs to be tested, has led to a newer, more general approach. A voluminous research uses that recently developed technique, the autoregressive distributed lag (ARDL) approach to cointegration. The ARDL approach, developed in a series of articles by Pesaran and Shin (1996), Pesaran and Smith (1998), and Pesaran et al. (2001), has several advantages over the conventional methods of cointegration testing. The technique can be applied irrespective of the order of integration of the series, whether the series are I(1) processes, or I(0), or a mix of both.

Following Pesaran and Pesaran (1997), the unrestricted error correction form of the money demand equation and its determinants can be specified in the following log-linearized form:

$$\begin{aligned}\Delta ln\, M_t &= C_0 + \sum_{i=1}^{n_1}\phi_{1i}\Delta ln\, M_{j,t-i} + \sum_{i=0}^{n_2}\phi_{2i}\Delta ln\, Y_{t-i} + \sum_{i=0}^{n_3}\phi_{3i}\Delta\, R_{t-i} + \sum_{i=0}^{n_4}\phi_{4i}\Delta ln\, E_{t-i} \\ &\quad + \beta_1 ln\, M_{j,t-1} + \beta_2 ln\, Y_{t-1} + \beta_3 R_{t-1} + \beta_4 ln\, E_{t-1} + \varepsilon_t\,, \end{aligned} \quad (2)$$

where Δ is first difference operator, C_0 is the intercept in Equation (2), $\phi_{1i}, \phi_{2i}, \phi_{3i}$ and ϕ_{4i} are the coefficients of short-run dynamics of the underlying variables in the ARDL model, with lag lengths n_1, n_2, n_3, and n_4 respectively, and $\beta_1, \beta_2, \beta_3$ and β_4 are the coefficients of the long-run relationship of the variables in the cointegrating set. Lastly, ε_t represents the error term which follows white noise process.

First Step: The first step in ARDL is to estimate Equation (2) by using ordinary least squares (OLS) to confirm a long run relationship among the underlying variables. For that purpose, the Wald test (F-statistic) is used by setting the long-run coefficients of one-period lagged levels of the variables to zero as the null hypothesis. In Equation (2), where the log change of real money balances is the dependent variable, the null hypothesis of no cointegration is therefore $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$, against the alternative $H_1 : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$.

After confirming the long-run relationship among the variables, the F-statistic reflects which variable in the system should be normalized. We represent the F-statistic that normalizes on real money balances as $F_P(ln M_j | ln Y, R, ln E)$. The computed F-statistic is compared with critical values given in Pesaran et al. (2001). They provide the two sets of critical values. The lower critical bound assumes that the variables follow I(0) processes, while the upper critical bound assumes that the variables follow I(1) processes. Without knowing the order of integration of the explanatory variables, the decision can be made regarding cointegration, provided the computed F-statistic falls outside either of the two critical bounds. If the computed F-statistic exceeds the upper critical bound, then the null hypothesis of no cointegration will be rejected, so that cointegration exists between the variables. If instead the estimated F-statistic falls below the lower critical bound, then the null hypothesis of no cointegration cannot be rejected. But if the F-statistic falls in between the lower and upper bounds, the result will be inconclusive.

Second Step: After establishing cointegration using the F-statistic, the second step of ARDL modeling involves estimating the long-run equilibrium money demand relationship by using the following equation. The appropriate length of lags needs to be determined to estimate this long-run relationship:

$$ln\, M_{jt} = C_0 + \sum_{i=1}^{n_1} \phi_{1i} ln\, M_{j,t-i} + \sum_{i=0}^{n_2} \phi_{2i} ln\, Y_{t-i} + \sum_{i=0}^{n_3} \phi_{3i} R_{t-i} + \sum_{i=0}^{n_4} \phi_{4i} ln\, E_{t-i} + \mu_t\,, \qquad (3)$$

where μ_t is an error term.

Third Step: In the third step of this Bounds Testing approach, short-run dynamic parameters are obtained by estimating an error correction model (ECM) associated with long run estimates. The ECM is specified as follows:

$$\begin{aligned}\Delta ln\, M_{jt} = C_0 &+ \sum_{i=1}^{n_1} \phi_{1i} \Delta ln\, M_{j,t-i} + \sum_{i=0}^{n_2} \phi_{2i} \Delta ln\, Y_{t-i} + \sum_{i=0}^{n_3} \phi_{3i} \Delta R_{t-i} + \sum_{i=0}^{n_4} \phi_{4i} \Delta ln\, E_{t-i} \\ &+ \psi ECT_{t-1} + \mu_t\,,\end{aligned} \qquad (4)$$

where ψ is the coefficient of the error correction term (ECT_{t-1}), which measures the speed of adjustment to long-run equilibrium. That term measures the speed with which the dependent variable returns to equilibrium, following a shock to the system.

4. Empirical Analysis

The ARDL approach to cointegration can be implemented without identical order of integration of variables. Variables may be I(0), I(1), or a combination mix of both. However, the variables should not be I(2), since the computed test statistic would be invalid (Pesaran et al. (2001)). Therefore, it is important to test for the order of integration. To this end, we employ two kinds of unit root tests: the augmented Dickey-Fuller (ADF) test by Dickey and Fuller (1981) and the Phillips-Perron (P-P) test by Phillips and Perron (1988). Both tests' null hypothesis is that the series has a unit root. The results are provided in Table A1 in the appendix. The application of the unit root tests reveals that almost every level series is non-stationary, but becomes stationary after first differencing. Our research finds mixtures of I(0) and I(1) series for all countries except Israel, where all series follow I(1) processes. Thus, the application of the ARDL method is justifiable in each case.

Table 3 shows the Bounds Test for cointegration between real money balance and its determinants for the four models, when real balances are calculated using the simple-sum monetary aggregates, M1 and M3, and the Divisia monetary aggregates, Divisia M1 and Divisia M3. In case of the Euro Area, the F-tests for models M1 and Div M1 are equal to 1.36 and 2.57, respectively, implying that the joint significance of the lagged level variables is lower than its critical value of 2.72 at the 10% level of significance. Hence, there is no cointegration among the variables. The F-test values for models M3 and Div M3 are equal to 15.52 and 6.05, respectively, which are higher than the critical value of 3.77. Hence, for the Euro area, the variables are cointegrated for the broad-money models. The simple-sum broad money models reject the null hypothesis of no cointegration for all six nations. Except for Poland, the model with Div M3 shows cointegration results similar to those for the model with M3. The simple-sum narrow money models show existence of cointegration for India, Poland, the UK, and the US. While

Israel's simple-sum narrow money model, M1, does not capture any cointegration, its Divisia counterpart does.

Now focusing on India's Div M1 and Div M3 models, we find the F-test values to be 3.47 and 3.51 respectively, falling between the lower, 2.72, and upper, 3.77, critical bounds. They lie in the inconclusive region. In such an inconclusive case, following the study of Kremers et al. (1992) and Banerjee et al. (1998), the ECM term of the respective models is useful to establish cointegration. The ECM terms for these two models are negative and significant, confirming existence of cointegration.

Table 3: Bounds Test for cointegration relationship

Countries	Models			
	M1	M3	Div M1	Div M3
Euro Area	1.36	15.52***	2.57	6.05***
India	3.82*	6.15***	3.47#	3.51
Israel	1.57	6.88***	4.91**	-
Poland	12.56***	4.58**	8.12***	1.57
UK	6.31***	9.18***	-	6.28***
US	18.04***	7.91***	9.63***	5.68***

Source: Authors' Calculations

Notes: (a) Bounds tests are based on *F* statistics. The lower and upper critical bounds values of the F statistic at the 10% level of significance are 2.72 and 3.77 respectively; at the 5% level of significance are 3.23 and 4.35 respectively; at the 1% level of significance are 4.29 and 5.61 respectively. Critical values are extracted from Pesaran et al. (2001, Table CI [iii] - Case III, p. 300); (b) Div stands for Divisia; (c) Instead of Divisia M1, # denotes the F value for model Divisia M2. (d) Cointegration at the 1%, 5%, and 10% levels are denoted by '***', '**', and '*'.

The rejection of no cointegration in almost every model provides strong evidence of a long-run steady state relationship between real money balances and their determinants. The determinants, including the scale variable, opportunity cost variable, and exchange rate, are therefore confirmed as long-run forcing variables for real money balances. The second step of ARDL modelling involves estimating the long-run coefficients of equilibrating real money balance. Inferences about the coefficients are made and evaluated in the light of the relevant economic theories.

Table 4 provides the estimated coefficients of long-run real income, interest rate, and exchange rate for the equilibrium real money balances equation of the four models for all countries. In almost each model, the real income, and interest rate coefficients have their theoretically expected signs at each level of significance. The sign of the exchange rate coefficient is either positive or negative, reflecting either currency substitution or wealth effect respectively.

We find that, in the long-run, real income is the most important determinant of real money balances, followed by the exchange rate and interest rate. Laidler (1982) argues: "Parameters should not change too much for stable money demand function. The requirement that parameters not change 'too much' has meant not only that they have been expected to take their theoretically predicted sign, but also to stay within reasonable quantitative ranges as well, in the region of 0.5—1.0 or a little greater for the real income elasticity of demand for money, somewhere around -0.1— -0.5 or less for the interest elasticity depending upon the interest rate."[10] Using the M1 model for India as a point of reference, *ceteris paribus,* one percent change in real income will increase the real money balance by about 1.35%. Hence the magnitude of the income elasticity is greater than unity.[11] We also find that a one-unit change in interest rate, *ceteris paribus,* will decrease real money balances by about 0.6%. Similarly, a one percent change in exchange rate, *ceteris paribus,* will decrease the real money balances by about 0.097%, representing the wealth effect for India. Other coefficients can also be interpreted similarly.

Dekle and Pradhan (1999) observe that greater-than-unity coefficient of the scale variable could reflect technological advances that may have changed the relationship between nominal money and prices, as well as reflect changes in the financial markets and private sector's money-holding behavior. In an emerging economy, the income elasticity of demand for real money balances is generally greater than one. The reason could be evolving monetization of the

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[10] See Laidler (1982, pp. 39-40).

[11] Several other studies (see, Dekle and Pradhan, 1999; Hossain, 2012) also show similar coefficient of income elasticity.

economy and/or the lack of high-return financial assets in which household savings can be held (Hossain (2009)). The process of evolving monetization reinforces the need for transaction balances. The rate of money growth is therefore an indicator of financial development, reflecting, on the one hand, a reduction in the barter system and, on the other hand, an increase in the commercial banking system (Hossain (2012) quoting Goldsmith (1969); and Bordo and Jonung (2003)).

Since money can also act as a store of value in a low inflationary economy, demand for money can increase more than proportionately to an increase in income (Hossain (2012)). Nevertheless, there is no consensus on why the income elasticity of real money balances is greater than unity in the case of advanced economies. Friedman (1959, p. 348) argued that interpreting the greater than unity magnitude of real income coefficient within the transaction demand for money is difficult. A magnitude of real income coefficient greater than unity could reflect the liquidity of the real money balances along with other services of money. Baharumshah et al. (2009) argued that wealth effects may provide another justification for real income elasticity greater than unity. Hence, wealth could be another scale variable along with income in the specification of money demand, provided asset prices are increasing sharply. Consequently, failure to include wealth in the model could lead to biased income-elasticity estimates of real money balances, although it would be difficult in theory to justify including both income and wealth simultaneously in a demand function.

But attempts to justify high values of that elasticity in terms of theory may be misguided, since these demand for money functions are not directly derived from microeconomic theory. For example, the scale values in these models are not measures of the income of any "representative" economic agent in the economy, and hence the coefficient of the scale value in these models is only loosely interpreted as an "income" elasticity. These "demand functions" are best viewed as purely empirical relationships widely used in policy and thereby very influential. See, e.g., Barnett (1997, 2000).

Table 4: Estimated long-run coefficients

Countries	Models	Regressors							
		ln Y		R		ln E		Constant	
Euro Area	M1	4.033	(0.00)	-0.066	(0.00)	-0.062	(0.75)	-58.869	(0.00)
	M3	2.295	(0.00)	-0.028	(0.00)	0.303	(0.02)	-34.952	(0.00)
	Div M1	2.691	(0.09)	-0.120	(0.17)	0.121	(0.82)	-38.757	(0.08)
	Div M3	1.204	(0.02)	-0.089	(0.00)	0.428	(0.06)	-18.578	(0.01)
India	M1	1.346	(0.00)	-0.006	(0.02)	-0.097	(0.50)	-22.528	(0.00)
	M3	1.133	(0.00)	-0.009	(0.20)	3.347	(0.01)	-34.741	(0.00)
	Div M2	1.376	(0.00)	-0.013	(0.00)	-0.044	(0.79)	-20.367	(0.00)
	Div M3	1.405	(0.00)	-0.016	(0.00)	-0.015	(0.93)	-20.847	(0.00)
Israel	M1	5.752	(0.42)	0.047	(0.82)	-3.793	(0.69)	-53.818	(0.32)
	M3	3.661	(0.42)	0.153	(0.65)	-1.252	(0.55)	-39.666	(0.40)
	Div M1	1.539	(0.00)	-0.021	(0.04)	0.153	(0.40)	-16.289	(0.00)
	Div M3	-	-	-	-	-	-	-	-
Poland	M1	3.586	(0.00)	0.063	(0.10)	1.078	(0.24)	-52.010	(0.00)
	M3	1.937	(0.00)	0.002	(0.51)	-0.175	(0.28)	-24.339	(0.00)
	Div M1	4.643	(0.19)	0.146	(0.54)	1.889	(0.63)	-68.067	(0.29)
	Div M3	2.165	(0.00)	-0.001	(0.92)	-0.810	(0.08)	-22.244	(0.00)
UK	M1	2.889	(0.00)	-0.015	(0.35)	0.257	(0.40)	-39.020	(0.00)
	M3	4.029	(0.00)	0.196	(0.10)	0.303	(0.68)	-54.415	(0.00)
	Div M1	-	-	-	-	-	-	-	-
	Div M3	2.033	(0.00)	-0.018	(0.28)	0.515	(0.29)	-26.069	(0.00)
US	M1	-0.697	(0.80)	-0.911	(0.39)	-1.897	(0.56)	23.555	(0.66)
	M3	0.049	(0.93)	-0.205	(0.00)	0.724	(0.09)	-3.389	(0.65)
	Div M1	7.836	(0.53)	0.913	(0.62)	-0.172	(0.95)	-120.638	(0.55)
	Div M3	1.027	(0.00)	-0.018	(0.25)	0.447	(0.02)	-15.230	(0.00)

Source: Authors' Calculation

Notes: (a) Value in parentheses is P-value of the null hypothesis that the parameter equals zero. (b) *ln* stands for natural logarithm

The next step in the ARDL model approach is estimation of the error correction model. The results are presented in Table 5. The estimated long-run error correction model shows the dynamic behavior of the money demand specification. According to Pesaran and Pesaran (1997), the short-run dynamics are essential for stability of the model's long-run coefficients. They suggested estimating the error correction mechanism (ECM) for this purpose, provided that the response variable has a long-run relationship with variables under study. In fact, Laidler (1993) argued that the problem of instability in the money demand relationship arose as a result of inadequate modeling of the short-run dynamics, explaining departures from the long-run equilibrium money demand relationship. Thus, ECM can serve as a test for parameter stability.

In most of the models, in the short run the estimated coefficients of real income and interest rate have their expected signs. The signs of the exchange rate coefficients are mixed, as also found in the long run. Nearly every estimated error correction model is robust with most of the short-term coefficients statistically significant in the dynamic relationship. The most important part of the error correction model is the error correction term (ECT), which is derived from the long-run relationship. In most of the models, the ECT term is correctly signed, i.e. negative, and statistically significant, thereby ensuring the attainment of a long-run equilibrium relationship in response to a system shock. The models with significant negative ECT coefficients are highlighted in bold.

The ECT coefficient measures the speed of adjustment of long-run real money balances, if disturbed by changes in its explanatory variables. As a reference point, the estimated value for the ECT coefficient in the case of the Euro Area is -0.122 for the M1 model. Hence, the speed of convergence of the relationship to its steady state equilibrium is 12.2 percent per quarter following a long-run deviation in the preceding period. In the case of India, the F-statistics for the Div M2 and Div M3 models lie between the lower and upper critical bounds, with the ECT being -0.590 and -0.495, respectively. Those estimates are statistically significant and negative. Accordingly, following Kremers et al. (1992) and Banerjee et al. (1998), the ECT term is helpful in establishing cointegration for the Div M2 and Div M3 models in India. The presence of a significant ECT term thus reinforces the presence of a long-run relationship between real money balances and its determinants. Thus, the given error correction model can be used to check whether the models are capable of tracking the movement of real money balances over the period considered.

Table 5: Error correction representation for the selected autoregressive distributed lag (ARDL) models

		Regressors										
Countries	Models	Δ ln (DV)		Δ ln Y		Δ R		Δ Ln E		ECT_{t-1}		Selected ARDL
Euro Area	**M1**	0.248	(0.03)	0.493	(0.04)	-0.025	(0.00)	-0.138	(0.02)	**-0.122**	**(0.02)**	[3, 0, 1, 1]
	M3	-	-	-0.333	(0.03)	-0.004	(0.00)	-0.063	(0.12)	**-0.127**	**(0.00)**	[1, 1, 1, 0]
	Div M1	-	-	0.134	(0.60)	-0.017	(0.01)	0.006	(0.79)	-0.050	(0.47)	[1, 0, 0, 1]
	Div M3	-	-	-0.285	(0.08)	-0.007	(0.00)	0.033	(0.05)	**-0.078**	**(0.00)**	[1, 1, 0, 0]
India	**M1**	-	-	0.554	(0.00)	-0.001	(0.48)	-0.040	(0.51)	**-0.412**	**(0.00)**	[1, 0, 0, 1]
	M3	-	-	0.143	(0.01)	-0.001	(0.28)	-0.302	(0.00)	**-0.126**	**(0.00)**	[1, 0, 6, 0]
	Div M2	-	-	0.812	(0.00)	-0.008	(0.00)	-0.026	(0.79)	**-0.590**	**(0.00)**	[1, 0, 0, 0]
	Div M3	-	-	0.696	(0.00)	-0.008	(0.00)	-0.008	(0.93)	**-0.495**	**(0.00)**	[1, 0, 0, 0]
Israel	M1	0.615	(0.00)	0.048	(0.45)	-0.013	(0.00)	-0.237	(0.01)	-0.008	(0.66)	[2, 0, 1, 2]
	M3	-	-	0.066	(0.10)	-0.007	(0.00)	-0.022	(0.33)	-0.018	(0.56)	[1, 0, 0, 1]
	Div M1	-	-	0.216	(0.00)	-0.014	(0.00)	0.021	(0.43)	**-0.140**	**(0.00)**	[1, 0, 0, 1]
	Div M3	-	-	-	-	-	-	-	-	-	-	-
Poland	M1			-0.188	(0.02)	-0.009	(0.00)	0.177	(0.00)	0.052	(0.08)	[1, 0, 2, 2]
	M3	0.181	(0.05)	0.207	(0.00)	-0.003	(0.03)	0.139	(0.00)	**-0.107**	**(0.00)**	[3, 0, 1, 2]
	Div M1			-0.101	(0.26)	-0.012	(0.00)	0.211	(0.00)	0.022	(0.53)	[1, 0, 2, 2]
	Div M3	0.341	(0.00)	0.173	(0.08)	-0.007	(0.01)	0.229	(0.00)	**-0.080**	**(0.08)**	[2, 0, 2, 2]
UK	**M1**	0.244	(0.01)	0.260	(0.00)	-0.001	(0.35)	-0.160	(0.02)	**-0.090**	**(0.00)**	[2, 0, 1, 0]
	M3	-	-	0.118	(0.01)	0.006	(0.00)	-0.239	(0.00)	**-0.029**	**(0.06)**	[1, 0, 1, 0]
	Div M1	-	-	-	-	-	-	-	-	-	-	-
	Div M3	-	-	0.664	(0.00)	-0.007	(0.00)	0.032	(0.06)	**-0.062**	**(0.06)**	[1, 1, 0, 1]
US	M1	-	-	-0.930	(0.00)	-0.005	(0.00)	0.135	(0.02)	-0.006	(0.39)	[1, 1, 1, 0]
	M3	**-**	**-**	-0.289	(0.03)	-0.010	(0.00)	0.162	(0.00)	**-0.030**	**(0.01)**	**[1, 1, 1, 1]**
	Div M1	-	-	-0.602	(0.00)	-0.004	(0.00)	0.142	(0.00)	0.004	(0.62)	[1, 1, 0, 1]
	Div M3	0.417	(0.00)	0.068	(0.00)	-0.008	(0.00)	0.030	(0.00)	**-0.066**	**(0.00)**	**[2, 0, 1, 0]**

Source: Authors' Calculation

Notes: (a) Values in ( ) are probability values; *Ln* stands for natural logarithm; Δ stands for the first difference operator (b) Values in [ ] represents the selected ARDL model, which is based on Schwarz Bayesian Criterion (SBC) (c) DV stands for dependent variable

Table 6 reports the results of diagnostic tests to gauge the accuracy and predictability of the estimated models. The diagnostic tests check for the presence of serial correlation, heteroscedasticity, functional form misspecification, and normality of the residual term. We use the Breusch-Godfrey statistic to test for serial correlation, the Breusch-Pagan-Godfrey statistic to test for heteroscedasticity, Ramsey's RESET statistic to test for misspecification in functional form, and the Jarque-Bera statistic to test for normally of the error structure. The bold highlighted results in Table 6 are for the models that passed all the diagnostic checks.

The M1 model passes all the diagnostic tests for every country except for the Euro Area, the UK, and the US. Except for Israel, the M3 model does not pass some of the diagnostic tests. The Div M1 model passes all of the diagnostic tests for all of the countries, except for the Euro Area, Poland, and the US, while the Div M3 model passes all of the tests in each country except for the UK. Overall, the regressions with Div M3 performed best in the diagnostic tests compared to any other monetary aggregate, and hence can be viewed as most reliable.

Table 6: Diagnostic testing

Countries	Models	Adj R^2	BG-LM		RESET		Jarque-Bera		BPG	
Euro Area	M1	0.999	1.272	(0.53)	0.164	(0.69)	27.480	(0.00)	15.863	(0.04)
	M3	0.998	13.187	(0.00)	2.215	(0.14)	0.841	(0.66)	9.586	(0.14)
	Div M1	0.998	12.093	(0.00)	0.845	(0.36)	0.379	(0.83)	5.532	(0.35)
	Div M3	**0.998**	**9.269**	**(0.01)**	**3.832**	**(0.05)**	**0.737**	**(0.69)**	**11.460**	**(0.04)**
India	M1	0.999	0.030	(0.98)	0.591	(0.45)	0.516	(0.77)	14.007	(0.02)
	M3	0.999	4.319	(0.12)	9.632	(0.00)	0.340	(0.84)	12.468	(0.25)
	Div M2	**0.998**	**2.751**	**(0.25)**	**2.941**	**(0.09)**	**0.720**	**(0.70)**	**2.653**	**(0.62)**
	Div M3	**0.998**	**0.666**	**(0.72)**	**1.958**	**(0.17)**	**1.787**	**(0.41)**	**2.914**	**(0.57)**
Israel	**M1**	**0.999**	**1.601**	**(0.45)**	**0.897**	**(0.35)**	**10.389**	**(0.01)**	**12.399**	**(0.13)**
	M3	**0.999**	**9.632**	**(0.01)**	**3.888**	**(0.05)**	**6.750**	**(0.03)**	**10.169**	**(0.07)**
	Div M1	**0.999**	**5.074**	**(0.08)**	**2.481**	**(0.12)**	**1.450**	**(0.48)**	**10.215**	**(0.07)**
	Div M3	-	-	-	-	-	-	-	-	-
Poland	**M1**	**0.999**	**3.539**	**(0.17)**	**2.537**	**(0.12)**	**2.309**	**(0.32)**	**7.413**	**(0.49)**
	M3	0.999	7.157	(0.03)	0.011	(0.92)	13.606	(0.00)	16.172	(0.06)
	Div M1	0.999	0.075	(0.96)	2.150	(0.15)	2.686	(0.26)	22.591	(0.00)
	Div M3	**0.9989**	**1.608**	**(0.45)**	**1.520**	**(0.22)**	**2.882**	**(0.24)**	**12.629**	**(0.18)**
UK	M1	0.999	3.664	(0.16)	0.165	(0.69)	130.835	(0.00)	12.617	(0.05)
	M3	0.999	7.225	(0.03)	8.425	(0.00)	27.702	(0.00)	16.260	(0.01)
	Div M1	-	-	-	-	-	-	-	-	-
	Div M3	0.999	18.902	(0.00)	7.014	(0.01)	7.174	(0.03)	13.433	(0.04)
US	M1	0.998	3.765	(0.15)	0.000	(0.98)	40.680	(0.00)	16.943	(0.01)
	M3	0.999	2.115	(0.35)	1.209	(0.27)	4.464	(0.11)	23.598	(0.00)
	Div M1	0.999	10.786	(0.00)	0.652	(0.42)	4.311	(0.12)	14.439	(0.03)
	Div M3	**0.999**	**1.306**	**(0.52)**	**3.100**	**(0.08)**	**2.800**	**(0.25)**	**6.027**	**(0.42)**

Source: Authors' Calculations.

Notes: (a) Values in parentheses are P-values of the null hypothesis that the parameter is zero. (b) *Adj* R^2 stands for adjusted R^2. (c) *BG-LM* is the Breusch Godfrey Serial Correlation Lagrange Multiplier test. (d) *RESET* is Ramsey's regression specification error test. (e) *Jarque-Berra* is used for testing normality. (f) *BPG* is the Breusch-Pagan-Godfrey test for heteroscedasticity.

After model estimation, to assess parameter constancy, Pesaran and Pesaran (1997) suggest applying the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) recursive residual tests (Brown et al.'s (1975)) to examine the structural stability of the error correction models. After estimating the models by ordinary least squares (OLS), we subjected the residuals to CUSUM and CUSUMQ. The robustness of the error correction models are reflected in Figure 1 in the appendix. That figure plots the CUSUM and CUSUMSQ of the recursive residuals. For nearly each country, each model suggests no systematic or haphazard changes in the coefficients of regression. In most models, the parameter estimates do not breach the 5% critical bounds for parameter stability.

5. Summary of the Results and Robustness Check

Table 7 summarizes the results of our analyzed models. We find from the Bounds Test, the error correction term, the respective model's diagnostic tests, and CUSUM and CUSUMSQ, that in most countries the Divisia monetary aggregates perform better than the simple-sum monetary aggregates. Both within the simple-sum monetary aggregates and the Divisia monetary aggregates, the broad monetary aggregate is stable and performs well. By both methods of aggregation, the broad estimates provide more robust results and provide coefficients more consistent with economic theory than the narrow aggregates.

Table 7: Summary

Model	Cointegration	Number of significant long-run and short-run coefficients out of 6	Negative and Significant ECM	Number of diagnostic tests satisfied out of 4	CUSUM	CUSUMSQ	Interpretation
Models with SBC lag selection criterion							
EURO							
M1	×	5	✓	3	✓	✓	Unstable
M3	✓	5	✓	3	✓	✓	Potentially Stable
Div M1	×	2	×	3	✓	✓	Unstable
Div M3	✓	6	✓	4	✓	✓	**STABLE**
India							
M1	✓	3	✓	4	✓	✓	**STABLE**
M3	✓	4	✓	3	✓	✓	Potentially Stable
Div M2	✓	4	✓	4	✓	✓	**STABLE**
Div M3	✓	4	✓	4	✓	✓	**STABLE**
Israel							
M1	×	2	×	4	✓	✓	Unstable
M3	✓	2	×	4	✓	✓	Unstable
Div M1	✓	4	✓	4	✓	✓	**STABLE**
Div M3	-	-	-	-	-	-	-
Poland							
M1	✓	5	✓	4	✓	✓	**STABLE**
M3	✓	4	✓	3	✓	✓	Potentially Stable
Div M1	✓	2	×	3	✓	✓	Unstable
Div M3	×	5	✓	4	✓	✓	Unstable
UK							
M1	✓	3	✓	3	✓	✓	Potentially Stable
M3	✓	5	✓	2	✓	✓	Potentially Stable
Div M1	-	-	-	-	-	-	-
Div M3	✓	4	✓	3	✓	✓	Potentially Stable
US							
M1	✓	3	×	3	✓	✓	Unstable
M3	✓	5	✓	3	✓	✓	Potentially Stable
Div M1	✓	3	×	3	✓	✓	Unstable
Div M3	✓	5	✓	4	✓	✓	**STABLE**

Overall, the broad Divisia monetary aggregate, Div M3, provides the best model for five locations (the Euro area, India, Israel, the UK and the US) out of the six used in the analysis.

Unstable demand for money was displayed in Table 7 by Div M3 for Poland, when the SBC lag selection criterion was used. However, Poland shows evidence of stable demand for money, when the AIC lag selection criterion was used. As further robustness checks, the results with the AIC criterion for all countries are given in Table 8 with the broad Divisia monetary aggregate, Div M3.

Table 8: Robustness Check

Models for DIV M3 with AIC lag selection criterion							
Model	Cointegration	No. of significant long-run and short-run coefficients out of 6	Negative and Significant ECM	Number of diagnostic tests satisfied out of 4	CUSUM	CUSUMSQ	Interpretation
Euro	✓	5	✓	4	✓	✓	**STABLE**
India	×	4	✓	4	✓	✓	**STABLE**[12]
Israel	✓	5	✓	4	✓	✓	**STABLE**
Poland	✓	5	✓	4	✓	✓	**STABLE**
UK	✓	1	✓	3	✓	✓	Potentially Stable
US	✓	4	✓	2	✓	✓	Potentially Stable

6. Conclusion

We find stable demand for broad money for the Euro Area, India, Israel, Poland, the UK and the US. The conclusion is based on the existence of long-term cointegration relationships between real money balances and real output, interest rate, and real effective exchange rate with the error correction mechanism. We find statistically significant and economically meaningful long-run and short-run coefficients of the independent variables. Demand for broad Divisia

[12] Although the F statistic's value, 3.51, lies between the two critical bounds, indicating inconclusive cointegration results, we conclude stable demand for Div M3 money on the basis of significantly negative ECM.

money delivers the best results in terms of achieving long-term cointegration, meaningful and significant long-run and short-run coefficients, significantly negative ECM, and satisfying all the diagnostic tests, including CUSUM and CUSUMSQ criteria.

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Appendix:

Table A1: Unit root test results (ADF and PP)

Country	Variables	ADF Statistics				PP Statistics			
		Level	P-Value	First Diff	P-Value	Level	P-Value	First Diff	P-Value
Euro Area	ln M1	-2.757	(0.22)	-4.983	(0.00)	-1.848	(0.67)	-4.859	(0.00)
	ln M3	-2.227	(0.03)	-	-	-1.556	(0.80)	-4.764	(0.00)
	ln GDP	-2.557	(0.30)	-3.700	(0.03)	-1.819	(0.69)	-3.783	(0.02)

	3IR	-3.082	(0.12)	-4.257	(0.01)	-2.336	(0.41)	-4.198	(0.01)
	LTIR	-2.308	(0.42)	-6.418	(0.00)	-2.023	(0.58)	-6.377	(0.00)
	ln Div M1	-2.857	(0.18)	-3.726	(0.03)	-1.683	(0.75)	-5.685	(0.00)
	ln Div M3	-4.030	(0.02)	-	-	-1.563	(0.80)	-7.558	(0.00)
	ln REER	-3.062	(0.12)	-6.641	(0.00)	-2.369	(0.39)	-6.641	(0.00)
India	ln M1	-1.349	(0.86)	-5.703	(0.00)	-1.388	(0.85)	-5.708	(0.00)
	ln M3	-2.553	(0.30)	-4.297	(0.01)	-1.804	(0.69)	-4.338	(0.01)
	ln GDP	-0.987	(0.94)	-4.035	(0.01)	-1.066	(0.92)	-6.668	(0.00)
	CMR	-4.779	(0.00)	-	-	-4.903	(0.00)	-	-
	TB-364	-2.536	(0.31)	-9.289	(0.00)	-2.419	(0.37)	-9.449	(0.00)
	G-Sec 10	-0.714	(0.97)	-5.949	(0.00)	-0.610	(0.97)	-5.950	(0.00)
	ln Div M2	-1.079	(0.92)	-4.500	(0.00)	-2.876	(0.18)	-23.779	(0.00)
	ln Div M3	-1.174	(0.90)	-4.344	(0.01)	-2.940	(0.16)	-22.477	(0.00)
	ln REER	-2.440	(0.36)	-5.459	(0.00)	-2.814	(0.20)	-5.446	(0.00)
Israel	ln M1	-3.128	(0.11)	-4.870	(0.00)	-2.050	(0.56)	-3.804	(0.02
	ln M3	-2.014	(0.58)	-5.182	(0.00)	-2.141	(0.51)	-5.254	(0.00)
	ln GDP	-2.887	(0.17)	-6.726	(0.00)	-2.477	(0.34)	-6.829	(0.00)
	3IR	-2.801	(0.20)	-7.097	(0.00)	-2.574	(0.29)	-6.754	(0.00)
	ln Div M1	-2.304	(0.43)	-5.780	(0.00)	-2.340	(0.41)	-5.728	(0.00)
	ln REER	-1.125	(0.92)	-7.606	(0.00)	-1.435	(0.84)	-7.667	(0.00)
Poland	ln M1	-3.105	(0.11)	-3.355	(0.06)	-2.124	(0.52)	-5.296	(0.00)
	ln M3	-3.458	(0.05)	-	-	-2.266	(0.45)	-5.940	(0.00)
	ln GDP	-2.196	(0.49)	-10.825	(0.00)	-2.221	(0.47)	-10.806	(0.00)
	3IR	-2.772	(0.21)	-4.767	(0.00)	-2.053	(0.56)	-4.872	(0.00)
	OIR	-2.593	(0.28)	-5.602	(0.00)	-1.746	(0.72)	-5.012	(0.00)
	ln Div M1	-3.817	(0.02)	-	-	-2.231	(0.47)	-7.021	(0.00)
	ln Div M3	-2.083	(0.55)	-4.847	(0.00)	-1.623	(0.78)	-8.051	(0.00)
	ln REER	-3.128	(0.11)	-7.090	(0.00)	-2.639	(0.26)	-6.831	(0.00)
UK	ln M1	-1.021	(0.94)	-6.970	(0.00)	-0.807	(0.96)	-6.866	(0.00)
	ln M3	-0.583	(0.98)	-6.801	(0.00)	-0.653	(0.97)	-6.800	(0.00)
	ln GDP	-1.840	(0.68)	-5.117	(0.00)	-1.771	(0.71)	-5.082	(0.00)
	3IR	-3.685	(0.03)	-	-	-2.757	(0.22)	-5.183	(0.00)
	LTIR	-3.341	(0.07)	-	-	-3.128	(0.11)	-8.805	(0.00)
	ln Div M3	-1.819	(0.69)	-3.745	(0.02)	-1.306	(0.88)	-6.114	(0.00)
	ln REER	-2.426	(0.36)	-6.115	(0.00)	-2.135	(0.52)	-6.114	(0.00)
US	ln M1	-1.977	(0.61)	-5.604	(0.00)	-1.732	(0.73)	-5.552	(0.00)
	ln M3	-3.179	(0.09)	-	-	-3.078	(0.12)	-6.396	(0.00)
	ln GDP	-1.910	(0.64)	-6.916	(0.00)	-2.062	(0.56)	-7.158	(0.00)
	3IR	-2.403	(0.38)	-5.531	(0.00)	-2.469	(0.34)	-5.432	(0.00)
	LTIR	-3.749	(0.02)	-	-	-3.293	(0.07)	-	-
	ln Div M1	-1.583	(0.79)	-5.385	(0.00)	-1.367	(0.86)	-5.323	(0.00)
	ln Div M3	-1.404	(0.85)	-5.300	(0.00)	-1.151	(0.91)	-5.221	(0.00)
	ln REER	-1.754	(0.72)	-7.472	(0.00)	-1.280	(0.89)	-7.473	(0.00)

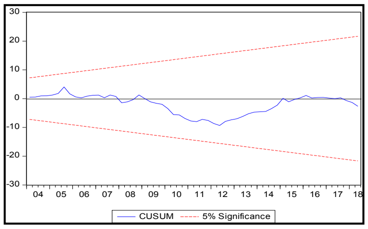
Notes: (a) P-Value stands for P-value of the null hypothesis that the parameter is zero.
(b) First Diff stand for first difference .

Figure 1: Plots of CUSUM and CUSUMQ for narrow money for different countries.

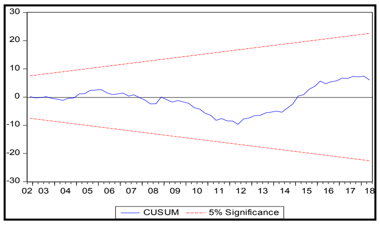
CUSUM		CUSUMSQ	
Narrow- Simple Sum	Narrow- Divisia	Narrow- Simple Sum	Narrow- Divisia

Euro Area

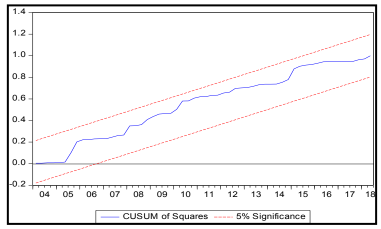
M1



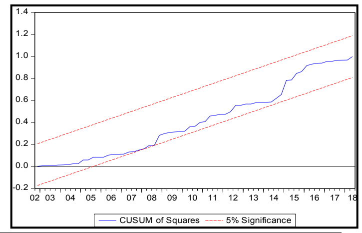
Div M1



M1

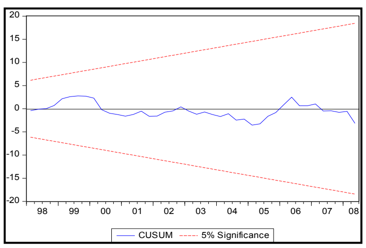


Div M1

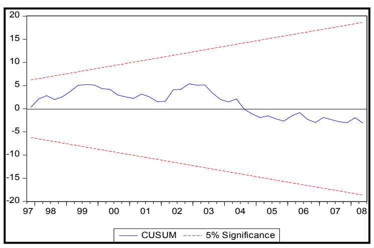


India

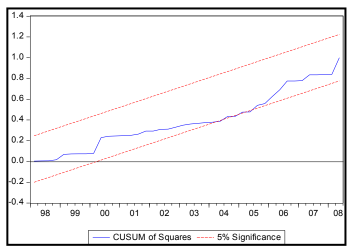
M1



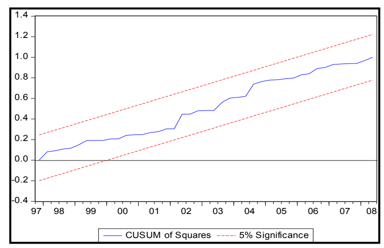
Div M2



M1

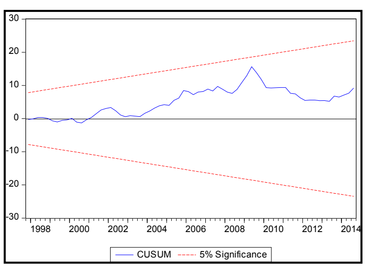


Div M2

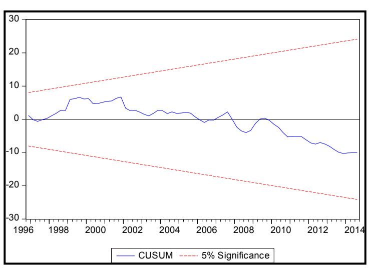


Israel

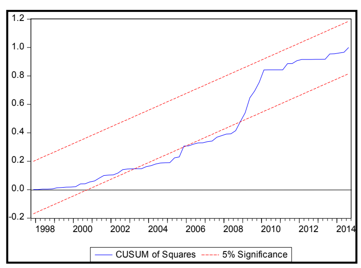
M1



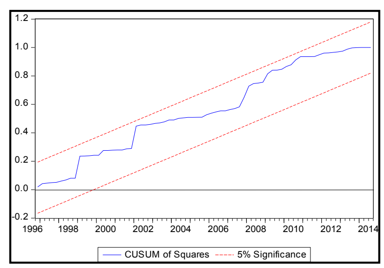
Div M1



M1

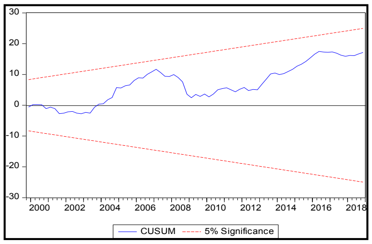


Div M1

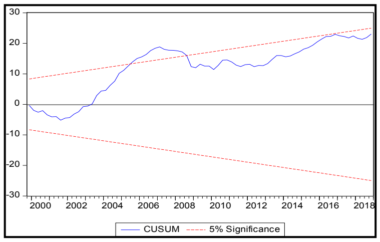


Poland

M1



Div M1



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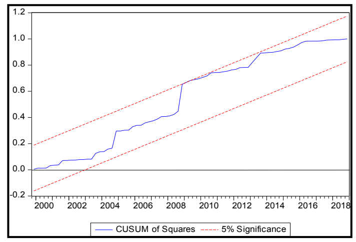

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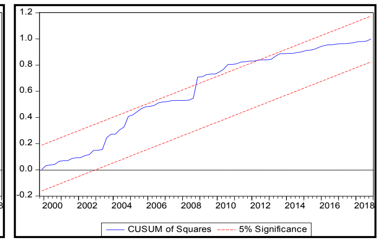
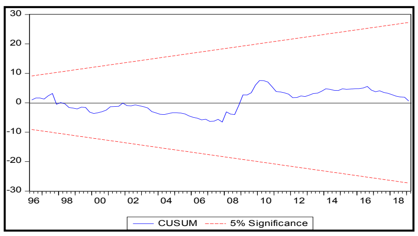


UK

M1



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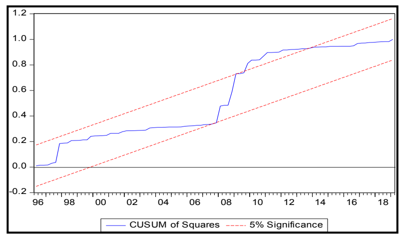
M1



Div M1

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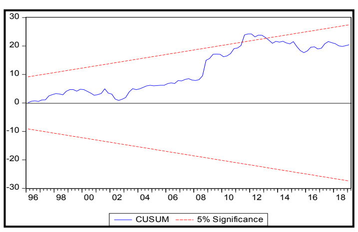
US

M1



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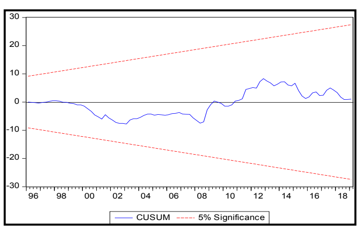

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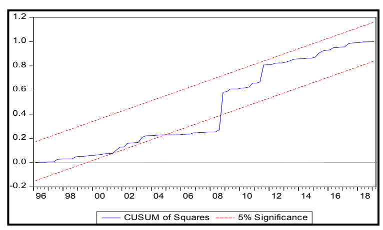

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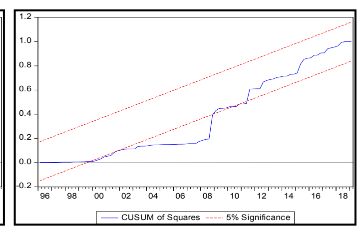
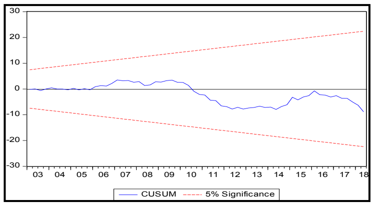
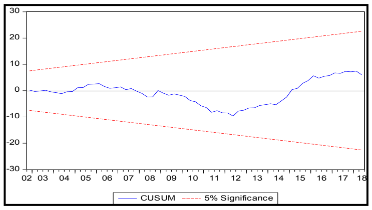
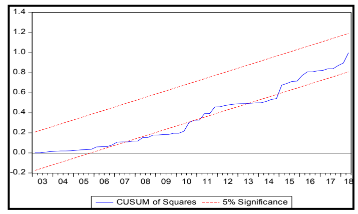
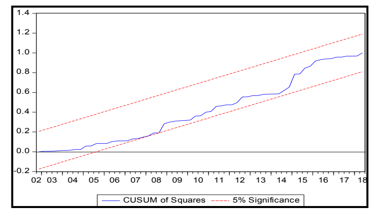
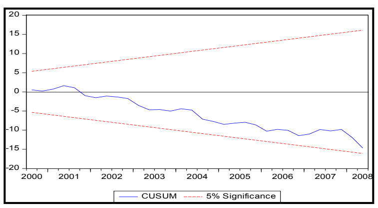
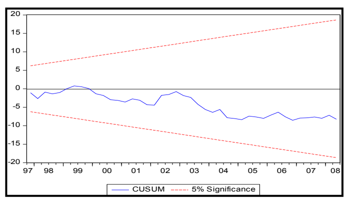
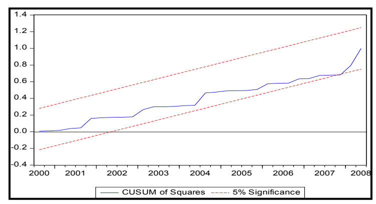
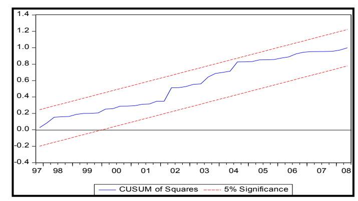
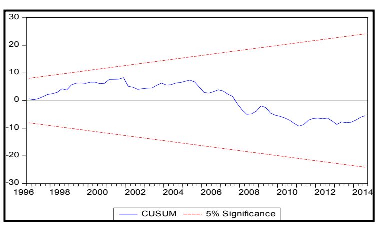
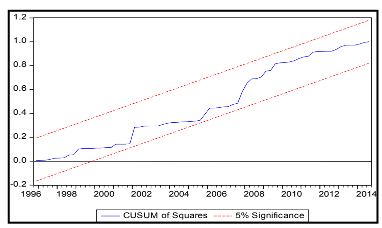
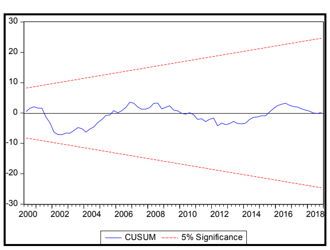
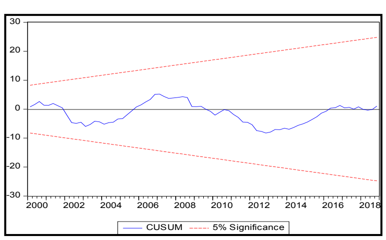
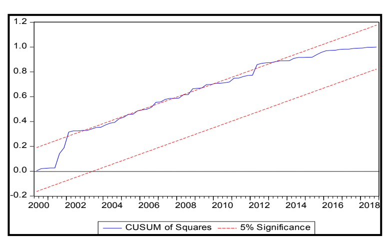
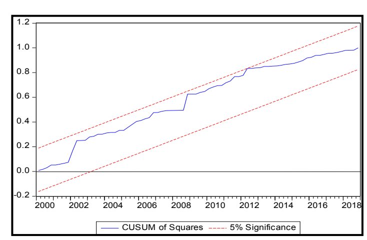


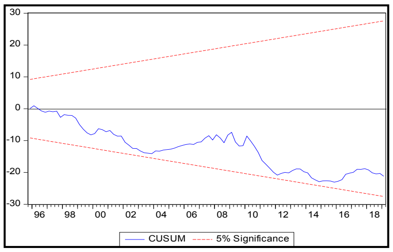
Source: Authors' Calculation

Figure 2: Plots of CUSUM and CUSUMQ for broad money for different countries.

CUSUM		CUSUMSQ	
Broad- Simple Sum	Broad - Divisia	Broad - Simple Sum	Broad - Divisia
Euro Area			
M3	Div M3	M3	Div M3
			
India			
M3	Div M3	M3	Div M3
			
Israel			
M3	Div M3	M3	Div M3
	Not Available		Not Available
Poland			
M3	Div M3	M3	Div M3
			

UK

M3



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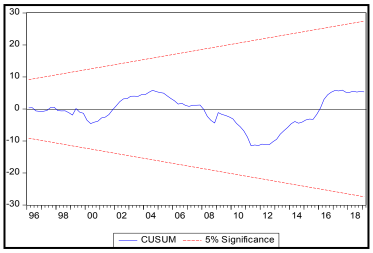
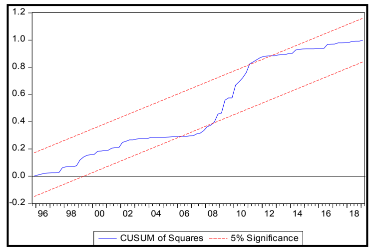
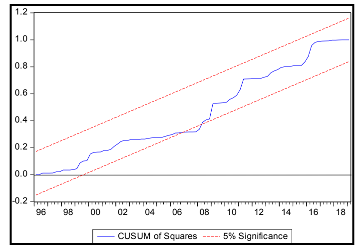


M3

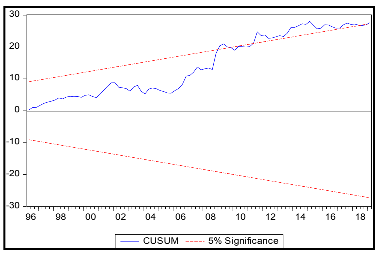


Div M3



US

M3



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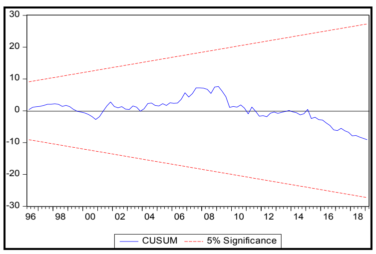
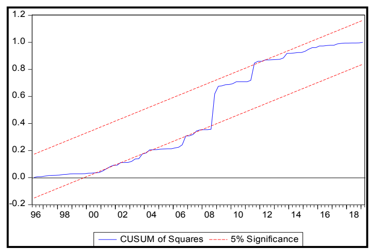
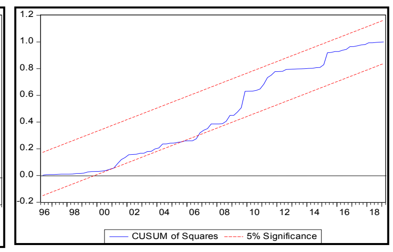


M3



Div M3



Source: Authors' Calculation