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Research Article

Uncertainty and Money Demand Function in Developing Countries [a]

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As monetary policy authorities influence many macroeconomic variables by determining monetary aggregates, their relationships with other macroeconomic variables are critical in setting the most appropriate monetary policy rules. Identifying the variables affecting money demand and having a stable money demand function is essential for monetary policy. This paper examines the stability of the money demand function for 12 developing countries over the sample 2006.Q1-2023.Q3. We employ the Autoregressive Distributed Lag Model and the Cross-Sectionally Autoregressive Distributed Lag Model because of the different degrees of integration of the selected variables. According to the results, there is a stable long-run relation in the money demand function for selected developing countries. The uncertainty variable, which is the study's primary objective, affects money demand negatively in the long run; it does not temporarily affect the demand for money. The findings also indicate that the real GDP (inflation) positively (negatively) impacts demand for real monetary aggregates as expected. The real interest rate measuring the opportunity cost of holding money does not significantly affect money demand. Although the effect of the exchange rate is positive in the short run, it turns negative as time passes and in the long run. This finding supports the 'wealth effect' in developing countries.

JEL codes: C23, E41, E52

Keywords: Money demand, Developing countries, ARDL model, Cointegration

1 Introduction

Since crises and structural transformations profoundly impact a country's economy, appropriate economic policies should be implemented to eliminate or mitigate their effects. The most essential component of these economic policies is monetary policy, which requires understanding the preferences of domestic economic agents for money demand.

The components and strength of the money demand function are essential for economists and policymakers to develop and conduct appropriate monetary policy. In the empirical literature, the cointegration analysis has been designed to estimate the function of money demand. Research indicates that the strength of money demand has a few implications

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(Azimi, 2023). First, if the money demand function is stable, it allows appropriate monetary policy instruments (Kumar et al., 2013). Second, the strength of the money demand function provides for estimating the impacts of shocks on the money supply process in any economy (Narayan, 2010). Finally, when the money demand function is stable, it tenders information about the direct relation between the quantity of monetary aggregates and inflation (Albulescu & Pépin, 2018).

The function of money demand has been widely estimated in the empirical literature due to its critical importance. According to the traditional money demand function, the reaction of demand for monetary aggregates to the real income and interest rate is investigated by cointegration methods. There are contradictory results in the empirical literature when this traditional money demand function is estimated. For instance, Fair (1987) indicates that income elasticity is zero, and Bahmani-Oskooee & Pourheydarian (1990) imply that it is over zero. In the later studies, some researchers could not find a stable cointegration relation between money demand and selected variables (Miyao, 1996).

Bahmani-Oskooee & Nayeri (2020) claim that the reason for not finding a stable cointegration relationship was the omitted variables, which has been widely studied in the literature. Bahmani-Oskooee & Shabsigh (1996) augment the money demand function with the exchange rate, and they find a stable cointegration relation with real gross domestic product (GDP), interest rate, and nominal exchange rate. Uncertainty changes people's preferences to hold money depending on their future economic activity expectations. The primary purpose of including uncertainty in the model is to evaluate the impact of volatility of monetary aggregates on the function of money demand. According to Bahmani-Oskooee & Nayeri (2020), the theoretical background to augment the model with uncertainty goes back to Friedman (1984), which stated that the unpredictability of monetary aggregates affects the volatility of the velocity of money, and therefore, it induces the demand for money. Thus, the volatility of monetary aggregates has been used in empirical literature to measure uncertainty. The results of Choi & Oh (2003), which augment the function of money demand with the volatility of GDP to measure uncertainty, imply that it has a negative impact, but the uncertainty of monetary aggregates has a positive effect on demand for money. After this research, numerous researchers have analyzed the influence of both monetary and GDP uncertainties; Bahmani-Oskooee & Xi (2011) for the Australian economy; Özdemir & Saygılı (2010) for Turkey; Bahmani-Oskooee et al. (2013) and Bahmani-Oskooee & Xi (2014) for selected developing countries; and Bahmani-Oskooee & Baek (2017) for Korea, Tan et al. (2020) for South Africa, and Gan et al. (2021) for developed and developing countries. In addition to this paper, Hossain & Arwatchanakarn (2020) investigated the effect of inflation uncertainty on demand for monetary aggregates.

In recent years, studies have developed the function of demand for monetary aggregates with the Economic Policy Uncertainty (EPU) index instead of GDP and monetary uncertainties because uncertainty is not just due to the GDP or monetary volatility (Bahmani-Oskooee & Nayeri, 2020). Economic Uncertainty Group constracts EPU Index based on Baker et al. (2015) and calculates the uncertainty level of many countries. The higher value of EPU represents a high uncertainty level, and the lower value of EPU gives a low uncertainty level. The first papers to use the EPU Index are Bahmani-Oskooee et al. (2015), which augmented the function of demand for monetary aggregates with EPU for the United Kingdom, and Ivanovski & Churchill (2019), which added EPU to the model for Australia and found that it negatively affects the short run and positively affects the long run.

Therefore, the essential objective of this study is to examine the influence of the World Uncertainty Index (WUI) on money demand in addition to the traditional explanatory variables in developing countries. We have two contributions to the existing literature. First, we prefer the WUI over output volatility, monetary volatility, or EPU. Although EPU is a good indicator for measuring uncertainty, it is not constructed for all countries, especially developing countries. The WUI was built by the Economic Intelligence Unit (EIU), which relies on Ahir et al. (2022) and has been available for 143 countries since the first quarter of 1952. The WUI has two crucial advantages over EPU. First, this index depends on the research of a single institution, EIU, and it is calculated based on country-specific economic and political developments. Second, a specific structure and process is considered when the WUI is conducted for respective countries. This structure of the WUI facilitates comparisons across countries and over a period of time (Ahir et al., 2022, p. 3). The evolutions of WUI in selected developing countries are represented in Figure 1.

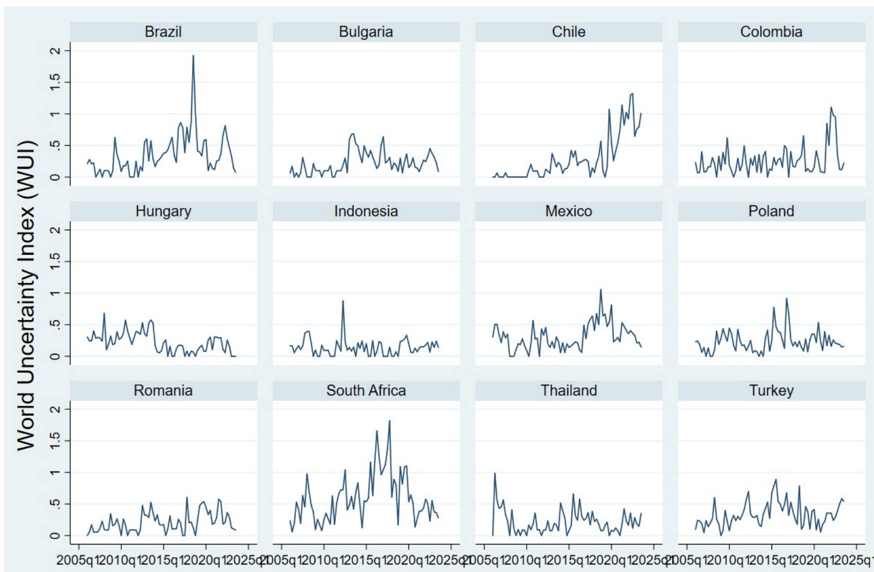

Figure 1: World Uncertainty Index for Developing Countries
Source: WUI (2023)

The second contribution to the existing literature is employing a cross-sectionally augmented autoregressive distributed lag (ARDL) model to search the money demand function. Mostly, traditional linear and non-linear ARDL models are applied among time series models. At the same time, primarily mean group and pooled mean group estimators are applied among panel series models in the empirical literature. In the related literature, cross-country heterogeneity and cross-section dependence are not considered when employing panel data models. We prefer to estimate the ARDL and cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model. We first prefer these models because they allow estimation even if the selected variables are stationary at level or first order. Traditional cointegration methods, on the other hand, only allow estimation with first-order stationary series. The second reason for using these models is to use heterogeneous panel data models considering coefficient heterogeneity and cross-sectional dependence.

The outcomes obtained from this study can be listed as follows. First, using the most recent dataset for developing countries over the sample 2006.Q1-2023.Q3, the findings verify that the function of money demand is stable in the long run for the selected 12 countries. A stable long-run relationship exists between real monetary aggregates, real income, real interest rate, inflation rate, exchange rate, and uncertainty variable. Second, WUI negatively and significantly impacts demand for monetary aggregates in both periods. It means that the influence of WUI is not temporary. Third, real income affects money demand function positively in the short and long run. Fourth, while one of the variables expressing the opportunity cost is inflation, which negatively affects money demand, the other opportunity cost indicator, the real interest rate, has no statistical effect. Finally, although the impact of the exchange rate is positive in the short run, it turns negative as time passes and in the long run. This finding supports the 'expectation effect' in the short run and the 'wealth effect' in the long run in developing countries.

The rest of the study is planned: Section 2 summarizes related research. Section 3 introduces the dataset and the techniques applied in the study. Section 4 gives the empirical outcomes. Section 5 outlines the research and presents policy implications.

2 Literature Review

2.1 Theoretical Literature

The money demand function enables monetary authorities to understand the behavior of economic agents that leads them to hold money and to set appropriate monetary policy. Moreover, according to the quantity theory of money, the money demand function affects the money supply and impacts inflation and economic growth. Therefore, it is essential to identify the variables affecting the stability of the money demand function and the theoretical framework behind it. There are many theoretical approaches to money demand, such as Keynesian, monetarist, new classical, and new Keynesian. Despite these theoretical differences, modern quantity theory stands out by combining the classical economists' quantity theory of money, rational expectations, and the criticisms of the new Keynesian approaches.

In addition to this theoretical diversity, the choice of variables to estimate the stability of the money demand function is also essential because many variables affect money demand. In the early studies on money demand in the related literature, real interest rate and real income were preferred among macroeconomic variables. Mundell (1963) augmented the money demand function with the exchange rate. It was assumed that demand for monetary aggregates depended on exchange, domestic interest rates, and income. Hamburger (1977) included the foreign interest rate in the model to examine the effect of the alternative domestic currency cost on the money demand function. According to the results, if the demand function is augmented with domestic and foreign interest rates, only domestic interest rates statistically affect money demand.

Arango & Nadiri (1981) extended the exchange rate and foreign interest rate model in addition to traditional variables for four developed countries. The results indicated that the exchange rate does not significantly affect the demand for money. According to Hueng (1998), the reason for the insignificant coefficient of the exchange rate variable is that the studies were conducted in the period when the fixed exchange rate system was in effect. Bahmani-Oskooee (1991) estimated the money demand function over the 1973-1987 period and eliminated the problem by showing that the exchange rate should be added to the money demand function during the floating exchange rate period. According to Bahmani-Oskooee et al. (2019) and Bahmani-Oskooee & Nayeri (2020), the exchange rate has two effects: 'the wealth effect' and 'the expectation effect'. The exchange rate influences the demand for holding domestic currency negatively and significantly in the long run. It means that there is a 'wealth effect' in developing countries. When the domestic currency depreciates in these countries, the value of foreign assets increases in terms of the domestic currency. Hence, developing countries' households think their wealth will increase and demand more domestic currency. The empirical literature shows that the effects of interest and exchange rates on the stability of the money demand function have been analyzed.

The inflation rates are added to the money demand function to measure the opportunity cost for real goods. Bahmani-Oskooee & Rehman (2005) implied that the inflation rates should be included in the model as the opportunity cost of holding money since financial markets are not developed in developing countries.

Bahmani-Oskooee & Nayeri (2020) implied that the money demand function cannot be estimated because of the omitted variables, one of which is uncertainty since, theoretically, it significantly affects monetary aggregates (Friedman, 1984). In the empirical literature, different omitted variables are added to the money demand function, such as volatility of monetary aggregates, volatility of output, and EPU.

2.2 Empirical Literature

Several researchers in the related literature investigate the function of money demand. We can divide these studies into two groups: one concerns developed countries, and the other concerns developing countries. This section first summarizes the empirical literature on developed countries and then on developing countries.

Oxley (1983) investigated money demand preferences for the United Kingdom from 1963-1979 and showed that structural breaks are observed in the function of money demand. Bahmani-Oskooee & Bohl (2000) analyzed the M3 money demand employing the Error Correction Model (ECM) over 1969.Q1-1995.Q4 and found that the money demand function in Germany is not stable. Preferences about the demand for money in the US economy have also been analyzed (e.g., Hafer & Jansen, 1991; Lütkephol, 1993; Choi & Cook, 2007; Rao & Kumar, 2009; Scheiblecker, 2017; Benchimol & Qureshi, 2020). Bae et al. (2006) employ both linear and nonlinear cointegration methods for Japan and found that the nonlinear estimation methods perform better than the linear ones. Kurihara (2016) showed that preferences about money demand in Japan are stable, and these results are consistent with traditional economic theory.

In addition to examining single-country cases in the literature, the preferences for money demand have also been analyzed for groups of developed countries. The stability relation for European countries (e.g., Fagan & Henry, 1998; Vlaar & Schuberth, 1999; Brand & Cassola, 2000; Hubrich & Vlaar, 2000; Brand & Cassola, 2000; Coenen & Vega, 2001; Holtemoller, 2004; Greiber & Lemke, 2005; Carstensen, 2006; Dreger et al., 2006; Dreger & Wolters, 2010; Avouyi-Dovi et al., 2012; Perez, 2014; Daniele et al., 2017; Mera et al., 2020) and for OECD countries (e.g., Dobnik, 2013; Kumar et al., 2013; Gan, 2019) have been investigated using different methods and periods.

After analyzing the studies for developed countries, the literature review section follows studies for developing countries. Chaisrisawatsuk et al. (2004) investigate the relationship between monetary aggregates and selected variables under the assumption of currency substitution and capital mobility and found that these assumptions are crucial for Asian countries. Bahmani-Oskooee & Rehman (2005) and Tang (2007) also analyze the preferences of money demand relations for Asian countries employing cointegration methods, and they find contradictory results. Abdullah et al. (2010) also examined the money demand relationship for the same countries employing the ARDL model and found a cointegration relation between real monetary aggregates and selected variables. The results of Arize & Nam (2012) investigating the model for Asian countries employing Fully Modified OLS and Dynamic OLS panel data methods from 1973 to 2009 showed that interest rates positively influenced the demand for money in both periods.

Bahmani-Oskooee & Gelan (2009) identified stable preferences for holding cash in African countries over the sample 1971.Q1-2004.Q3. Bahmani (2013) showed that real income, interest rate, exchange rate, and volatility of exchange rate impact holding cash only in the short run in 15 less-developed countries over the sample 1980-2009.

Bahmani-Oskooee et al. (2013) examined the holding cash preferences for ten emerging economies, and Hamdi et al. (2015) considered Gulf Cooperation Council countries. The results show that the preference for holding cash is stable in most Gulf Cooperation Council countries. Bahmani-Oskooee et al. (2019) searched the asymmetric effects of the exchange rates in emerging economies and found the asymmetric impact of exchange rate changes in the long run. Nepal & Paija (2020) using a panel ARDL model for South Asian countries over 1986-2017 revealed that real income positively, whereas interest rate and price level negatively impact the demand for holding cash in the long run.

Numerous studies have also been conducted for individual developing countries; for Crotia (Anusic, 1994), Taiwan (Arize, 1994), Indonesia (Hossain, 2007; Bahmani-Oskooee & Rehman, 2005), Argentina (Yu, 2022), Morocco (Zouhar & Kacemi, 2008), China (Zuo & Park, 2011; Bahmani-Oskooee et al., 2012, 2016), Saudi Arabia (Abdulkheir, 2013), the Republic of Macedonia (Kjosevski, 2013), Tunisia (Ben-Salha & Jaidi, 2014), Korea (Bahmani-Oskooee & Baek, 2017), Malaysia (Leong et al., 2019), Pakistan (Khan & Hye, 2013; Sarwar et al., 2013), Thailand (Jiranyakul & Opiela, 2014), Nigeria (Odularu & Okunrinboye, 2009; Jonah et al., 2020), India (Adil et al., 2020), and Turkey (Bahmani-Oskooee & Karacal, 2006; Algan & Gencer, 2011; Korap, 2011; Özcan & Arı, 2013; Gencer & Arısoy, 2013; Doğru & Recepoğlu, 2013; Talaş et al., 2013; Doğru, 2014; Tümtürk, 2017; Usta, 2022).

Since we analyze the impact of uncertainty in developing countries, we have presented the related literature on this issue separately. Bahmani-Oskooee & Xi (2011) searched for the effects of economic and monetary uncertainty on the Australian economy using the ARDL model and found both variables have considerable effects in both periods. Bahmani-Oskooee et al. (2013) showed that uncertainty variables' influence on selected developing countries is higher in the short run than in the long run. Bahmani-Oskooee & Xi (2014) questioned the influence of two uncertainty variables for six Asian countries using the ARDL model. According to the results, although almost all country's uncertainty variables have a short-run effect, the impact of these variables varies in the long run. The ARDL analysis of Bahmani-Oskooee & Baek (2017) for the Korean economy showed that these variables considerably impact demand for monetary aggregates in the short-run, but only economic uncertainty has long-run effects. Bahmani-Oskooee & Nayeri (2018) revealed that there was an asymmetric effect of uncertainty in Australia.

Tan et al. (2020) studied the economic uncertainty index using the GARCH method on the ARDL model for South Africa, and they found that the financial uncertainty index has a negative impact in the long run. Gan et al. (2021) searched the effect of output uncertainty for selected developed and developing countries using a pooled mean group estimator. They constructed their uncertainty variable using the grid search algorithm, and they found that this variable had a negative effect on both developing and developed countries.

The first paper to use the Economic Policy Uncertainty Index for economic and monetary uncertainty was Bahmani-Oskooee et al. (2015), which augmented the demand function for monetary aggregates with EPU for the United Kingdom and found that the public increased the demand for money when there was a positive shock to EPU, vice versa. Ivanovski & Churchill (2019) add EPU to the demand function for monetary aggregates for Australia and found that its effect is negative in the short term but positive in the long term.

In the case of New Zealand, Hossain & Arwatchanakarn (2020) showed that there is an asymmetric effect of uncertainty and a negative relationship between economic uncertainty and demand for holding cash. Bahmani-Oskooee & Nayeri (2020) evaluated the preferences for holding cash in Japan, expanding the model with the policy uncertainty index, which resulted in no stable relation. Moreover, according to the estimation outcomes, Japanese people held more cash when there was a change in uncertainty. Nusair et al. (2024) used EPU as output uncertainty and searched for its effects in developed countries. According to the outcomes of the linear model, EPU has no impact in the short or long run except in the United States. The outcomes of the non-linear model show that EPU has negative long-run effects for Canada and the United Kingdom, a positive impact in the United States, and a positive influence on demand for holding cash for Japan.

3 Research Method

3.1 Data Analysis

In this paper, the stability of demand for monetary aggregates is examined over 2006.Q1-2023.Q3 for 12 developing countries: Brazil, Bulgaria, Chile, Colombia, Hungary, Indonesia, Mexico, Poland, Romania, South Africa, Thailand, and Turkey. There are two essential criteria while the country sample is constructed: the availability of all chosen variables for the entire period and having countries that are as homogeneous and similar to each other as possible. Although a heterogeneous sample is constructed by choosing many dissimilar countries in the related empirical literature, they employ econometric methods relying on the homogeneous sample assumption. Thus, the estimated results are not reliable. To avoid this problem, countries with similar economic structures are preferred, and thus, a sample of developing countries, based on the definition of IMF (2023), is constructed.

The variables selected for this paper are consistent with the theoretical model and the related literature (Azimi, 2023). The dataset contains the real monetary aggregates, the real GDP, the short-term domestic real interest rate, the nominal exchange rate, the inflation rate, and the uncertainty index. Table 1 represents the definitions of the variables and the data source.

The real monetary aggregate is obtained by dividing the nominal money demand by the GDP Deflator[1] for each country. The real GDP reflects the real income and captures the demand for money for the transaction motive. The exchange rate is the value of the

[1] GDP deflator of selected variables is taken from IFS (2024).

Table 1: Definitions of Variables and Their Data Sources

	Definition	Measurement	Source
Dependent Variable			
lnm2	Broad Monetary Aggregates	Broad Money (current local currency)	IFS (2024)
Explanatory Variables			
lngdp	Real Gross Domestic Product (GDP)	Real GDP (Chained Value)	IFS (2024)
inf	Yearly Changes in Consumer Price Index	CPI (Base Year 2010)	IFS (2024)
lnfx	Exchange Rate	Exchange Rate (Nominal Values)	IFS (2024)
realinterest*	Money Market Rate	Interbank Rates	IFS (2024)
WUI	World Uncertainty Index	Index-GDP Weighted Average	WUI (2023)

* The interest rate for Hungary (Turkey) is obtained from St. Louis FED (2024) (OECD, 2024).

chosen country's coins against the US dollar, and the reason for including this variable in the model is to test the 'wealth effect' and 'expectation effect'. A real interest rate variable is also included in the model to calculate the opportunity cost of other assets. Thus, the interest rate is expected to influence the preference for holding cash, which should be negative. Furthermore, the opportunity cost of holding cash against goods and services is examined by the inflation rate. Therefore, the inflation rate influences the preferences for holding cash, which should also be negative. Finally, we augmented the model for developing countries with the World Uncertainty Index, and the estimate of the coefficient of WUI could be negative or positive. Finally, all level variables, such as real monetary aggregates, real GDP, and exchange rate, are transformed into their natural logarithm forms.

Table 2: Descriptive Statistics

Variables	Obs.	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis
lnm2	852	29.486	3.030	24.251	36.151	0.492	2.463
lngdp	852	14.854	3.126	9.702	21.846	0.585	2.657
inf	840	0.013	0.017	-0.028	0.230	6.390	70.546
lnfx	852	3.347	3.044	-0.821	9.559	0.607	2.064
interest	852	5.316	4.119	-0.68	23.500	1.545	6.302
WUI	852	0.282	0.257	0.000	1.922	1.919	8.686

Descriptive statistics of variables are represented in Table 2. The quarterly average value of monetary aggregates is 29.49, and the real GDP is 14.85. Indonesia has the highest real GDP and demand for monetary aggregates, while Bulgaria has the lowest. These results confirm that there should be a positive relationship between reel income and real demand for monetary aggregates. Average inflation is 0.013; the average exchange rate is 3.35; the average real interest rate is 5.32; and the average uncertainty index is 0.28 in these countries.

Skewness measures the deviation of a specified variable from the symmetric distribution. Positive skewness means a positively skewed distribution, and the data distribution is shifted to the left, with its tail, i.e., the most extreme values, on the right side. A negative skewness value indicates a distribution with its tail on the left side. According to the descriptive statistics in Table 2, values of skewness of selected variables are all positive, and the data distribution is shifted to the right. Although skewness values are positive for all variables, real monetary aggregates, real GDP, and exchange rate values are lower than the others and close to zero. Thus, the distribution of these variables is closer to the normal distribution than the others, especially inflation.

Table 3: Correlation Matrix

Variables	lnm2	lngdp	INF	lnfx	interest	WUI
lnm2	1.000	–	–	–	–	–
lngdp	0.992* (0.000)	1.000	–	–	–	–
Inf	-0.074** (0.032)	-0.058*** (0.090)	1.000	–	–	–
lnfx	0.948* (0.000)	0.953* (0.000)	-0.106* (0.002)	1.000	–	–
interest	0.145* (0.000)	0.202* (0.000)	0.155* (0.000)	0.168* (0.000)	1.000	
WUI	-0.081** (0.019)	-0.095* (0.005)	0.110* (0.002)	-0.134* (0.000)	0.005 (0.879)	1.000

Notes: Confidence levels of 1%, 5%, and 10% are expressed as *, **, *** respectively.

Kurtosis is a measure of the tailedness of a distribution. It is used to help measure how data is dispersed between the center of the distribution and tails. The larger values mean that data distribution may have 'heavy' tails, i.e., more outliers in the data. When kurtosis values are analyzed, as in the case of skewness, real monetary aggregates, real GDP, and exchange rate values are closer to the normal distribution. In contrast, inflation, uncertainty, and interest rate variables have more tails than the normal distribution. Although inflation's mean and standard deviation are lower than the other variables, the kurtosis and skewness values are much higher, indicating more outliers in the inflation series. Interest rate and uncertainty variable values also suggest that these variables have higher outliers.

Table 3 shows the correlation between selected variables. Real GDP and demand for real monetary aggregates have a positive relationship. However, the nominal exchange rate and the real interest rate have a positive, while inflation has a negative influence, as expected.

3.2 Estimation Methods

We estimate the model of Bahmani-Oskooee & Xi (2014); Bahmani-Oskooee & Nayeri (2020) to analyze the stability of demand for monetary aggregates for open economies. Adding the uncertainty variable into our specification results in the following long-run demand for money:

$$lnM2_{i,t} = a + b\ lnGDP_{i,t} + c\ inf_{i,t} + d\ lnFX_{i,t} + e\ interest_{i,t} + f\ WUI_{i,t} + u_{i,t} \qquad (1)$$

We assume a long-run equilibrium relationship exists between real money demand and the selected variables. Real money demand is the dependent variable (natural logarithm of broad money) and the natural logarithm of real income (lnGDP), the natural logarithm of the exchange rate (lnFX), the inflation rate (inf); the real interest rate (realinterest), and World Uncertainty Index (wui) are explanatory variables. We can expect that the estimate of b is positive and that of c is negative. The exchange rate is the nominal exchange rate in this model, and the decline in the exchange rate reflects the depreciation of the domestic currency. Mundell (1963, p. 484) was the first researcher to propose including the exchange rate in the model; the demand for monetary aggregates depends on the exchange rate, real income, and interest rate. The 'wealth effect' implies domestic currency depreciation increases the value of foreign assets in domestic currency terms. Thus, households think their wealth will increase, and if it increases, they want to hold much more domestic money; thus, we expect

d to be estimated as negative. In contrast, after the depreciation of domestic currency, the expectation of depreciation in domestic currency increases, and households might demand foreign currency instead of domestic currency, so-called ‘the expectation effect’ (Bahmani-Oskooee et al., 2019). Contrarily, the positive coefficient of the exchange rate (d) implies ‘the expectation effect’ (Bahmani-Oskooee & Nayeri, 2020). Thus, exchange rate changes may positively or negatively impact money demand. Finally, we augment the model with the measure of uncertainty (WUI), and the estimate of f could be negative or positive.

This paper investigates the effect of selected variables on money demand employing both the ARDL and CS-ARDL models. We can write the long-run relation between dependent and independent variables as follows:

$$y_{i,t} = a_0 + a_1\ t + X'_{i,t}\theta + u_{i,t} \tag{2}$$

$y_{i,t}$ represents the dependent variable, and $X_{i,t}$ is a 5*1 vector of explanatory variables. a_0 represents intercept, and a_1 represents the slope coefficient of a linear time trend. i is a number of units $i = 1, \ldots, N$ and t is consecutive time points $t = 1, \ldots, T$. $u_{i,t}$ is error-term and distributed $N(0, \sigma)$ for all i and t.

Equation (2) is a static model. Its dynamic version with lags of the dependent and independent variables can be written as follows:

$$y_{i,t} = b_0 + b_1\ t + \sum_{j=1}^{p}\ \phi_j y_{i,t-j} + \sum_{j=1}^{q}\ \beta'_j X_{i,t-j} + \epsilon_{i,t} \tag{3}$$

Equation (3) is the general form of the panel ARDL(p, q) model, where p and q are the lag orders of the variables. As Kripfganz & Schneider (2023) emphasized, augmenting the static model with lags of the variables makes it a dynamic model with the error term free of serial autocorrelation. Eliminating the autocorrelation problem requires choosing the appropriate number of lags utilizing the Akaike Information Criteria, Schwarz Information Criteria, and Hannan-Quinn Information Criteria. Once the optimal lag length is determined, the independent variables become weakly exogenous, and any contemporaneous relation from independent variables to dependent variables is prevented. A stable long-run relationship allows using asymptotic theory if some variables are non-stationary (Pesaran & Shin, 1998).

ARDL model can estimate the short-run and long-run relationship by developing a dynamic error correction model (ECM). The ARDL in ECM representation can be written as follows (Hassler & Wolters, 2006):

$$\Delta y_{i,t} = \alpha_0 + \alpha_1\ t + \sum_{j=1}^{p-1}\ \phi_{ij} y_{i,t-j} + \sum_{j=0}^{q-1}\ \delta'_{ij} \Delta X_{i,t-j} + \mu_i \left(y_{i,t-1} - \theta' x_{i,t-1}\right) + \epsilon_{i,t} \tag{4}$$

The impact of selected explanatory variables in periods can be found by estimating Equation (4), where θ stands for the equilibrium in the long run, ϕ_{ij} and δ_{ij} stand for short-run dynamics between selected variables, and μ_i is the speed of adjustment to restore equilibrium if there is a shock to the model, called the ECM term. Then, the deviations from the long-run equilibrium is $e_{i,t-1} = y_{i,t-1} - \theta' x_{i,t-1}$. Equation (4) cannot be estimated directly using the OLS method because there is a nonlinear interaction between μ and θ.

The CS-ARDL method adds a linear combination of cross-sectional averages of dependent and explanatory variables to the ARDL method, aiming to seize the cross-sectional correlation in the error term. To employ the CS-ARDL model, the panel data's time dimension (T) should be large enough to estimate the model for each unit. Furthermore, if the validity of the estimator is to be ensured, an acceptable number of lagged cross-section averages should be added to the model. If these two conditions are met, the Mean Group (MG) and Pooled Mean Group (PMG) estimators can be applied in the estimation of the CS-ARDL method (Chudik & Pesaran, 2015).

First, the mean group estimator estimates the time series equation for every unit independently. Then, coefficients across countries can be calculated as unweighted averages of the estimated coefficients. However, the MG estimator estimates the average of parameters consistently if the time dimension is sufficiently large, as shown in Pesaran (2015); it does not enforce any constraints on the parameters of cross-sections and avoids the possibility of homogeneity of some parameters. Thus, this estimator implies the highest degree of heterogeneity when it assumes intercepts and all parameters can differ freely. Despite these advantages, the MG estimator can be inefficient if the number of units (N) is small. The MG estimator is precise in outlier units that can impact the unit coefficients (Arnold et al., 2011; Samargandi et al., 2015; Li & Ingham, 2020).

The other estimator is the PMG estimator developed by Pesaran et al. (1999). Samargandi et al. (2015) and Li & Ingham (2020) emphasized that the PMG estimator is not just another method but an intermediary between averaging and pooling estimation methods, offering a unique perspective. When the PMG estimator is employed, the long-run coefficient is first estimated jointly across units. Then, the speed of adjustment, short-term coefficients, intercepts, and error variances are estimated for every unit. However, the long-run equilibrium parameters, θ, are homogenous between units; the error correction parameter, constant, and the short-run parameter can vary across units. If the number of units is enormous, this method estimates the average of the short-run coefficient across units by averaging the coefficients of every unit (Samargandi et al., 2015; Li & Ingham, 2020).

PMG estimator is employed if some conditions are met. First, there must be a cointegration relationship in the model, a condition of utmost importance, and the negative sign of the error correction coefficient reviews the essence of this cointegration. Then, for the explanatory variables to satisfy the weak exogeneity assumption, the dynamic specification of the technique should be established. Finally, residuals of the PMG model must be serially uncorrelated (Li & Ingham, 2020).

The homogeneity assumption of the long-term parameters determines the selection of MG and PMG estimators. If the long-term parameters are heterogeneous, the MG estimates parameters consistently, but the PMG estimates them inconsistently. If the long-term parameters are homogenous, each country's long-run parameters are identical. In this situation, both estimators are efficient, but only the PMG estimator is efficient (Samargandi et al., 2015; Li & Ingham, 2020). The empirical research shows that the PMG method is superior to the MG estimator in consistency and efficiency. To test the stability of the money demand function, the homogeneity assumption of the long-run coefficient is more appropriate. On the contrary, macroeconomic outlook and country-specific monetary policies can affect the short-term parameters. Thus, the assumption of heterogeneity of these parameters is more appropriate.

According to the ARDL model, the selected variables can be used if they have different orders of integration, and it estimates the slope coefficients under the assumption that they are heterogeneous. If the cross-section correlation in the error term is ignored, the traditional ARDL model may cause some problems (Phillips & Sul, 2003; Chudik & Pesaran, 2015). To avoid this problem, Chudik et al. (2016) advanced the CS-ARDL method by adding the cross-sectional averages of the explanatory variables, explained variables, and their lags to the model. Thus, the model can be written as follows:

$$\begin{aligned}\Delta y_{i,t} = \omega_i + \sum_{j=1}^{p-1} \phi_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta'_{ij} \Delta X_{i,t-j} \\ + \mu_i \left(y_{i,t-1} - \theta'_i x_{i,t-1} + \alpha_i^{-1} \eta_i \overline{y}_t + \alpha_i^{-1} \zeta_i \overline{X}_t \right) \\ + \sum_{j=0}^{p-1} \upsilon_{ij} \Delta \overline{y}_{t-j} + \sum_{j=0}^{q-1} \varsigma_{ij} \Delta \overline{X}_{t-j} + \epsilon_{i,t}\end{aligned} \tag{5}$$

where $\overline{X}_t$ and $\overline{y}_t$ are the cross-section averages of $X_{i,t}$ and $y_{i,t}$, respectively.

4 Empirical Results

4.1 Results of Cross Dependence Test

The results may be wrong if unit root and estimation methods are chosen without testing for autocorrelation in the selected series. For this reason, we perform Pesaran's (2004) Cross-Dependence (CD) Test, which suggests that the residuals should be used from the estimation of Augmented Dickey-Fuller regression, and the correlation coefficient of the unit with other units is estimated. The CD test searches the null hypothesis, 'there is no autocorrelation between units', against the alternative hypothesis, 'autocorrelation between units exists'.

Table 4: Cross Dependence Test

Variables	Stats	Prob.
lnm2	64.509*	0.000
lngdp	61.704*	0.000
inf	25.241*	0.000
lnfx	30.504*	0.000
interest	50.433*	0.000
WUI	4.442*	0.000

Note: * represents the significance at %1 confidence level.

Table 4 exhibits the CD Test's outcomes; the null hypothesis should be rejected. These results implied an autocorrelation between units in the selected variables.

4.2 Results of Unit Root Tests

The outcomes of the CD test indicate that autocorrelation exists in the selected variables. Therefore, unit root tests that take autocorrelation into account should be applied. If the results of unit root tests are contradictory, more than one unit root test should be utilized to make a clear decision. We applied the Levin, Lin, and Chun (LLC), Fisher Augmented (Fisher ADF), and Cross-Sectionally Augmented Im, Pesaran, and Shin (CIPS) unit root tests. All of the three tests take into account the problem of autocorrelation between units.

According to the LLC panel unit root test, the autoregressive parameter can be heterogeneous to reduce the correlation effect between units. This test allows for heterogeneity in the autoregressive parameter of series different from their cross-sectional means.

Maddala & Wu (1999) developed the Fisher ADF test, which is applied to a series of differences from their unit averages to reduce the correlation effect between units. In addition to the test, we employ the CIPS test. Pesaran (2007) suggested a unit root to eliminate the autocorrelation problem. CIPS test develops the Augmented Dickey-Fuller (ADF) regression with the cross-sectional averages of the lagged levels and cross-sectional averages of the first differences of the selected variables. Hence, autocorrelation between units in the series is eliminated with this method. The null hypothesis of these tests is that 'unit root exists in the selected variables' against the alternative hypothesis: 'unit root does not exist in the selected variables'.

Table 5: Results of Panel Unit Root Tests

Variables	Constant		Constant and Trend		Constant		Constant and Trend	
	Stats	Prob.	Stats	Prob.	Stats	Prob.	Stats	Prob.
	Level		Level		1^{st} Difference		1^{st} Difference	
LLC Unit Root Test								
lnm2	-1.053	0.146	-0.703	0.241	-8.147*	0.000	-6.417*	0.000
lngdp	1.651	0.951	0.696	0.757	-8.331*	0.000	-7.262*	0.000
inf	-4.457*	0.000	-4.127*	0.000	-17.575*	0.000	-16.717*	0.000
lnfx	0.357	0.640	1.375	0.916	-8.916*	0.000	-7.693*	0.000
Interest	-3.011*	0.001	-1.579***	0.057	-9.553*	0.000	-8.208*	0.000
WUI	-3.142*	0.001	-1.669**	0.048	-13.718*	0.000	-12.510*	0.000
Fisher Type ADF Test								
lnm2	24.997	0.406	25.517	0.378	167.111*	0.000	141.258*	0.000
lngdp	10.698	0.991	28.943	0.222	160.869*	0.000	171.617*	0.000
inf	97.006*	0.000	78.764*	0.000	268.423*	0.000	211.904*	0.000
lnfx	30.254	0.176	19.063	0.749	247.303*	0.000	195.626*	0.000
Interest	48.933*	0.002	21.113	0.632	126.171*	0.000	99.217*	0.000
WUI	60.479*	0.000	43.163*	0.000	367.775*	0.000	306.212*	0.000
CIPS Unit Root Test								
lnm2	-2.366**	0.013	-2.133	0.814	-5.331*	0.000	-5.466*	0.000
lngdp	-1.786	0.491	-1.744	0.994	-5.379*	0.000	-5.611*	0.000
inf	-2.123***	0.098	-3.834*	0.000	-5.524*	0.000	-5.512*	0.000
lnfx	-1.89	0.338	-2.342	0.513	-5.240*	0.000	-5.360*	0.000
Interest	-3.087*	0.000	-3.353*	0.000	-4.270*	0.000	-4.242*	0.000
WUI	-3.872*	0.000	-4.084*	0.000	-6.190*	0.000	-6.420*	0.000

Note: Confidence levels of 1%, 5%, and 10% are expressed as *, **, *** respectively. Lag numbers are determined by the Akaike Information Criteria (AIC).

The outcomes of the CIPS test, demonstrated in Table 5, show that contradictory outcomes were obtained for the dependent variable, the real money demand variable. This is a crucial problem if the dependent variable is level stationary. As Pesaran et al. (2001) indicate, there is a severe problem if the dependent variable is trend-stationary or stationary at first difference. Therefore, determining the degree of integration of real monetary aggregates is critical. However, the result of the CIPS test indicates that the real monetary aggregates are stationary; the results of the other two tests show that this variable has the unit root and is stationary when the first difference is taken.

The real GDP and exchange rate have a unit root, and if their difference is considered, these variables are stationary. The inflation rate, the real interest rate, and the World Uncertainty Index do not have a unit root, and these variables are not stationary.

4.3 Results of Autocorrelation Tests between Units and Homogeneity Test

If there is an autocorrelation in the error term, the estimation method should be selected according to this problem. The autocorrelation problem can be detected by the LM test developed by Breusch & Pagan (1980), the CD test developed by Pesaran (2004), and the NLM test developed by Pesaran et al. (2008). The LM test is appropriate for data sets where N is more significant than T; the CD test is appropriate for data sets where T is more significant than N; and the NLM test is appropriate for data sets where both T and N are big enough (Tatoğlu, 2020). Since the time dimension (T= 71) of the data set of our study is larger than the number of countries (N = 12), we preferred employing the LM test.

The Breusch-Godfrey test is employed to determine the autocorrelation between residuals of the selected model. The results of Breusch & Pagan's (1980) LM test are demonstrated in Table 6 rejects the null hypothesis of 'autocorrelation does not exist between residuals', against the alternative hypothesis, 'autocorrelation exists between residuals'. Thus, this model has an autocorrelation problem, which indicates a cross-dependence problem.

Table 6: Correlation and Homogenous Test

Bresuch Pagan LM	664.40*	0.000
$\tilde{\Delta}$	41.386*	0.000
$\tilde{\Delta}_{Adj.}$	43.257*	0.000

Note: * represents the significance at 1% confidence level.

We prefer the Pesaran & Yamagata (2008) test, a standardized version of the Swamy S test, to analyze the slope coefficients homogeneity for the model. $\tilde{\Delta}$ is another version of the Swamy statistics. This statistic is regression standard errors for the individual cross-section units and computed using the Pooled Fixed effects instead of the OLS estimator. If N and T go to infinity, Δ tests have a standard normal distribution. For the $\tilde{\Delta}$ test, $\sqrt{N}/T^2 \to 0$ when N and T go infinity. The errors are normally distributed in the mean-variance-biased adjusted version, which $\tilde{\Delta}$ is called. This test is accurate when N and T go to infinity with no restrictions (Pesaran & Yamagata, 2008, p. 51). However, this test is developed for data sets in which N is more significant than T; the test also gives satisfactory results for dynamic panels when T is more significant than N, as Pesaran & Yamagata (2008) emphasized. In this paper, N is 12, and T is 71. Thus, our data set is appropriate for this test.

The test searches for the 'slope coefficients are homogenous' hypothesis against the 'slope coefficients are heterogenous' hypothesis. The outcomes of Pesaran & Yamagata's (2008) homogenous tests are demonstrated in Table 6. The outcomes emphasize that the 'slope coefficients are homogenous' hypothesis should be rejected, and it is implied that slope coefficients are heterogenous.

4.4 The Results of the CS-ARDL Model

In the ARDL and CS-ARDL methods, variables should be stationary at level, first-degree integrated, or both. The selected variables are stationary at the level and first-degree integrated according to the outcomes of the unit root tests. Hence, variables are not second-degree integrated, which means that one of the most critical assumptions for estimating the ARDL method is satisfied. Furthermore, the CS-ARDL method gives reliable results under cross-sectional dependence and slope coefficient heterogeneity. The ARDL method gives unreliable results under these conditions. LM test and Pesaran and Yamagata homogeneity test indicate autocorrelation in the residuals and heterogeneity of slope coefficients. For these reasons, after estimating the ARDL model due to its popularity in the empirical literature, we also estimated the CS-ARDL model, which gives more reliable results.

For empirical work, the data set should contain sufficiently large time dimensions and several units to allow for heterogeneity and autocorrelation (Samargandi et al., 2015; Li & Ingham, 2020). Therefore, this study's time dimension is kept long and determined as 71.

The MG estimator is inefficient in small cross-country dimensions and conscious of unit outliers. In contrast to the MG estimator, PMG proposes efficient estimation, which is generally used in empirical research. Although the ARDL method is popular for analyzing the stability of the model, the potential error cross-sectional dependence problem raises doubt about the reliability of the results of the ARDL model. Therefore, we prefer to interpret the estimation results of the CS-ARDL model, which provides more reliable results due to the cross-sectional dependence to analyze the strength of demand for monetary aggregates for developing countries.

The results of the ARDL model are given in the first column of Table 7. The sign of the error correction parameter is -0.15, which is statistically significant. These results indicate a cointegration between selected variables, and the system is mean-reverting after a shock hits the model. Hence, there is a stable cointegration relation for 12 developing countries. Furthermore, the second and third lag values of real monetary aggregates and the first lag of real GDP negatively influence demand for monetary aggregates. The opportunity cost variable for other assets is the real interest rate, and it does not influence the demand for monetary aggregates. The other opportunity cost variable is inflation, and the inflation rate influences the demand for monetary aggregates positively in contrast to expectations. Moreover, the changes in the exchange rate have a positive influence, but the exchange rate lag negatively influences the demand for monetary aggregates in the short run. WUI does not influence the demand for holding cash in the short run.

The real GDP and exchange rate influence positively, but the real interest rate and the inflation rate influence the demand for monetary aggregates negatively in the long run, which is in line with theoretical expectations. The effect of WUI is also negative in the long run for developing countries.

The results show that the ARDL method's short-run outcomes do not match theoretical expectations. The validity of the ARDL method's results depends on the independence of the errors among the units. The Breusch Pagan test results indicate that they may be cross-sectionally dependent, and according to this test, the ARDL method's outcomes are questionable. To deal with this problem, the CS-ARDL method is employed, and the results of this method are represented in the last column of Table 7. Since the reliability of the CS-ARDL method depends on the appropriate value of the averages of the cross-section coefficients, the lag numbers are set to 3 by following Chudik & Pesaran (2015).

Table 7: Estimation Results of ARDL and CS-ARDL Models

Variable	ARDL(4,2,2,2,2,2)	CS-ARDL(3,2,2,2,2,2)
Long-Run Equation		
lngdp	0.565* (0.000)	0.702*** (0.055)
lnFX	0.017 (0.670)	-0.481** (0.014)
inf	-4.209* (0.000)	-0.778* (0.000)
realinterest	-0.559* (0.005)	1.277 (0.100)
WUI	-0.076* (0.002)	-0.012** (0.046)
Short-Run Equation		
Cointeq	-0.151* (0.000)	-0.630* (0.000)
$\Delta(lnm2(-1))$	0.010 (0.764)	0.324* (0.000)
$\Delta(lnm2(-2))$	0.102* (0.000)	0.941 (0.269)
$\Delta(lnm2(-3))$	0.088*** (0.056)	0.019 (0.694)
$lngdp$	-0.084 (0.180)	0.226* (0.006)
$\Delta(lngdp(-1))$	-0.219* (0.000)	-0.027 (0.837)
$\Delta(lngdp(-2))$	–	0.400** (0.045)
$\Delta(lnfx)$	0.163* (0.000)	0.174** (0.036)
$\Delta(lnfx(-1))$	-0.068** (0.031)	-0.213** (0.019)
$\Delta(lnfx(-2))$	–	-0.125** (0.039)
$\Delta(interest)$	0.103 (0.573)	0.352 (0.293)
$\Delta(interest(-1))$	0.021 (0.899)	-0.028 (0.914)
$\Delta(inf)$	0.271** (0.041)	-0.283** (0.040)
$\Delta(inf(-1))$	0.212** (0.023)	-0.406* (0.005)
$\Delta(inf(-2))$	–	-0.226** (0.032)
$\Delta(WUI)$	0.003 (0.358)	-0.005 (0.320)
$\Delta(WUI(-1))$	0.002 (0.724)	-0.002 (0.813)
$\Delta(WUI(-2))$	–	-0.020** (0.024)
Constant	3.149 (0.000)	–
Trend	0.001 (0.000)	–
Post-Estimation Results		
Wald Test	17.981* (0.000) (df: 5,643)	–
CD-Test	–	-0.13 (0.899)

Note: Confidence levels of 1%, 5%, and 10% are expressed as *, **, and ***, respectively. The appropriate lag numbers of the ARDL model are determined according to the Akaike Information Criteria (AIC).

The result of the CD test (-0.13) with a probability of 0.899, at the bottom of Table 7, indicates that cross-sectional dependence is controlled when the lagged values of cross-sectional averages should be added to the regression. These outcomes imply that the Pooled Mean Group under the CS-ARDL method is more appropriate than the ARDL.

The error correction parameter of the CS-ARDL model is -0.63 and statistically significant at the 1% significance level. The negative error correction term implies a cointegration relation and, thus, a stable demand for monetary aggregates in the selected 12 developing countries. However, the theory emphasized that the real GDP, the real interest rate, and the exchange rate predicts the demand for money (Ericsson, 1998; Brissimis et al., 2003; Azimi, 2023); the outcomes of CS-ARDL cannot fully support this idea. The real GDP has a positive impact, as the theory emphasized, and this outcome is parallel with the outcomes of many studies (e.g., Tang, 2007; Narayan et al., 2009; Talaş et al., 2013; Baidoo & Yusif, 2019). Contrary to these studies and the coefficient value in the correlation matrix, the real interest rate is statistically insignificant, and this outcome is in line with Hossain & Arwatchanakarn (2020) and Bahmani-Oskooee & Nayeri (2020). There may be two reasons for this result. First, since the study is based on panel data, obtaining reliable interest rate data for each developing country is impossible. Second, as emphasized in Bahmani-Oskooee et al. (2019), since financial markets are not significantly developed in developing countries, the interest rate may not have much impact on money demand.

Contradictory findings about the impact of exchange rates on the demand for holding domestic coins were found in the research. As emphasized above, the exchange rate has two effects: wealth and expectation effect' (Bahmani-Oskooee et al., 2019; Bahmani-Oskooee & Nayeri, 2020). The exchange rate influences the demand for holding domestic currency negatively and significantly in the long run. It means that there is a 'wealth effect' for these developing countries. When the domestic currency depreciates in these countries, the value of foreign assets increases in terms of the domestic currency. Hence, developing countries' households think their wealth will increase and demand more domestic currency.

According to the outcomes of the CS-ARDL method, the inflation rate has a negative response in the long run, as many studies, such as Azimi (2023), Bahmani-Oskooee et al. (2019), and Dreger & Wolters (2010), have found.

When we analyze the effects of independent variables in the short run, we see that lags of real monetary aggregates have a positive and statistically significant effect on their changes in the short run. Furthermore, the real GDP and its second lag have a positive and statistically significant response in the short run as in the long run.

The impact of the exchange rate on the demand for monetary aggregates is contradictory. The exchange rate has a positive impact, but the first and second lags have a negative impact. These results indicate that although the exchange rate has a positive effect in the current period, the sign turns negative as time passes. According to these results, 'the expectation effect' in the short run and 'the welfare effect' in the long run are valid in developing countries.

When the inflation rate increases, demand for monetary aggregates decreases in the short run. These impacts are effective for two quarters in developing countries in accordance with the outcomes of the CS-ARDL method. Hence, the inflation rate is a key factor in the demand for monetary aggregates, as emphasized in the related literature.

The real interest rate does not influence the demand for monetary aggregates in the short run as it does in the long run. These outcomes indicate that the real interest rate does not influence the demand for monetary aggregates in the short run or the long run.

Our results reveal that WUI has a negative impact in the long run. Furthermore, its impact is also negative in the short run. One unit change of uncertainty effect has -0.005 unit on the demand for monetary aggregates. Moreover, the second lag of WUI negatively influences the preference for holding cash. However, these findings align with those of Bahmani-Oskooee et al. (2013). Ivanovski & Churchill (2019) stated that the uncertainty variable has a negative effect in the short run, while uncertainty influences the preferences of holding cash in the long run (Bahmani-Oskooee & Xi, 2014; Bahmani-Oskooee & Baek, 2017; Tan et al., 2020; Nusair et al., 2024).

5 Conclusions

This study considers the strength of demand for monetary aggregates augmented with the uncertainty index for 12 selected developing countries in 2006.Q1-2023.Q3. The CS-ARDL method is the estimation method since the panel data set has cross-sectional dependence and the selected variables have different degrees of integration. According to the results, a cointegrated relationship exists between demand for the monetary aggregates and the selected variables for the 12 developing countries. The real income is positive, but the exchange rate, the inflation rate, and WUI have negative impacts on demand for the monetary aggregates in both periods. Contrary to these findings and expectations, the real interest rate variable has no impact.

The estimation outcomes offer several policy implications. First, since the money demand function is stable, the money supply can be used effectively to ensure macroeconomic stability when conducting monetary policy. The development of institutions and policies to stabilize macroeconomic variables in the short and long run is also essential for the effective use of monetary policy. Second, the real GDP positively influences the demand for monetary aggregates in both periods. Therefore, within one of the functions of the transaction motive of money, the demand for domestic currency can be increased by increasing the real income of domestics. Thus, stable and balanced growth is also essential for the demand for money. Third, the negative effect of inflation, both in the short and long run, indicates that inflation targeting is crucial in ensuring a stable and low inflation rate. Therefore, policymakers should adopt or continue to implement inflation-targeting policies. Fourth, the exchange rate has a positive effect on the demand for money in the short run, meaning there is a 'substitution effect' for developing countries. The impact of the exchange rate on domestic assets should be considered when setting or implementing appropriate policy, as the currency 'substitution effect' on money demand will also affect monetary policy. Thus, monetary and trade policies should be coordinated to achieve this objective. Finally, uncertainty may create an uncertain environment, and thus, domestic households might decide to demand less or more cash. Households may hold less cash because they act with precautionary motives and try to hold risk-free assets. The results indicate that the uncertainty variable negatively affects the demand for monetary aggregates in both periods. Therefore, it can be said that the effect of uncertainty is not temporary for developing countries. Hence, households want to hold less money. For these reasons, developing policies to eliminate economic uncertainty can diminish the negative impacts on money demand.

This paper has potential limitations. First, although selecting countries close to each other makes sense to ensure homogeneity, this preference reduces the sample size and makes it difficult to generalize the results. Increasing the number of countries in the selected sample may make the results more reliable. Second, each of the selected countries has an open economy. Therefore, they are affected by economic developments and capital movements. The effects of the difference between foreign and domestic interest rates can also be evaluated by adding the foreign interest rate to the model. Third, the skewness and kurtosis values of the inflation rate are very high. These high values indicate that there are outliers in the data set. Thus, estimating the model by excluding countries with these outliers may also change the results.

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