Stability of Money Demand Function in the SAARC Region:  
A Panel Co-Integration Approach

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Abstract  This study explores the causality relationships between money demand, real income, price, and interest rate by focusing on South Asia for the period between 1986 and 2017 using panel data econometrics. Our estimations based on panel auto-regressive distributed lag (ARDL) reveal a significant and positive long-run relationship between real income and money demand, while a negative relationship exists with interest rate and price. The panel vector error correction model causality results highlight a feedback relationship between money demand and real income, but a short-run unidirectional causality between price and interest rate and real income. We also discover long-run bidirectional causality among these variables. Our results indicate that the money demand function was stable in South Asian economies during the time period considered by this study. Therefore, the central bank of these countries can use money supply as an appropriate instrument to manage monetary policy to achieve overall price and macroeconomic stability.

Keywords: Money Demand, Panel ARDL, Granger Causality, Interest Rate.

JEL Classifications: E41, E51, E52, E42

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I. Introduction

Monetary authorities implement monetary policies to maintain economic growth and stability. Monetary policy framework relies on estimating the money demand function because it provides a foundation for macroeconomic modeling in many countries. The stability of economic policy instruments such as money supply, interest rate, and inflation are the fundamental factors for determining economic growth rates. Understanding the relationships between the money demand

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function and its determinants is important for exploring theories of macroeconomic behavior and implementing appropriate macroeconomic policies (Goldfeld 1994). Consequently, the demand for money and its functional specification has remained a contemporary issue subject to extensive empirical scrutiny in panel studies (Dobnik 2011, Dreger et al. 2000, Garcia-Hiernaux and Cerno 2006, Lee and Chang 2013).

The estimated relationship between the determinants of money demand provides guidance to central banks in the implementation of suitable monetary policies (Foresti and Napolitano 2013). Central banks of developing economies use the interest rate as the most appropriate instrument of monetary policy even though there is no robust evidence to confirm that their specific money demand functions are unstable (Rao and Kumar 2009). In a developing economy, if the interest rate is chosen as a monetary policy instrument rather than the money supply, monetary policy is ineffective when the money demand function is stable (Poole 1970, Rao and Kumar 2008). An earlier study by Bahmani-Oskooee and Rehman (2005) found that the demand functions of money are stable in many developing Asian countries even though such evidence is largely missing in the South Asian context. Therefore, it is important to understand from an economic policymaking perspective that the demand for money functions in South Asian developing countries has become unstable.

This paper aims to explore the meaningful causal relationships among the determinants of money demand functions in South Asia. The researchers apply panel data econometrics using a panel co-integration approach for this purpose. The underlying assumption of our study is that money demand estimations are an integral aspect of the monetary policy framework, while the stability of money demand is a necessary condition for using monetary aggregates in conducting macroeconomic policy (Goldfeld and Sichel 1990). This study seeks to provide empirical evidence regarding the impact of real income, overall price levels, and real interest rates on the demand for money in South Asia. We consider the South Asian Association of Regional Cooperation (SAARC) region for our analysis because these economies are responsible for promoting the development of economic and regional integration in South Asia. Monetary policy in the SAARC region also aims to achieve the twin objectives of fostering economic growth and encouraging overall price stability.

We apply a pool mean group (PMG) estimator based on Pesaran et al. (1999) to an unbalanced data for our analysis. We further compare the results from the PMG with two alternative panel estimation methods, namely mean group (MG) and dynamic fixed effect (DFE) estimators, to ensure the efficiency and consistency of the estimates. The contribution of this study to the existing literature on the relationship between the determinants of money demand is documented through two possible channels. First, we examine the impact of real income on money demand in South Asian economies. Second, we demonstrate that both money demand and interest rate are important for monetary policy formation even though the existing literature
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predominantly incorporates short-term interest rates in the Equation for money demand. An over-reliance on short-term interest rates is problematic because this does not allow the opportunity cost of holding money to be fully captured (Valadkhani 2008). Our paper also differs from a previous study by Kumar et al. (2009) in two ways. First, we consider long-term instead of short-term interest rate for our analysis. Second, Kumar et al. (2009) only investigated long-run relationships among the determinants of money demand but we analyze short-run relationships as well.

The remainder of the article is structured as follows. Section 2 summarizes the relevant literature. The data, theoretical models, and econometric methodologies applied to estimate the money demand function are discussed in Section 3. Section 4 presents and discusses the results. Section 5 highlights future areas for research and concludes the study.

II. Literature Review

Monetarists believe that the regulation of an economy by means of money supply and interest rates is a way to drive economic growth. The establishment of a modeling framework to estimate money demand functions is, therefore, quite important for the effective management of macroeconomic policies (Lucas 1988, Stock and Watson 1993). Monetary policies rely on the determination of a well-specified money demand function and accurately modeled relationships between its determinants (Laidler 1999). Earlier studies have shown that the long-run efficiency of interest rate policy might be impacted by any disequilibrium or disturbance in the demand for money (Ball 2001, Gerlach and Svensson 2003). Yoshino et al. (2017), for instance, showed that monetary policy instruments, such as negative interest rates in Japan, have been ineffective in stimulating a recovery in the Japanese economy.

As a result, empirical estimations of money demand functions using panel data are widely captured in the literature (Bahmani 2015, Carrera 2008, Dreger and Wolters 2010, Dreger and Wolters 2014, Dobnik 2011, Elbadawi and Schmidt-Hebbel 2007, Fidrmuc 2009, Hamori 2008, Hamori and Hamori 2008, Harb 2004, Khalid et al. 2010, Kjosevski et al. 2016, Kumar et al. 2013, Mark and Sul 2003, Nautz and Rondorf 2011, Tang 2007, Valadkhani 2008, Valadkhani and Alauddin 2003). Dilan and Örsal (2017) demonstrated that the long-run demand for money in 13 Organisation for Economic Co-operation and Development (OECD) economies was driven by the interdependence between cross-sections in the sample. Kumar et al. (2009) showed that the determinants of money demand formed a long-term equilibrium relationship within each of five South Asian economies, as well as for a group of five South Asian economies as a whole. Nepal’s money demand function was unstable but that of the other four countries was stable, which contradicted the findings of an earlier study by Buddha (2011) in which a
stable money demand function for Nepal was established.

Nautz and Rondorf (2011) applied a PMG estimate to explore cross-country perspectives on money demand and its determinants in the European area. Variable omissions in money demand model specification led to instability in the standard money demand models estimated for these countries. Rao and Kumar (2009) employed the co-integration technique of money demand for 14 Asian economies and concluded that money supply, not the interest rate, should be the focal instrument of monetary policy advocated by their central banks. Harb (2004) investigated the demand function for money in six Gulf region economies by employing the panel co-integration procedure based on Pedroni (1999). The study by Harb (2004) confirmed that the determinants of money demand form a stable, long-term equilibrium relationship.

Foresti and Napolitano (2013) employed the panel dynamic ordinary least squares (DOLS) estimate methodology in order to capture the long-run estimates of money demand for nine OECD economies. The results showed that wealth and real income had an intensified role in determining money demand while the incorporation of wealth into the model specification increased the stability of the demand function. Simmons (1992) estimated the money demand for five African economies using an error correction model and concluded that domestic interest rates and overall price levels play an important role as determinants of money demand. Taghizadeh-Hesary et al. (2018) examined the impact of price transfers in order to analyze their inflationary effects and concluded that the effect of prices on the economy is in their effect on household expenditures, which, in turn, influence aggregate demand. Another study by Taghizadeh-Hesary and Yoshino (2014) showed that expansionary monetary policies induced through interest rate manipulation were the cause of an overall long-term price increase throughout the economy.

Kjosevska et al. (2016) analyzed the stability of the money demand functions of five western Balkan economies using the DOLS technique and confirmed the existence of a long-run equilibrium relationship as well as the stability of the money demand function. Nominal interest rates, exchange rates, inflation, and real money showed a long-run equilibrium relationship between the economies of the five Balkan countries. Dobnik (2011) found long-run equilibrium in the money demand functions of 11 OECD economies based on the panel error correction model. Income had a positive impact on the demand for money while interest rate and stock prices generated negative impacts. Apergis (2015) estimated a money demand specification model based on an ordinary least squares estimation using a panel framework to account for structural breaks in East Asian economies. The empirical findings provided valuable guidance to East Asian monetary authorities and central banks as their money demand responded positively to real income and was inversely related to interest rate increases, the effective exchange rate, inflation, and the United States (US) real interest rate.
III. Methodology and Data

The sub-sections below describe the data, the model specifications, and the econometric methodologies applied in our study.

A. Data

The variables used in our analysis are as follows: M2 is the nominal broad money supply initially obtained in local currency but transformed into real broad money supply M2 (in billions of US dollars) and deflated by the gross domestic product (GDP) deflator where 2010 is the base year (2010=100); real GDP is a measure of income (in constant 2010 US dollars) in billions; the price variable is the consumer price index where 2010 is the base year (2010=100); and the real interest rate is the inflation-adjusted lending interest rate. All data are retrieved from the World Development Indicators (WDI) published by the World Bank (WDI 2019). The data sample consists of seven South Asian economies, namely Nepal, India, Bhutan, the Maldives, Bangladesh, Sri Lanka, and Pakistan. The dataset is an unbalanced panel since there are data gaps in our sample. Therefore, the period of analysis runs from 1986 to 2017 for Nepal, Bangladesh, the Maldives, Bhutan, and India. Likewise, the period of analysis respectively runs from 2004 to 2017 and from 2001 to 2016 for Pakistan and Sri Lanka (please see Appendix for more information).

B. Model specifications

We began our analysis by creating a specification for the money demand function as in earlier studies (Beyer 2009, Driscoll 2004, Ericsson 1998, Harb 2004). This is primarily because understanding how the demand for money responds to its determinants, such as the overall price level and interest rate, is a foundational goal in the pursuit of monetary policy objectives. Equation 1 below is a standard specification of the money demand function to test for a long-run equilibrium relationship (i.e. co-integration) among its determinants:

\[
\ln M2_{it} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln P_{it} + \beta_3 IR_{it} + \epsilon_{it}
\]  

where \(M2\) is the real aggregate monetary term, \(Y\) is income in real terms, \(P\) is the consumer price index, \(IR\) is the real interest rate, and country and time are represented by the subscripts \(i\) and \(t\), respectively, and \(\epsilon_{it}\) is the normally distributed residual term. All variables, except for real interest rate, are log transformed by taking their natural logarithms.

We expected a positive coefficient for income \(\beta_1\) with a value exceeding 1, although this
value tends to differ across studies. Foresti and Napolitano (2013) have shown that the value of $\beta_1$ usually falls between 1 and 2 with two theoretical implications. The quantity theory of money (Friedman 1956) is supported when the value of $\beta_1 = 1$, while $\beta_1 = 0.5$ confirms the theory advocated by Baumol-Tobin (Baumol 1952 Tobin 1956). The value and sign of $\beta_1$ has macroeconomic policy implications, for example, a value of less than 1 rules out the optimality conditions under the Friedman rule whereby output must grow faster than money demand in order for macroeconomic price stability to be attained (Ball 2001). Price is used as a proxy for the rate of inflation, in that it captures the returns of holding onto goods and foreign currencies as per Ericsson (1998).

C. Econometric approaches

The sub-sections below describe the econometric methodologies based on panel co-integration, the panel Auto-Regressive Distributed Lag (ARDL) model, and the Granger causality tests on the panel data, respectively.

1. Panel co-integration approach

We then applied the panel co-integration test proposed by Pedroni (1999). This method accommodates for heterogeneity among the individual cross-sections to test for the null hypothesis of no co-integration (i.e. no long-run equilibrium relationship) existing in the dynamic panel. Pedroni (1999) extended the two-step strategy proposed by Engle and Granger (1987) to test for co-integration and error correction in the panel data application by applying the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) principles. Equation 2 is specified below:

$$y_{it} = \alpha_i + \delta_i t + \theta_i + \beta_1 x_{1it} + \cdots + \beta_M x_{M_it} + \epsilon_{it}$$ (2)

where the number of cross-sectional units and time observation are represented by $(i = 1, \cdots, N)$ and $(t = 1, \cdots, T)$, respectively, and $M$ is the number of regressors. This can be seen as a fixed-effects model where, $\alpha_i$, $\delta_i t$, and $\theta_i$ represent individual specific effect, individual specific linear trend, and common time effect, respectively. The heterogeneity of the coefficients is captured by $\beta_M$.

To test the stationarity property of the error process, Pedroni (1999) suggested conducting seven tests that are distributed asymptotically normally to a standard distribution. The seven test statistics can be classified as “within dimension tests” and “between dimension tests.” The “within dimension tests” statistic assumes the homogeneity of the restricted auto-regressive
parameter on the estimated residuals for all countries included in our sample. The four test statistics under the “within dimension tests” statistic include the panel v-statistic, panel p-statistic (rho statistic), panel PP-statistic, and panel ADF-statistic. A large positive value for panel v-statistics rejects the null hypothesis of no co-integration. The “between dimension tests” include the group p-statistic, group PP-statistic, and group ADF-statistic. A large negative value implies the rejection of the null hypothesis for all other test statistics except for the panel v-statistics.

2. Panel ARDL approach

We applied the dynamic panel models based on the PMG estimate model proposed by Pesaran et al. (1999). It is appropriate to apply the PMG estimator when the length of time series “T” exceeds the size of cross-sections “N” (i.e., $T > N$). One of the fundamental assumptions of the PMG estimator is that it allows for heterogeneity in the short-term coefficients but does not allow homogeneity in the long-run slope coefficients (Pesaran et al. 1999). The long-term coefficients are constrained to be equal to the error correction model, but the long-term coefficients can vary from the error variances. The PMG estimate or panel ARDL have been applied in the earlier works of Dunne and Kasekende (2018), Kjosevski and Petkovski (2017), Mbazia and Djelassi (2019), and Nautz and Rondorf (2011) to estimate the demand for money and identify the determinants of money demand. The panel ARDL of the order $(p, q)$ model is formulated below:

$$y_{it} = \sum_{j=1}^{q} \lambda_{ij} y_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} x_{i,t-j} + \mu_{i} + \epsilon_{i,t}$$

(3)

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

Equation 4 is the error correction model representation obtained by transforming Equation 3:

$$\Delta y_{i,t} = \varphi_{i}(y_{i,t-1} - \theta_{i,t} - \theta_{i} x_{i,t}) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{q-1} \delta_{ij} \Delta x_{i,t-j} + \eta_{i} + \epsilon_{i,t}$$

(4)

where, $x_{i,t} = (Income_{i,t}, Price_{i,t}, Interest_{i,t}$ as represented by Equation 1), $\varphi_{i} = (1 - \sum_{j=1}^{p} \lambda_{ij})$, $\theta_{i} = -\frac{\sum_{j=1}^{q} \delta_{ij}^{*}}{\varphi_{i}}$, $\lambda_{ij} = -\sum_{m=j+1}^{p} \lambda_{i,m}$, $\delta_{ij}^{*} = -\sum_{m=j+1}^{q} \delta_{i,m}$.

Therefore, the model to be estimated is:
\[
\Delta \ln M_{2t} = -\mu_i + \varphi_i (\ln M_{2t-1} - \lambda_1 \ln P_{t-1} - \lambda_2 \ln IR_{t-1} + \sum_{j=1}^{p-1} \delta_j (\Delta \ln M_{2t-j}) + \sum_{j=1}^{p-1} \delta_j (\Delta \ln IR_{t-j}) + e_{it}
\]

Equation 4 captures the long-run relationship between money demand and the independent variables based on the term \( \varphi_i (y_{it-1} - \theta_{n1} \cdot x_{it}) \), where \( \theta_i \) is the vector of the associated long-term coefficients. A principle property of co-integration is that there are short-run deviations that converge with a speed of \( \varphi_i \) toward the long-run equilibrium in forming the long-term equilibrium relationship, provided that the series is integrated at most to the order of 1 (I (1)) or order of 0 (I (0)). We expect \( \varphi_i \) to be statistically significant and negative. The error correction model (i.e. Equation 4) is estimated based on three estimation techniques: PMG, MG, and DFE. Homogeneity in the long-term relationships allows the PMG estimator to be consistent and efficient (Pesaran et al. 1999). The MG estimator calibrates an average of individual parameters from each cross-sectional specific regression while imposing no conditions of homogeneity on any of the parameters, both in the short-term as well as long-term (Pesaran and Smith 1995). The DFE estimator allows for intercept heterogeneity but no homogeneity of all other parameters across individual countries in the sample (Hsiao et al. 2002). Finally, we applied the Hausman test to compare the consistency and efficiency properties of these three estimators.

3. Granger causality test approach

We applied the Granger causality test in a vector error correction model (VECM) framework only after confirming a long-run equilibrium relationship based on Pedroni (1999). The VECM Granger causality tests capture the short-run and long-run causality relationships based on the lagged values of the error correction term (ECT (-1)). The Granger causality test model based on VECM is represented below:

\[
\begin{bmatrix}
\Delta M_{2t} \\
\Delta Y_{it} \\
\Delta P_{it} \\
\Delta IR_{it}
\end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} + \sum_{p=1}^{\hat{p}} \begin{bmatrix} \beta_{1p} \\ \beta_{2p} \\ \beta_{3p} \\ \beta_{4p} \end{bmatrix} + \begin{bmatrix} \Delta M_{2t-1} \\ \Delta Y_{it-1} \\ \Delta P_{it-1} \\ \Delta IR_{it-1} \end{bmatrix} \times \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} + ECT_{it-1} + \begin{bmatrix} e_{1it} \\ e_{2it} \\ e_{3it} \\ e_{4it} \end{bmatrix}
\]

where \( t \) captures the time dimension, \( i \) indicates the individual countries in the panel (1,2,...,7 South Asian countries), \( e_{it} \) is the error term, and \( ECT \) is the lagged error correction term obtained from the co-integrating Equation represented by Equation 4. The \( ECT \) term disappears from Equation 6 in the absence of any co-integrating relationships among the variables. The Akaike’s information criterion is applied to gauge the optimal lag order as it has powerful properties in small sample like ours (Liew 2004, Lutkepohl 1991). We used \( \chi^2 \)-statistics to conduct the
short-run Granger causality test and $t$-statistics of lagged ECT to determine the direction of long-run causality.

IV. The Estimation Results

We undertake these tests to detect the presence or absence of unit roots in the panels to determine the integration order of the time series variables, namely money demand, income, price, and interest rate. The unit root tests are based on Levin, Lin, and Chu (LLC) (Levin et al. 2002); Im, Pesaran, and Shin (IPS) (Im et al. 2003); the ADF-Fisher chi-square ($\chi^2$); and the PP-Fisher ($\chi^2$) (Maddala and Wu 1999). The results of this panel unit root test are reported in Table 1. Money demand, income, and price variables are stationary at their first differences but non-stationary at other levels, indicating a unit root property. Hence, the application of the panel co-integration and PMG/ARDL tests to confirm the presence or absence of long-term equilibrium relationships between the demand for money, interest rates, overall price levels, and real income, is desirable.

| Variables | LLC | IPS | ADF-Fisher $\chi^2$ | PP-Fisher $\chi^2$ |
|-----------|-----|-----|---------------------|---------------------|
| $\ln Y$  | 0.380 | -0.195 | 14.193 | 24.640 |
| $\ln M_2$ | -1.293 | -0.172 | 11.743 | 9.869 |
| $\ln P$  | -0.149 | 1.809 | 11.437 | 3.575 |
| $\ln IR$ | -0.854 | -1.519 | 22.728* | 68.005*** |

(Note) *, **, and *** respectively indicate the significance at 10%, 5%, and 1% levels.

Table 2 presents the results of panel co-integration according to Pedroni (1999, 2004), applied to the four non-stationary variables, namely demand for money, interest rate, overall price level, and real income. The null hypothesis of no co-integration is rejected by a majority of the seven test statistics at the 1% significance level. Therefore, the panel co-integration tests strongly confirm the presence of a long-run equilibrium relationship between the demand for money and its determinants in these seven South Asian economies.
We estimated Equation 4 using three different estimators: PMG, MG, and DFE, in columns (1) to (3). Table 3 reports the results based on these three estimators, as well as the Hausman test results. The Hausman tests (Hausman 1978) are necessary to compare an efficient model against a more efficient model that also provides consistent results. We found that this test failed to reject the assumption of the long-run parameter restriction at the 5% level of significance. The Hausman distributed chi-square is 7.75 and 0.02 while Prob>chi2 is 0.065 and 0.99, respectively, both of which exceed the value of 0.05. Thus, the Hausman test confirms that the PMG estimator is the best efficient estimator under the null hypothesis and, hence, is the most appropriate model for our analysis.

The panel ARDL model confirms the presence of a co-integrated relationship. The estimated ECT, or adjustment coefficient \( (\varphi) \), is significantly negative, allowing us to conclude that there are short-run deviations in the relationships, converging toward a long-run equilibrium relationship between the demand for money, overall price level, real income, and interest rate. The presence of a co-integrated relationship suggests that using money demand as an instrument of monetary policy has impacts on real income and overall price levels. Table 4 shows that the values of \( (\beta) \), or the income elasticities, are greater than 1 (spanning from 1.33 to 1.58), which does not confirm the assumption of the quantity theory of money, which assumes \( \beta_1 = 1 \).

The results from the preferred PMG estimator in column (1) demonstrate that there is a long-run equilibrium relationship since the long-run coefficient of real income is significantly positive and greater than 1. Therefore, we can conclude that the velocity of money declined for these seven South Asian economies during the specified sample time period of this analysis. This result is consistent with the hypothesis supported by the broader definition of money demand (Apergis 2015, Nautz and Rondorf 2011).

We also noticed statistically significant (at the 1% significance level) coefficients of price and interest rate. Likewise, interest rate spread and price have statistically significant negative coefficients of -0.489 and -0.022, respectively. All other things remaining constant, a 1% increase in inflation level tends to decrease the real value of money by 0.489% based on our results. Interest rate increases also contribute to discouraging the holding of real money balances.
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ARDL \((p = 1, q = 1)\)

\[
\begin{align*}
\text{PMG} & : -0.3082 \ (2.7140^{**}) \\
\text{MG} & : -0.5156 \ (2.9590^{***}) \\
\text{DFE} & : -0.2042 \ (4.0316^{***})
\end{align*}
\]

Long-term coefficients \((\theta_i)\)

\[
\begin{align*}
Y & : 1.3496 \ (8.5529^{***}) \\
& : 1.5803 \ (3.6773^{***}) \\
& : 1.3322 \ (4.3664^{***})
\end{align*}
\]

\[
\begin{align*}
P & : -0.4890 \ (-3.1659^{***}) \\
& : -1.9434 \ (-3.5483^{***}) \\
& : -0.2979 \ (-1.1073)
\end{align*}
\]

\[
\begin{align*}
IR & : -0.0215 \ (3.1290^{***}) \\
& : -0.0080 \ (0.7340) \\
& : -0.0071 \ (0.4744)
\end{align*}
\]

Short-term \((\delta_i)\)

\[
\begin{align*}
\Delta Y & : 1.4926 \ (2.3472^{**}) \\
& : 1.1448 \ (-1.0262) \\
& : 0.5819 \ (2.0820^{**})
\end{align*}
\]

\[
\begin{align*}
\Delta P & : -0.2401 \ (-1.7341^{*}) \\
& : -0.7302 \ (-1.1337) \\
& : -0.6465 \ (-2.4868^{**})
\end{align*}
\]

\[
\begin{align*}
\Delta IR & : -0.0013 \ (-0.8123) \\
& : -0.0020 \ (-1.0366) \\
& : -0.0026 \ (1.2762)
\end{align*}
\]

Constant

\[
\begin{align*}
& : -0.0269 \ (3.1290^{***}) \\
& : -1.0093 \ (0.7340) \\
& : -0.1014 \ (0.4744)
\end{align*}
\]

Number of observation

\[
\begin{align*}
179 & \quad 179 \quad 179
\end{align*}
\]

Number of countries

\[
\begin{align*}
7 & \quad 7 \quad 7
\end{align*}
\]

Hauman test

\[
\begin{align*}
\text{Chi2} & : 7.7500 \quad 0.0200 \\
\text{Prob.}>\text{Chi2} & : 0.06510 \quad 0.9992
\end{align*}
\]

(Notes) (i) *, **, and ***, respectively, indicate the significance at 10%, 5%, and 1% levels; the estimated ARDL is of order \((1, 1, 1, 1)\), and the order of variable is money, income, price, and interest.

(ii) \(a\) \(H_0\): PMG is efficient than MG estimation.

(iii) \(b\) \(H_0\): PMG is efficient than DFE estimation.

Table 3. Hausman tests of the PMG, MG, and DFE estimators

| Dependent variable | Causality (short-run) | Causality (long-run) |
|-------------------|----------------------|---------------------|
| \(\Delta M2\) | \(\Delta Y\) | \(\Delta P\) | \(\Delta R\) | \(ECT\) |
| \(\Delta M2\) | 4.812** | 10.992** | 0.000 | -0.015** | [-2.518] |
| \(\Delta Y\) | 2.859* | 42.119*** | 3.022* | -0.594** | [-2.325] |
| \(\Delta P\) | 1.336 | 0.685 | 2.687* | -0.005** | [-2.741] |
| \(\Delta R\) | 0.052 | 0.083 | 4.561** | -0.598*** | [-6.833] |

(Note) *, **, and ***, respectively, indicate the significance at 10%, 5%, and 1% levels.

Table 4. Panel granger causality test results
The results from the ARDL (1, 1, 1, 1) model demonstrate that short-run interest rate dynamics are not impacted by the assumptions while only income influences money demand.

However, it is not possible to maintain an alternative interpretation of the inflation Equation with exogenous money demand if weak exogeneity in the inflation rate is demonstrated (Hendry and Ericsson 1991, Revankar and Yoshino 1990). Therefore, we also conducted tests of weak exogeneity by undertaking a joint exclusion test; the results are reported in Table 4. We cannot reject the null hypothesis of weak exogeneity for the price variable. Therefore, price is treated as an exogenous variable.

Although the co-integration test results confirmed the presence of a long-run equilibrium relationship it cannot determine the direction of causation. Therefore, the Granger causality test is justifiable in order to examine the nature of the causal relationships among the co-integrated variables. We applied the VECM-based Granger causality test to discern the nature of causal relationships, which also allowed us to differentiate between short-term and long-term causal effects. The results of the Granger causality tests are reported in Table 4.

There is an evidence of feedback relationships (i.e. a bidirectional Granger causality) between money demand and real income, respectively, at the 5% and 10% significance levels in the short-term. We also find a short-term feedback relationship between price and interest rate, respectively, at the 5% and 10% significance levels. A one-directional Granger causality runs from price and interest rate to real income as well as from price to money. There is no causal relationship, in a Granger sense, between interest rate and money, unlike the earlier evidence presented by Kumar et al., (2009), which indicated a Granger causation between demand for money and short-term domestic interest rate but no evidence of causality with short-term foreign interest rate.

We found that the ECT coefficients in each model were negatively signed and statistically significant for the estimation of Equation (6) at the 1% and 5% levels of significance. Therefore, there is a feedback relationship among all variables in the long-run: (1) from income, price, and interest rate to money, (2) from money, price, and interest rate to income, (3) from money, income, and interest rate to price, and (4) from money, income, and price to interest rate. An interesting conclusion from the Granger causality results is that the demand for money is linked with price, real income, and interest rate in the long run. Thus, our results are aligned with the expectations of monetary transmission mechanism theories.

V. Conclusions

A prerequisite for the proper management of monetary policy is the existence of a well-specified money demand function. This paper investigates the long-run equilibrium relationships using
the panel co-integration methods between the determinants of demand for money such as income, price, and interest rates in South Asian countries. The panel ARDL technique based on Pesaran et al. (1999) is applied in order to model a standard money demand function. The tests were carried out on the premise that comparing specific countries’ coefficients enable us to capture the heterogeneity among these countries.

The test results from the panel co-integration provided significant evidence of the existence of a stable long-run money demand function for the economies of these seven South Asian countries. Interestingly, the estimation coefficient of income is above one and is statistically positive. Moreover, the price and interest rate are statistically negative and significant. The results provide strong evidence of a theoretically consistent impact of real income, interest rate, and price on money demand. Income is positive and statistically significant while price and interest rate are insignificant in the short-run. Our results from the panel VECM show that there is a feedback relationship between the demand for money and real income, but only a unidirectional causation between price and interest rate to income and price to money. However, there is evidence of bidirectional long-run relationships among all the variables.

Our findings indicate that an increase in real income increases money demand while money demand decreases with a rise in the interest rate, implying that these results are consistent with the theoretical expectations. Monetarists believe that money demand does not affect economic growth, but it does influence inflation. Our findings support a useful policy recommendation for the central banks of the South Asian countries to maintain price stability. Disequilibrium in the money market, such as an excess increase in money supply, can exaggerate inflation and widen the output gap in the future as per our findings. Therefore, these economies should avoid creating any unnecessary disequilibrium in the money market, such as an increase in the money supply, in order to minimize price instability. We conclude that controlling the money supply is a suitable instrument of monetary policy management in South Asian economies.

References

Apergis, N. (2015). “Long-run estimates of money demand: New evidence from East Asian countries and the presence of structural breaks.” *Applied Economics* 47, no. 31, 3276-3291. doi.org/10.1080/00036846.2015.1013615

Bahmani, S. (2015). “Stability of the Demand for Money in the Middle Stability of the Demand for Money in the Middle East.” *Emerging Markets Finance and Trade* 938, October. doi.org/10.2753/REE1540-496X440104

Bahmani-Oskooee*, M., and Rehman, H. (2005). “Stability of the money demand function in Asian developing countries.” *Applied Economics* 37, no. 7, 773-792. doi.org/10.1080/0003684042000337424
Ball, L. (2001). “Another look at long-run money demand.” *Journal of Monetary Economics* 47, 31-44. doi.org/10.1016/S0304-3932(00)00043-X

Bandt, O. De, Bruneau, C., and Amri, W. El. (2008). “Convergence in household credit demand across euro area countries: Evidence from panel data.” *Applied Economics* 41, no. 27, 3447-3462. doi.org/10.1080/00036840701493774

Basher, S. A., and Fachin, S. (2014). “Investigating long-run demand for broad money in the Gulf Arab countries.” *Middle East Development Journal* 6, ni. 2, 199-214. doi.org/10.1080/17938120.2014.961330

Baumol, W. J. (1952). “The transactions demand for cash: an inventory theoretic approach.” *Quarterly Journal of Economics* 66, November, 545-56.

Beyer A (2009). “A stable model for euro area money demand revisiting the role of wealth.” ECB Working Paper No. 1111.

Budha, B. B. (2011). “An empirical analysis of money demand function in Nepal.” *NEPAL RASTRA BANK* 23, 54.

Dilan, D., and Örsal, K. (2017). “Analysing money demand relation for OECD countries using common factors.” *Applied Economics* 49, no. 60, 6003-6013. doi.org/10.1080/00036846.2017.1371842

Driscoll, J. C. (2004). “Does bank lending affect output? Evidence from the US states.” *Journal of monetary economics* 51, no. 3, 451-471. doi.org/10.1016/j.jmoneco.2004.01.001

Dobnik, F. (2011). “Long-run Money Demand in OECD Countries-Cross-Member Cointegration.” *RUHR Economic Papers*, 237.

Dreger, C., and Wolters, J. (2010). “Investigating M3 money demand in the euro area.” *Journal of International Money and Finance* 29, 111-122. doi.org/10.1016/j.jimonfin.2009.02.002

Dreger, C., and Wolters, J. (2014). “Money demand and the role of monetary indicators in forecasting euro area inflation.” *International Journal of Forecasting* 30, no. 2, 303-312. doi.org/10.1016/j.ijforecast.2013.09.008

Dreger, C., and Wolters, J. (2015). “Unconventional monetary policy and money demand.” *Journal of Macroeconomics* 46, 40-54. doi.org/10.1016/j.jmacro.2015.07.005

Dunne, J. P., and Kasekende, E. (2018). “Financial Innovation and Money Demand: Evidence from Sub-Saharan Africa.” *South African Journal of Economics* 0, 1-21. doi.org/10.1111/saje.12205

Engle, R. F., and Granger, C. W. (1987). “Co-integration and error correction: Representation, estimation, and testing.” *Econometrica: journal of the Econometric Society*, 251-276. doi.org/10.2307/1913236

Ericsson, N. R. (1998). “Empirical modeling of money demand.” *Empirical Economics* 23, 295-315.

Fidrmuc, J. (2009). “Money demand and disinflation in selected CEECs during the accession to the EU.” *Applied Economics* 41, 1259-1267. doi.org/10.1080/00036840601019323

Foresti, P., and Napolitano, O. (2013). “Modelling long-run money demand: A panel data analysis on nine developed economies.” *Applied Financial Economics* 23, no. 22, 1707-1719. doi.org/10.1080/09603107.2013.848024

Friedman, M. (1956). “The quantity theory of money-a restatement.” In *Studies in the Quantity Theory of Money*, ed. M. Friedman. Chicago: University of Chicago Press.

Gerlach, S., and Svensson, L. (2003). “Money and inflation in the euro area: A case for monetary indicators?.” *Journal of Monetary Economics* 50, 1649-72. doi.org/10.1016/j.jmoneco.2003.02.002
Goldfeld, S. M., and Sichel, D. E. (1990). “The demand for money.” *Handbook of Monetary Economics*, Chapter 8, 1, 299-356.

Goldfeld, S. M. (1994). “Demand for money: Empirical studies.” in *The New Palgrave Dictionary of Money & Finance*, Eds P. Newman, M. Milgrate & J. Eatwell. London, Macmillan Press.

Harb, N. (2004). “Money demand function: A heterogeneous panel application.” *Applied Economics Letters* 11, no. 9, 551-555. doi.org/10.1080/1350485042000225739

Hamori, S., and N. Hamori (2008). “Demand for Money in the Euro Area.” *Economic Systems* 32, no. 3, 274-284. doi.org/10.1016/j.ecosys.2008.03.001

Hausman, J. (1978). “Specification tests in econometrics.” *Econometrica* 46, no. 6, 1251-1271.

Hendry, D. F., & Ericsson, N. R. (1991). “An econometric analysis of UK money demand in monetary trends in the United States and the United Kingdom by Milton Friedman and Anna J. Schwartz.” *The American Economic Review*, 8-38.

Hsiao, C., M. H. Pesaran, and A. K. Tahmiscioglu (2002). “Maximum likelihood estimation of fixed effects dynamic panel data models covering short time periods.” *Journal of Econometrics* 109, 107-150.

Khalid, A. M. (2010). “Modelling money demand in open economies: The case of selected Asian countries.” *Applied Economics*, (October 2014), 37-41. doi.org/10.1080/000368499323616

Kjosevski, J., and Petkovski, M. (2017). “Are the determinations of money demand stable in selected countries from southeastern europe?” *Romanian Journal of Economic Forecasting* 20, no. 4, 84-96.

Kjosevski, J., Petkovski, M., and Naumovska, E. (2016). “The stability of long-run money demand in western balkan countries: An empirical panel investigation.” *South East European Journal of Economics and Business* 11, no. 2, 61-70. doi.org/10.1515/jeb-2016-0011

Kumar, P., Seema, N., and Mishra, V. (2009). “Estimating money demand functions for South Asian countries.” *Empirical Economics* 36, 685-696. doi.org/10.1007/s00181-008-0219-9

Kumar, S., Chowdhury, M. B., and Rao, B. B. (2013). “Demand for money in the selected OECD countries: A time series panel data approach and structural breaks.” *Applied Economics* 45, no. 14, 1767-1776. doi.org/10.1080/00036846.2011.637897

Laidler, D. E. W. (1985). *The demand for money: Theories, evidences, and problems*, Harper and Row, Publishers, New York.

Laidler, D. E. W. (1999). *The quantity of money and monetary policy*, Bank of Canada Working Paper Series No. 99-5, Bank of Canada, Ottawa

Lee, C. C., and Chang, A. H. (2013). “Revisiting the demand for money function: Evidence from the random coefficients approach.” *Quantitative Finance* 13, no. 9, 1491-1502. doi.org/10.1080/14697688.2011.653386

Levin, A., Lin, C. F., and Chu, C. S. J. (2002). “Unit root tests in panel data: Asymptotic and finite-sample properties.” *Journal of econometrics* 108, no. 1, 1-24. doi.org/10.1016/S0304-4076(01)00098-7

Li, T., Wang, Y., and Zhao, D. (2016). “Environmental kuznets curve in China: New evidence from dynamic panel analysis S.” *Energy Policy* 91, 138-147. doi.org/10.1016/j.enpol.2016.01.002

Liew, V. K. S. (2004). “Which lag length selection criteria should we employ?.” *Economics bulletin* 3, no. 33, 1-9.

Im, K. S., Pesaran, M. H., and Shin, Y. (2003). “Testing for unit roots in heterogeneous panels.” *Journal*
Lucas Jr, R. E. (1988). “Money demand in the United States: A quantitative review.” *Carnegie-Rochester Conference Series on Public Policy* 29, 137-67. 10.1016/0167-2231(88)90009-7

Lütkepohl, H. (1991). *Introduction to Multiple Time Series Analysis*, Springer-Verlag, Berlin.

Maddala, G. S., and Wu, S. (1999). “A comparative study of unit root tests with panel data and a new simple test.” *Oxford Bulletin of Economics and statistics* 61, no. S1, 631-652. doi.org/10.1111/1468-0084.06104

Mark, N. C., and Sul, D. (2003). “Cointegration vector estimation by panel DOLS and long-run money demand.” *Oxford Bulletin of Economics and statistics* 65, no. 5, 655-680. doi.org/10.1111/j.1468-0084.2003.00066.x

Mbazia, N., and Djelassi, M. (2019). “Housing prices and money demand: Empirical evidence in selected MENA countries.” *Review of Middle East Economics and Finance*, 1-18. doi.org/10.1515/rmeef-2017-0034

Nautz, D., and Rondorf, U. (2011). “The (in) stability of money demand in the euro area: Lessons from a cross-country analysis.” *Empirica* 38, 539-553. doi.org/10.1007/s10663-010-9139-y

Pedroni, P. (1999). “Critical values for cointegration tests in heterogeneous panels with multiple regressors.” *Oxford Bulletin of Economics and statistics* 61, no. S1, 653-670. doi.org/10.1111/1468-0084.06104

Pedroni, P. (2004). “Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis.” *Econometric theory* 20, no. 3, 597-625. doi.org/10.1017/S0266466604203073

Pesaran, M. H., and Smith, R. (1995). “Estimating long-run relationships from dynamic heterogeneous panels.” *Journal of econometrics* 68, no. 1, 79-113. doi.org/10.1016/0304-4076(94)01644-F

Pesaran, M. H., Shin, Y., and Smith, R. P. (1999). “Pooled mean group estimation of dynamic heterogeneous panels.” *Journal of the American Statistical Association* 94, no. 446, 621-634. doi.org/10.1016/S0266466604203073

Poole, W. (1970). “Optimal choice of monetary policy instruments in a simple stochastic macro model.” *The Quarterly Journal of Economics* 84, no. 2, 197-216. doi.org/10.2307/1883009

Revankar, N. S., and Yoshino, N. (1990). “An 'Expanded Equation' Approach to Weak-Exogeneity Tests in Structural Systems and a Monetary Application.” *The Review of Economics and Statistics*, 173-177.

Rao, B. B., and Kumar, S. (2008). “A Panel Data Approach to the Demand for Money and the Effects of Financial Reforms in the Asian Countries.” *MPRA Paper No. 6805.*

Rao, B. B., and Kumar, S. (2009). “A panel data approach to the demand for money and the effects of financial reforms in the Asian countries.” *Economic Modelling* 26, no. 5, 1012-1017. doi.org/10.1016/j.econmod.2009.03.008

Rao, B. B., Tamazian, A., and Singh, P. (2009). “Demand for Money in the Asian Countries: A Systems GMM Panel Data Approach and Structural Breaks.” *MPRA Paper No. 15030*, (15030). Retrieved from http://mpra.ub.uni-muenchen.de/15030/

Setzer, R., and Wolff, G. B. (2013). “Money demand in the euro area: new insights from disaggregated data.” *MPRA Paper No. 17483*, 10, no. 2, 297-315. doi.org/10.1007/s10368-012-0214-7

Simmons, R. (1992). “An Error-correction Approach to Demand for Money in Five African Developing Countries.” *Journal of Economic Studies* 19, 29-47. doi.org/10.1108/01443589210015935
Stock, J. H., and Watson, M. W. (1993). “A simple estimator of cointegrating vectors in higher order integrated systems.” *Econometrica* 61, 783-820. doi.org/10.2307/2951763

Taghizadeh-Hesary, F., and Yoshino, N. (2014). “Monetary policies and oil price determination: An empirical analysis.” *OPEC Energy Review* 38, no. 1, 1-20. doi.org/10.1111/opec.1202

Taghizadeh-hesary, F., and Yoshino, N. (2018). “Assessment of the channels of transmission of oil price fluctuations to the economy.” *Argumenta Oeconomica* 41, no. 2, 5-34. doi.org/10.15611/aoe.2018.2.01

Tang, T. C. (2007). “Money demand function for Southeast Asian countries: An empirical view from expenditure components.” *Journal of Economic Studies* 24, no. 6, 476-496. doi.org/10.1108/01443580710830952

Tobin, J. (1956). “The interest-elasticity of transactions demand for cash.” *Review of Economics and Statistics* 38, August, 241-47.

Valadkhani, A. (2008). “Long- and short-run determinants of the demand for money in the Asian-Pacific Countries: An empirical panel investigation.” *Annals of Economics and Finance* 9, 77-90.

Valadkhani, A., and Alauddin, M. (2003). *Demand for M2 in Developing Countries: An Empirical Panel Investigation.*

WDI (2019). “World Development Indicators, WDI.” Available at: https://datacatalog.worldbank.org/dataset/world-development-indicators

Xing, J. (2012). “Tax structure and growth: How robust is the empirical evidence?.” *Economics Letters* 117, no. 1, 379-382. doi.org/10.1016/j.econlet.2012.05.054

Yoshino, N., Taghizadeh-hesary, F., and Miyamoto, H. (2017). “The Effectiveness of the Negative Interest Rate Policy in Japan.” *Credit and Capital Markets* 50, no. 2, 189-212.

Yoshino, N., Taghizadeh-hesary, F., and Tawk, N. (2017). “Decline of oil prices and the negative interest rate policy in Japan.” *Economic and Political Studies* 4816, May, 1-18. doi.org/10.1080/20954816.2017.1310798
Appendix 1. South asian countries and time periods analyzed in the sample data.

| Country         | Data Period |
|-----------------|-------------|
| Bangladesh      | 1986-2017   |
| Bhutan          | 1986-2017   |
| India           | 1986-2017   |
| The Maldives    | 1986-2017   |
| Nepal           | 1986-2017   |
| Pakistan        | 2004-2017   |
| Sri Lanka       | 2001-2016   |