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Is the Money Supply Endogenous or Exogenous? A Panel Data Investigation of Developing Asian Countries

Abstract: This study investigates whether the money supply (MS) is endogenously or exogenously determined in 10 developing Asian countries. The study implemented the Panel FMOLS, DOLS, and ARDL/PMG approaches with quarterly panel data from 1980Q1 to 2020Q4. The results reveal that bank lending and income positively influence the MS, while the inflation rate has a negative impact. These findings support the idea that the MS is endogenously determined while rejecting the view of the Monetarists that the MS is exogenously determined or that there is a "helicopter drop" of money. Central banks should espouse a flexible approach to monetary policy that considers the broader economic environment. Recognizing the endogeneity of the MS can lead to more prudent strategies for achieving sustainable economic outcomes.

Keywords: Money supply, Post-Keynesian Hypothesis, endogeneity, Asia

JEL Classification: E5, E12, N15.

1. Introduction

Money serves as the lifeblood of an economy, tightly connected with its growth and development. Decisions made by the monetary authorities of a nation regarding the regulation of the money supply (*MS*) and related measures wield significant influence over economic development. The concept of *MS* encompasses the entirety of financial assets functioning as both a store of value and a medium of exchange. A deep understanding of the dynamics governing the *MS* is essential for formulating and executing monetary policies aimed at achieving macroeconomic objectives such as reducing unemployment, stabilizing prices, and addressing deficits in the balance of payments. Central to this discourse is the ongoing debate in the literature over the nature of money; whether it is endogenously or exogenously determined. In his study, Wray (1992, p. 1145) defined the term exogeneity stating that "Exogeneity usually means that a variable is determined by the government, or it indicates a variable whose value is taken as given because the theorist does not wish to explain its determination. In the case of the money supply, exogeneity is usually used in the first sense: the assumption is that the central bank controls the money supply through its control of bank reserves."

The Monetarist view, based on the belief that Central Banks (CBs) have significant control over the *MS* through monetary base and assuming a constant money multiplier, argues that the *MS* is exogenously determined (Nayan, Kadir, Abdullah, and Ahmad, 2013). This control is exemplified by the ability of CBs to influence the *MS* through its manipulation of high-powered money as documented by Brunner (1968). Monetarists advocate for a direct relationship between the growth rate of *MS* and inflation, signifying that increases in *MS* led to inflationary pressure on the general prices level. Emphasizing the importance of monetary aggregates over interest rate, Monetarist suggest for a restrictive monetary policy by the CB to curb excessive growth of *MS*. This policy is implemented through various instruments, including adjustment to discount rate, reserve requirement ratios and open market operations, aimed at constraining the growth of excess reserves.

Brunner (1968) and Wray (1993) further explained that the Monetarists firmly believe that such constricted money will undeniably slow the *MS* growth rate, resulting in lower price levels directly and lower interest rates indirectly. Moreover, Brunner (1968, pp. 9-24) noted that "since governments control the reserve requirement ratio and, thus, reserves, they can control the supply of money as

well." Cottrell (1994) emphasizes the concept of "helicopter drop[1,2] as central to orthodox enquiries into fluctuations in *MS* and their economic impacts. It is also noted by Palley (2017, p .8) that monetarism appeared as a vital macroeconomic doctrine in the 1960s, and its core theoretical claims were: (1) the MS is exogenous and controlled by the CB, (2) money is the most important factor and fiscal policy is ineffective unless it is money-financed, (3) inflation is solely caused by MS growth, and (4) CBs should follow a simple MS growth rule to enhance economic stability.

The Post-Keynesians (PK) school of thought challenges the notion of exogenous control over *MS*, arguing that it instead depends on the demand for bank credit. According to this, the CB can influence the interest rate by adjusting the amount of monetary reserve but difficult to regulate the quantity of money (Palley, 1993)[3]. PK school of thought expounds that the *MS* is endogenously determined within the monetary system, meaning that its creation is not dictated by the external forces. Consequently, the CBs cannot exogenously control the quantity of credit money, rather they can only influence interest rates. In this regard, Davidson (1978) and Moore (1988) have contributed significantly, emphasizing the endogenous nature of the *MS*. The PK claims that money is endogenous, and the endogeneity of money depends on the supply of money as explained by the bank loans (demand for credit) (Nayan et al. (2013). It is also noted by Smithin (1997, p. 395) that "production takes time and is financed by loans from the financial intermediaries such as banks." Further, Moore (1988, p. 384) mentioned that "An

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[1] Helicopter money, also known as a helicopter, drop, is a hypothetical and unconventional monetary policy tool that involves printing a large amount of money and distributing it to the public in order to stimulate the economy.

[2] Friedman (1969, pp. 4-6) wrote "Let us suppose now that one day a helicopter flies over this community and drops an additional $1,000 in bills from the sky, which is, of course, hastily collected by members of the community. Let us suppose further that everyone is convinced that this is a unique event which will never be repeated. To begin with, suppose further that each individual happens to pick up an amount of money equal to the amount he held before, so that each individual finds himself with twice the cash balances he had before. If every individual simply decided to hold onto the extra cash, nothing else would happen…….But this is not the way people would behave…..We know only that each individual will seek to reduce his cash balances at some rate. He will do so by trying to spend more than he receives.....It is easy to see what the final position will be. People's attempts to spend more than they receive will be frustrated, but in the process these attempts will bid up the nominal value of services....."

[3] The monetarists assert that CBs are accountable for stability at the macro level, which can be explained using the Fisher equation "MV = PY". The monetarists argue that the money supply (M) is exogenous, money demand (1/V) is stable, and changes in the money supply led to changes in nominal income (PY). This implies that changes in the exogenous money supply by the CB are the main cause of macroeconomic instabilities.

endogenous money supply is sometimes interpreted as implying that CBs are passive and cannot affect the behaviour of money growth. This is clearly a misperception. An endogenous money supply simply denotes that the money supply is determined by market forces. Central banks are able to administer the level of short-term interest rates exogenously within a substantial range. This will obviously affect the quantity of credit and money demanded, and so the behaviour of money growth." Moore (1988, p. 384) also mentioned that "Only once it is fully comprehended that the supply of credit money is inherently endogenous and that the money supply function should be viewed as horizontal in interest-money space, at a level of short-term interest rates established by the CB, can the base-multiplier relationship be understood for what it is: a purely descriptive tautology."

In contrast to the conventional perspective, the PK theory challenges the prevailing reliance on money multiplier and instead underscores the significance of bank lending in determining *MS* (Palley, 2015). While traditional perspectives prioritize the role of deposits in creating loans (Elhendawy, 2016), PK theory asserts that bank lending primarily influences bank deposits, thereby shaping the *MS*. The emphasis on endogeneity contradicts the conventional belief in the exogeneity of *MS*, which rests on the high-powered base money multiplier (Moore, 1988). Palley (2015) highlights the central role of money on Keynesian macroeconomics, noting the limited attention of Keynes to the determination of *MS* and its treatment as exogenous, which has led to considerable confusion. Sieron (2019) argued that the dichotomy between endogenous and exogenous money oversimplifies the complexities of monetary dynamics, cautioning against drawing overly broad conclusion from this debate. The study of Sliwiński (2023) emphasizes the prevailing acceptance of endogenous money creation as a fundamental characteristic of contemporary economies, underscoring the need to check the bidirectional link between the quantity of money and GDP (nominal) in the extant empirical research. Azam and Rashid (2025) noted that challengers of the quantity theory of money recognize that inflation can be caused by printing and distributing money, but they also argue that other factors can also play an important role. They also mentioned that there are many alternative explanations for inflation, including structural, cost-push, and state balance sheet. Moreover, questions have been raised about the monetary mechanism, such as whether deposits produce loans or vice versa, and whether money is endogenous or exogenous.

While the debate over the endogeneity of *MS* persists, the existing literature reflects a divergence of perspectives. Despite efforts by the Post Keynesians to advocate for the endogenous nature of *MS*, mainstream acceptance remains

limited, partly due to the scarcity of experiential evidence on money endogeneity. Most of the available evidence comes from the US and the UK (Moore & Threadgold, 1980; Moore, 1988), leaving a gap in understanding this phenomenon in another region. However, the money endogeneity thesis has been supported by empirical evidence from Shanmugam, Nair, & Li (2003) for Malaysia, Howells and Hussein (1998) for the G7 nations, Panagopoulos and Spiliotis (2006) for Greece, Haghighat (2011) for Iran, Almutair (2015) for Saudi Arabia, and Elhendawy (2016) for Egypt. Notably, no comprehensive examination of the Post Keynesian Hypothesis for a larger number of Asian countries has been undertaken, highlighting the need for further exploration (Vera, 2001). The motivation for this study stems from the key role that the *MS* plays in driving economic growth and development. However, existing literature lacks clarity on whether the MS is exogenous or endogenous, which is essential for policymakers devising effective policies. To address this gap, this study aims to empirically investigate the impact of domestic credit, inflation rate, and income on the MS in 10 developing Asian countries4 over 1980Q1–2020Q[4,5] by using the most appropriate econometric techniques and robust data set, this study seeks to fill this gap and make three main contributions to the literature. Firstly, it tests the money endogeneity hypothesis for a panel of developing Asian countries, providing valuable insights into monetary dynamics in these often-overlooked economies. Secondly, the study enhances the reliability and consistency of its empirical findings by employing the most appropriate estimation strategy. Among these, the implementation of the panel ARDL (Autoregressive Distributed Lag) and PMG (Pooled Mean Group) estimators stand out. Lastly, this research distinguishes itself from erstwhile studies by covering a broader and more recent dataset, allowing for an enhanced understanding of current economic conditions and long-term trends in monetary dynamics. The empirical findings are expected to be beneficial for policymakers in developing Asian countries, helping them formulate effective macroeconomic policies for economic and financial growth and stability.

The study highlights the significance of recognizing the endogenous nature of the *MS* in the context of 10 developing countries in Asia. The empirical findings reveal strong support for the idea that 'the money supply is endogenous', while rejecting the Monetarist view that 'the money supply is exogenous'. The findings indicate a need to reconsider how monetary control is approached. The tradi-

[4] This study focuses on 10 developing Asian countries: Pakistan, Thailand, Sri Lanka, the Philippines, Papua New Guinea, Nepal, Malaysia, Indonesia, India, and Bangladesh.

[5] However, this study intends to use longer period data, as consistent data on the selected variables and countries were only available from 1980 to 2020,

tional belief that CBs can directly manage the MS through tools like open market operations, discount rates, or reserve requirements may need to be reassessed. Central banks should consider a more adjustable approach to monetary policy that take into account the overall economic environments. Acknowledging the endogeneity of the MS can result in more effective strategies for achieving long-term economic and financial stability.

The article is organized as follows: Section 2 reviews previous studies on money exogeneity. Section 3 covers data sources, model specification, and estimation techniques. Section 4 presents empirical results. Section 5 offers concluding remarks.

2. Earlier Theoretical and Empirical Evidences

The literature on the determinants of the money supply (*MS)* presents a diverse array of findings, reflecting varying economic contexts and methodologies utilised across different studies. Several empirical investigations have provided evidence in support of the endogeneity hypothesis, suggesting that the *MS* is determined by internal economic dynamics rather than exogenous factors. For instance, Mookerjee and Peebles (1998) utilized a broad range of macroeconomic variables to empirically survey the determinants of the *MS* in China and concluded that money is endogenous. Similarly, Vera (2001) tested the Post-Keynesian (PK) hypothesis using time series data for Spain and found empirical support for endogenous MS. The study added that empirical results favoured the endogenous money hypothesis and provided support to both the "structuralist" and "accommodationist" approaches. Further, corroborating indication for the endogeneity of the *MS* comes from studies conducted in other countries. Badarudin, Khalid, & Ariff (2012) demonstrated the endogeneity of the *MS* for Australia over a specific period, highlighting the influence of internal economic factors on money creation. Ahmed, Muzib, & Saha (2015) identified significant effects of foreign remittance, bank rate, inflation, and real interest rate variables on the broad money supply of Bangladesh, underscoring the endogenous nature of *MS* dynamics in the Bangladeshi context.

Similarly, studies conducted in Saudi Arabia (Almutair, 2015) and Iraq (Thwaini and Hamdan, 2017) have consistently found empirical evidences supporting the endogeneity of the *MS* in these respective countries. Incekara and Amanov (2017) examined the endogeneity of the *MS* for Turkey from 1990 to 2016 and found that the *MS* is endogenous. The study by Regret (2018) also found that the *MS* is endogenous in Zimbabwe from January 2009 to May 2017. Moreover, using

quarterly data from 1990–2017, Cyrille & Christophe (2022) confirmed the endogeneity of the *MS* in the Economic and Monetary Community of Central Africa. Bastav (2021) found that the *MS* is endogenous in Turkey, which is determined by the credit demand of firms and households from 2011–2018 (monthly data). Sliwiński (2023) found that real and financial economic activity, along with global liquidity, have a positive impact on domestic credit and the *MS* in 17 OECD countries from 2012–2018. Park (2023) examined two endogenous *MS* channels in Korea: the accommodationist and structuralist channels. The study revealed a one-way causality from loans to reserves and a two-way causal relationship between loans/reserves and the deposit ratio. The authors suggest that both accommodationist and structuralist channels operate concurrently in Korea. These findings suggest that the creation and expansion of the *MS* are driven by internal economic dynamics and credit demand, rather than being externally determined by monetary authorities. Liu et al. (2024) observed robust evidence in the South-Asian region supporting post-Keynesian theories (1991–2018).

However, contrasting results have also been reported in several studies, favouring the exogenous nature of the *MS*. In this regard, Ahmad and Ahmed (2006) found that the *MS* in Pakistan exhibits endogeneity in the short run but becomes exogenous in the long run (1980–2003). The study suggests a significant relationship between internal and external determinants of money creation. Similarly, Jayaraman and Choong (2009) found that reserve money Granger causes monetary aggregates in four Pacific Island countries, namely Samoa, Solomon Island, PNG, and Tonga, using quarterly data from 1980 to 2007, thereby the *MS* is exogenous. Likewise, Dash (2017) observed that forecast error variance decomposition indicated that thereby suggesting *MS* is dimly endogenous in India from 1970/1971 to 2009/2010.

Based on the aforementioned discussion, the literature on the endogeneity of the *MS* provides mixed findings, reflecting the complexity of monetary dynamics and the diverse economic contexts in which these dynamics operate. While many studies support the endogeneity hypothesis, some reveal the presence of exogenous influences on money creation. Further research is needed to explore the underlying mechanisms driving the endogeneity of the *MS* across different countries and regions, as well as its implications for monetary policy and macroeconomic stability. Some more related available empirical studies on whether money is endogenous or exogenous are presented in Table 1.

Table 1: Erstwhile empirical studies on the factor determining money supply

Author(s)	Data, countries	Methodology	Response variable	Regressors	Findings
Ongan, & Gocer (2023)	2003M4-2019M01, Japan	ARDL	Money supply (*MS*)	Monetary Base	MS found endogenous
Chen & Zheng (2020)	2000–2014, China	Cointegration analysis, Granger causality test	*MS*	GDP, stock market turnover, total retail sales of social, consumer goods, foreign exchange reserves	MS found endogenous
Dedeoglu, & Ogut (2018)	2009.10 and 2016.12 Turkey	Granger causality test	Bank loans, deposits, and MS	Bank loans, deposits, and M2	MS found endogenous
Nyumuah (2017)	1980–2012, Eight African countries[6]	FMOLS, ECM	Real narrow money balances	Real GDP, interest rate and inflation rate	Inflation and interest rate have inverse, while real GDP has positive effect on money demand.
Dash (2017)	1970–71 to 2009–10, India	VAR	Inflation	MS, and GDP	Found that the monetarist position that the MS is exogenously determined is weakly rejected
Nayan et al., (2016)	2001–2011 174 countries	Pooled OLS, FE, and GMM	*MS*	Real per capita income, bank lending, Inflation	MS found endogenous
Elhendawy (2016)	1990–14 Egypt	Cointegration method and VECM	*MS*	Domestic credit, inflation, and total deposits	Result vindicates that MS in Egypt is Endogenous
Almutair (2015)	1997 –2015 Saudi Arab	Cointegration method and VECM	*MS*	Bank loans and demand deposit	MS found endogenous
Nayan et al. (2013)	1970–2011 177 countries	Pooled OLS, FE, and GMM	*MS*	Bank lending, real GDP per capita, inflation	MS found endogenous
Ali and Islam (2011)	1975-76 to 2008-2009 Bangladesh	OLS	*MS*	Real high-powered money, deposit interest rate, real external resources[7] Govt. spending[8], and total no of bank	Found mixed results

[6] Countries used are Angola Equatorial Guinea, Gambia, Guinea-Bissau, Kenya, Mali, Nigeria and Uganda

[7] sum of foreign aid, loan and remittances

[8] Govt. spending as % of Govt. revenues for Govt. budget deficits

Haghighat (2011)	1968–2009 Iran	Cointegration method and VECM	*MS*	Bank credit and Income	Empirical findings strongly support the PK hypothesis that MS is Endogenous
Cerqueira (2009)	1964.04 to 1986.02, Brazil	Kalman filter and cointegration procedures	*MS*	Inflation	MS found exogenous
Valadkhan (2008)	1975–2002 six countries (Asian-Pacific)[9]	Fixed-effects	Stock of nominal money (M_2)	GDP price deflator, deposit interest rate, real GDP, real effective exchange rate, lending interest rate, the US real interest rate	Real GDP has positive, while inflation, the interest rate, the US real interest rate, and the real effective exchange rate have inverse effects on money demand
Panagopoulos and Spiliotis (2006)	1975Q1to 1998Q2 Greece	ECVAR	*MS*	Index of industrial production and the monetary base	MS in Greece found endogenous
Alqudair (2006)	1970- 2001. Kingdom of Saudi Arabia	Cointegration method and VECM	Loan	Deposits and GDP	MS found exogenous
Shanmugam et al., (2003)	1985 Q1– 2000Q Malaysia	Cointegration, and ECM	MS commercial bank loans to the monetary base & income	Total commercial bank loans to the monetary base, MS, income (GNP)	Empirical findings support the PK hypothesis that MS is endogenous.
Howells and Hussein (1998)	Data[10] G7 countries	Cointegration method and VECM	*MS*	Bank lending	Empirical findings indicate that broad money is endogenous.
Moore (1989)	1959–1983 USA, UK.	Granger causality	Total assets	Total loans	Empirical findings support the view of the endogeneity of the monetary aggregates[11].

Note: GMM=Generalized method of moment, VECM= Vector Error Correction models, OLS= Ordinary least squares, VAR= Vector Autoregression

Source: Author`s compilation

[9] Countries are Singapore, the Philippines, Malaysia, Japan, Fiji, and China.

[10] For the USA, Japan, Italy, and Canada time period is (1957.1 to 1992.4), Germany (1969.1 to 1992.4), France (1977.4 to 1992.4) and UK (1975.1 to 1993.4).

[11] Moore (1989: 81) mentions that "Changes in the credit money stock in both the US and the UK may be attributable primarily to changes in the quantity of bank credit demanded. Changes in bank credit in turn can be well explained by changes in the demand for working capital, and in particular by changes in the money wage bill. Nominal wage increases govern both the rate of inflation and the rate of credit money growth."

3. Empirical methodology and data

Model Specification

To examine the potential determinants of growth in the money supply (*MS*) in 10 developing Asian countries, this study utilized a *MS* model based on General Theory of Liquidity Preference[12] (Keynes, 1936) and cab be written as follows:

$$M = L\ (y,\ r) \tag{1}$$

This study made slight modifications to Eq. (1) by adding inflation variable. This multivariate regression model is similar to the one used by Zulkhibri and Majid (2007), Valadkhani (2008), Badarudin et al. (2012), Farazmand, Ansari, & Moradi (2016), Thwaini and Hamdan (2017), Dedeoglu and Ogut (2018), and Ongan and Gocer (2023) and can be expressed as follows:

$$\mathrm{MS_{it}} = \beta_{0,\mathrm{i}} + \beta_{1,\mathrm{i}}\mathrm{BL_{it}} + \beta_{2,\mathrm{i}}\mathrm{Y_{it}} + \beta_{3,\mathrm{i}}\mathrm{P_{it}} + \mu_{\mathrm{it}} \tag{2}[13]$$
$$\beta_1\ \beta_2 > 0\ and\ \beta_3 < 0$$

Where, $\mathrm{MS_{it}}$ is broad money growth (annual %), $\mathrm{BL_{it}}$ is domestic credit provided by financial sector (% of GDP), $\mathrm{Y_{it}}$ is GDP per capita (constant 2010 US$), and $\mathrm{P_{it}}$ is inflation measured by consumer prices (annual %). B_0 shows the constant and β_1–β_3 are the coefficient of regressors to be estimated, while μt is the error term. The *i* and *t* represent the i^{th} country and the t^{th} time period, respectively (i = 1,2, …, N (in this case 10 countries); t = 1,2,… T (40 years). It is assumed that the μ_t is distributed independently and identically (μit ~ iid (0, σ2). Quarterly data[14] from 1980Q1 to 2020Q4 was collected from the 'World Development Indicators (2023)', a publication by the World Bank, for the empirical examination. Generally, data is converted into log form whenever we have positive values for a variable and the researcher intends to explain it in percentage changes for a variable (elasticities), which may have different measurement units. In this study, the data on all variables, except for the money supply and inflation rate, has been transformed

[12] See (Palley, 2015)

[13] We did not provide the specific algebraic equation for the Panel ARDL suggested by Pesaran and Shin (1995). However, we followed the same standard equation and proper procedure in the case of Panel ARDL

[14] The data collected were originally annual, but they have been converted into quarterly format using EViews software for computational purposes. The data used in this study are openly available and have been gleaned from the World Development Indicators (2023), the World Bank publication. http://data.worldbank.org/country

into natural logarithms to reduce any non-linearity problems and to normalize the data. The log transformation is generally used to decrease the skewness of a measurement variable. The log model smooths the data and may improve the estimate, providing empirically precise and effective results compared to a linear transformation (see Zafar, Majeed, Nosheen, & Iqbal, 2021). Variables definitions, data sources, and references supporting the variables are presented in Table 2. A concise summary of the descriptive statistics is given in Table 3.

Table 2: Variables definition, data sources and references in support of variables

Variables	Labels	Sources	References
Broad money growth (annual %)	MS	World Development Indicators (WDI) (2023)	Zulkhibri and Majid (2007), Haghighat (2011), Almutair (2015), Nayan et al., (2016), Elhendawy (2016), Farazmand et al. (2016), Dedeoglu, & Ogut (2018), Chen & Zheng (2020)
Domestic credit provided by financial sector (% of GDP)	BL	WDI (2023)	Nayan et al. (2013), Almutair (2015), Elhendawy (2016), Dedeoglu, & Ogut (2018)
GDP per capita (constant 2010 US$)	Y	WDI (2023)	Haghighat (2011), Farazmand et al. (2016), Chen & Zheng (2020)
Inflation measured by consumer prices (annual %)	P	WDI (2023)	Nayan et al. (2013), Ahmed et al. (2015), Farazmand et al. (2016), Elhendawy (2016)

Source: Author`s compilation

Table 3: Summary of descriptive statistics

Statistics/ variables	MS	P	Y	BL
Mean	51.56169	7.598766	2000.704	54.74365
Median	42.62123	6.695615	1262.581	47.45318
Maximum	140.7617	58.38709	12486.68	163.3545
Minimum	2.674720	0.290008	283.0523	10.41790
Std. Dev.	31.43187	5.569086	2336.855	33.30965
Skewnes	1.385848	4.275631	2.441746	1.462963
Kurtosis	4.214419	35.84959	8.815485	4.566952
J-B	114.4638	14402.75	720.8544	137.7047
Prob.	0.000000	0.000000	0.000000	0.000000

Source: Author`s own work

Estimation Strategy

Some previous studies, including Moore (1989), used monthly, quarterly, and yearly data from 1959-1983 for the USA and UK, and used Granger causality. Valadkhan (2008) used the Fixed-effect method for six Asian Pacific countries

over 1975–2002. Nayan, Kadir, Yusof, and Ali (2016) used Pooled OLS, Fixed-effect, and GMM methods for 174 countries over the period of 2001–2011, and Nyumuah (2017) employed the FMOLS method for estimating unknown parameters for eight African countries during 1980–2012.

Cross-section Dependence (CSD) test and Panel Unit root tests

In panel data analysis, it is generally necessary to check for cross-section dependency (CSD) when the time dimension is significantly high. This study employs widely used CSD tests such as CD-Pesaran scaled LM (Pesaran, 2004), CDLM (Breusch-Pagan, 1980), CD-Bias-corrected scaled LM (Pesaran, 2004), and CD-LMadj (Pesaran Ullah, and Yamagata, 2008). After checking for CSD in the series, this study applies commonly used 1st generation panel unit root tests such as LLC (Levin, Lin & Chu, 2002) and IPS (Im-Pesaran-Shin) to assess the stationarity properties in panel data. Additionally, the CIPS test by Pesaran (2007) is implemented for further analysis.

3.4. The FMOLS (Fully Modified Ordinary Least Squares)

This study implements initially the Panel FMOLS to measure the impacts of bank lending, real income, and inflation rate on the *MS* growth rate for 10 developing Asian countries due to its prominent features. Phillips and Hansen (1990) introduced the FMOLS estimator to recover the unbiased estimators of co-integrating regressions under a single equation-base. Largely, the FMOLS approach amends the Least Squares technique to reduce the potential endogeneity bias problem. The FMOLS method effectively addresses potential autocorrelation issues and is asymptotically unbiased and highly reliable even in the presence of a mixture normal asymptotic. Ramirez (2007) also documented features of FMOLS that "In addition, it proceeds to estimate the pooled production (productivity) function via a 'group-mean' panel FM-OLS estimator developed by Pedroni (1999; 2001) not only generates consistent estimates of the parameters in relatively small samples but also controls for the potential endogeneity of the regressors and serial correlation." Hence, based on the visible advantages of FMOLS method, this study employs it to deal with the potential endogeneity and autocorrelation biases, if any, in the data used. In their studies, Nguyen et al. (2021) and Addis and Cheng (2023) also endorsed that FMOLS can correct endogeneity, autocorrelation problems, and potential dynamic heterogeneity across cross-sectional dimensions. The FMOLS specification of cointegrating systems for panel data

by Pedroni (1999, 2001), which has been used in many studies including (Muye & Muye, 2017; Khan & Khan, 2023), can be written in algebraic form as follows:

$$y_{it} = \beta_0 + x_{it}\beta_1 + \vartheta_{it} \quad (3)$$
$$x_{it} = x_{it-1} + \varepsilon_{it}$$

Where the vector error process $\varphi_{it} = (\vartheta_{it}, \varepsilon_{it})$ is a stationary with co-variance matrix represented by Ω_i. The between-dimension, group-mean panel FM-OLS estimator by Pedroni can be expressed algebraically as follows:

$$\hat{\beta}_{GFM} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} (x_{it} - \overline{x}_i)^2\right)^{-1} \left(\sum_{t=1}^{T} (x_{ti} - \overline{x}_i) z_{it}^* - T\tau_i\right) \quad (4)$$

Where,

$$z_{it}^* = (z_{it} - \overline{z}_{it}) - \left(\frac{\widehat{\Omega}_{21i}}{\widehat{\Omega}_{22i}}\right) \Delta x_{it}$$

and

$$\tau_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^0 - \left(\frac{\widehat{\Omega}_{21i}}{\widehat{\Omega}_{22i}}\right)\left(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^0\right).$$

$$\hat{t}_{\hat{\beta}_{GFM}^*} = N^{-\frac{1}{2}} \sum_{t=1}^{T} \left(\hat{\beta}_{FM,i}^* - \beta\right) \left(\hat{L}_{11i}^{-1} \sum_{t=1}^{T} (x_{it} - \overline{x}_{it})^2\right)^{\frac{1}{2}} \quad (5)$$

where the FMOLS estimator employed to each panel member is $\hat{\beta}_{FM,i}^*$. The properties of the related t-ratios are standard and ordinarily distributed as $T \to \infty$ and $N \to \infty$.

The DOLS (Dynamic Ordinary Least Squares OLS)

The DOLS model proposed by Saikkonen (1991) is also employed which serves the purpose of certifying the consistency of the regression and of removing the influence of regressor endogeneity. Another benefit of this estimator is that the residuals require not to be free from serial correlation (Buch, 2004). Nguyen et al. (2021) and Addis and Cheng (2023) also explicate that DOLS model can correct endogeneity, autocorrelation problems, and potential dynamic heterogeneity across cross-sectional dimensions. The DOLS model can be derived from the equation (5) given below:

$$y_{it} = z_{it-1}'\beta + \sum_{j=-p^1}^{j=p^2} C_{it} \Delta Z_{it+j} + \nu_{it} \quad (6)$$

Where, Cij is the coefficient of a lead or lag of 1st differenced variables.

The Panel ARDL/PMG (Autoregressive Distributed Lag/Pooled Mean Group) Approach

In their studies, Pesaran and Shin (1995) suggested that the panel ARDL model can be used even with variables having dissimilar orders of integration, regardless of whether the variables are I(0) or I(1), or a combination of the two. Also, both the short- and long-run impacts can be assessed simultaneously from a dataset with a large cross-section and time dimensions. Likewise, the ARDL model, mainly PMG gives reliable coefficients even with the likely existence of endogeneity because it contains lags of response and explanatory variables (Pesaran, Shin, & Smith, 1999; Samargandi, Fidrmuc, & Ghosh, 2014).). Therefore, in addition to the FMOLS and DOLS models, this study employs the ARDL/PMG approach to analyze the long-run relationship and validate the estimates obtained from the FMOLS and DOLS models. The panel ARDL (p, q) model is utilized in this study as suggested by Pesaran, Shin, & Smith (2001), and can be expressed as follows:

$$\Delta MS_{it} = \beta_{0i} + \emptyset_{1,i} MS_{i,t-1} + \theta_{1,i} BL_{it} + \theta_{2,i} Y_{it} + \theta_{3,i} P_{it} + \sum_{j=1}^{n-1} \delta_{ij} \Delta MS_{i,j-1} + \sum_{j=0}^{n-1} \alpha_{1j} \Delta BL_{i,j-1} + \sum_{j=0}^{n-1} \alpha_{2j} \Delta Y_{i,j-1} + \sum_{j=0}^{n-1} \alpha_{3j} \Delta P_{i,j-1} + \omega_{it} \quad (7)$$

Where,

$$\emptyset_i = -\left(1 - \sum_{j=1}^{n-1} \delta_{ij}\right)$$

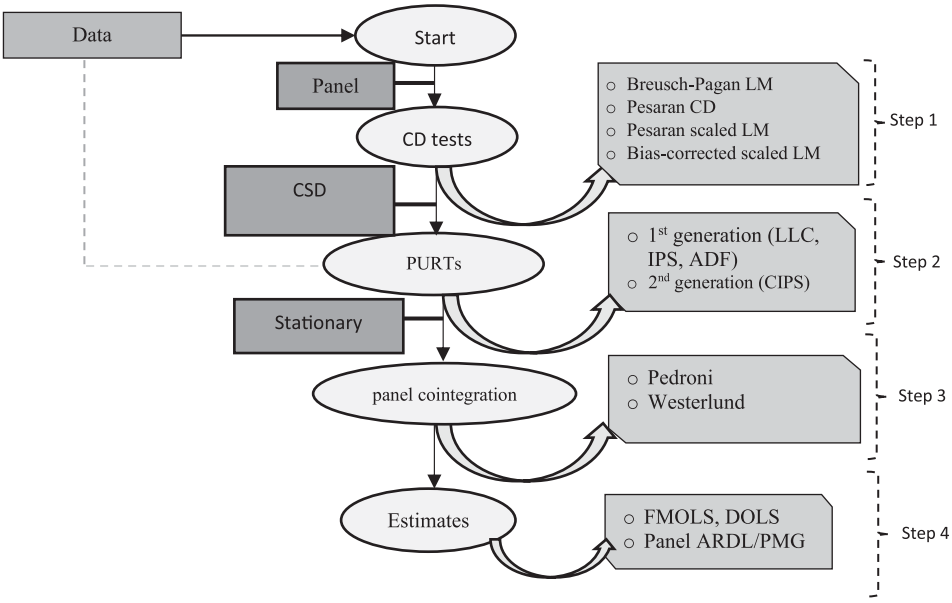
$$\beta_i = \sum_{j=1}^{q} \alpha_{ij},$$

$$\delta_{ij} = \sum_{m=j+1}^{p} \delta_{im}, j = 1,2, \ldots\ldots, p-1, and$$

$$\alpha_{ij} = \sum_{m=j+1}^{q} \alpha_{im}, j = 1,2, \ldots, q-1, i = 1,2, \ldots, n$$

Where i = 0,1,2,…, n and $\emptyset_i$ is the error correction term. Moreover, the terms in level and in 1st difference reflects long-run dynamics and short-run effects respectively. εit represents the error term and Δ the 1st difference operator. Figure 1 displays the visualization of the study's overall analytical framework.

Figure 1: Analytical Framework



Source: Author's construction

4. Results and discussions

Table 4 presents the results of cross-sectional dependency tests, indicating a persistent presence of cross-sectional dependency across all four tests. The 2nd generation panel unit root test is highlighted as potentially offering more reliable inference. To ensure robust findings, this study initially employed the 1st generation panel unit tests (PURTs), and then the 2nd generation PURTs, and the results reported in Table 5. Variables such as MS growth rate, domestic credit provided by the financial sector (% of GDP), and GDP per capita (constant 2010 US$) were found to be non-stationary at the level but became stationary after the first difference with individual constant and trend in a panel. Inflation (consumer prices, annual %) was stationary at the level. These panel unit root results suggest that all selected variables in the study are integrated of order one, I(1), in each panel, while the inflation rate variable is integrated of order zero, i.e., I(0).

To analyse the long-term relationship among variables, the study implemented different prominent panel cointegration tests proposed by Pedroni (1999) and Westerlund (2007) on stationary data at the same level. The results of the Pedroni

panel cointegration test are reported in Table 6, which suggest that growth rate of *MS*, domestic credit, real GDP per capita, and inflation rate are cointegrated over the period of 1980Q1–2020Q4.

In addition, to confirm the cointegration among variables, the study employed the Westerlund (2007) cointegration approach, and the results are reported in Table 7. Based on the bootstrapped robust critical values, all four tests reject the null hypothesis, endorsing the presence of cointegration in the selected variables, namely *MS*, real income, bank credit, and inflation rate.

Table 4: Cross-Section Dependence test analysis

Tests	MS_{it}	Y_{it}	BL_{it}	P_{it}
Breusch-Pagan LM	3118.976*	5582.132*	1577.881*	819.763*
Pesaran scaled LM	322.971*	582.611*	160.526*	80.613*
Bias-corrected scaled LM	322.938*	582.577*	160.493*	80.579*
Pesaran CD	50.411*	74.161*	28.075*	23.272*

Note: Null hypothesis: No cross-section dependence. Level of significance: *p < 0.1

Source: Author`s own work

Table 5: PURTs results

Tests	Variables	Level C&T	1st difference C&T
LLC	MS_{it}	-1.679	-12.122*
	Y_{it}	0.921	-20.707*
	BL_{it}	-0.983	-32.818*
	P_{it}	-0.783	-3.4576*
IPS	MS_{it}	-1.327	-22.866*
	Y_{it}	2.654	-25.562*
	BL_{it}	0.275	-30.496*
	P_{it}	-7.920*	-19.385*
ADF	MS_{it}	29.655	412.969*
	Y_{it}	7.936	413.460*
	BL_{it}	14.5378	587.935*
	P_{it}	104.138*	329.956*
CIPS	MS_{it}	-2.269	-6.420*
	Y_{it}	-1.988	-6.420*
	BL_{it}	-2.262	-6.190*
	P_{it}	-3.404*	-6.190*

Note: C&T= constant and trend. Level of significance: *p < 0.1,

Source: Author`s own work

Table 6: Pedroni panel cointegration test results

Series: MS_{it} P_{it} Y_{it} BL_{it} Test	Panel Statistics (within-dimension)		Group Statistics (Between-dimension)
v-Statistic (P-value)	1.411*** (0.07)	0.567 (0.285)	-
rho-Statistic(P-value)	-1.975** (0.02)	-1.063 (0.143)	-1.131 (0.129)
PP-Statistic (P-value)	-2.340* (0.009)	-1.409*** (0.079)	-1.514*** (0.064)
ADF-Statistic (P-value)	-2.391* (0.008)	-1.6212** (0.052)	-1.863* (0.031)

Note: Alternative hypothesis: common AR coefficients. (within-dimension).
Alternative hypothesis: common AR coefficients (within-dimension).
Level of significance: *p < 0.1, **p<, 0.05, ***p < 0.01

Source: Author`s own work

Table 7: Westerlund panel cointegration test results

Test Statistic	Value	Z-value	P-value
Gt	-3.907*	5.614	0.000
Ga	20.949*	-4.487	0.000
Pt	-4.357*	-4.357	0.000
Pa	-4.176*	-4.176	0.000

Note: Level of significance: *p < 0.1

Source: Author`s own work

After identifying the long-term cointegration, the study estimated the cointegration relationship between *MS*, bank credit, real income, and inflation rate using the FMOLS, DOLS, and PMG estimators. The empirical results of the panel FMOLS, DOLS, and ARDL/PMG models are presented in Table 8 and Table 9. These results exhibit that all estimated coefficients are statistically significant, demonstrating that the empirical models are theoretically and statistically valid. Table 8 shows that the estimation has significant explanatory power based on the adj. R^2 values of 0.925 (FMOLS) and 0.933 (DOLS), means that the 93 percent of the variations in the *MS* growth rate (dependent variable) are jointly explained by the included explanatory variables (domestic credit, real GDP per capita, and inflation rate).

The study included domestic credit provided by financial sector (BL) because usually, bank lending upsurges the *MS* in circulation by creating additional demand deposits (Sillers,2017). The Post Keynesian theory mainly emphasizes on bank lending, which drives money creation (Palley, 2015). Elhendawy (2016) found that the causal link between bank lending and bank deposits reveal that bank lending leads to bank deposits, contrary to the common belief that deposits generate loans. Table 8 shows that bank lending and *MS* have a positive relation-

ship. The estimated coefficient for bank lending is found to be 0.614(FMOLS) and 0.584 (DOLS) and statistically significant at the 1% level. This result suggests that a one-percentage change in bank lending leads to bring changes in the *MS* by around 0.61% and 0.58% for each specific country. In the case of PMG results given in Table 9, the estimated coefficient for bank lending is found to be 0.897 and statistically significant at the 1% level. This result suggests that a one-percentage change in bank lending leads to an increase in the *MS* by around 0.89 basis points for each specific country. Similar results were also found by Howells and Hussein (1998; 336), where the estimated coefficient indicates that a one-percentage change in bank lending may lead to bring changes in the *MS* by 0.76-0.93%. Palley (1998, p. 171) noted that" Post Keynesians object to Milton Friedman's notion of a 'helicopter drop' of money. This study suggests that their objections are appropriate. Basil Moore asserted that the CB just holds the line on interest rates and accommodates everything." The results exhibit a positive and significant link between bank lending and *MS*, in accordance with those of other studies such as Valadkhan (2008), Nayan et al. (2016), Nyumuah (2017), and Dedeoglu and Ogut (2018).

The impact of income, measured as real GDP per capita (Y), on the *MS* is found significantly positive. The estimated coefficient is 0.273 in FMOLS and 0.286 in DOLS are also significant at the one percent level. This means that a one-percentage changes in income will lead to bring changes in the MS around a 0.27%-0.28% in each panel country during the period under study. It is evident from Table 9 that using the PMG approach, the impact of real income on the *MS* is found to be positive but statistically insignificant. The statistically significant impact of income on *MS* growth is consistent with previous studies by Valadkhan (2008), Arize and Nam (2012), Nayan et al. (2016), Farazmand et al. (2016), and Ongan and Gocer (2023).

It is also evident from Table 8 that the inflation rate (P) shows a statistically negative impact on the *MS* growth, which is consistent with the hypothesized expectation. The estimated coefficient is found to be -0.005 (FMOLS) and -0.004 (DOLS) significant at the 1 per cent and 4 percent levels of significance, respectively. These results reveal that a one-unit increase in the inflation rate will decrease the *MS* by almost 0.4-0.5 percent. Table 9 reveals that using the panel ARDL/PMG approach, the impact of the inflation rate on *MS* is also found to be -0.012 and statistically significant. The result suggests that a one-unit increase rise in the inflation rate will decrease the *MS* by ten per cent. These results are in line with the findings obtained by Valadkhan (2008), Kjosevski (2013), Farazmand et al. (2016), Incekara and Amanov (2017), and Ongan and Gocer (2023) who also

observed an inverse relationship between the inflation rate and the money supply growth rate.

Table 8: The FMOLS and DOLS estimations

	FMOLS		DOLS	
Variable	Coefficients	p-value	coefficients	p-value
P_{it}	-0.005* [0.001]	0.000	-0.004** [0.002]	0.020
Y_{it}	0.273* [0.028]	0.000	0.286* [0.028]	0.000
BL_{it}	0.614* [0.029]	0.000	0.584* [0.029]	0.000
adj. R^2		0.925		0.933
S.E. of regression		0.139		0.130
Long-run variance		0.079		0.065

Note: Dependent variable is money supply. Level of significance: *p < 0.1, **p<, 0.05,

Source: Author' estimation

Table 9: The PMG estimation

Variables	Coefficient	Std. Error	t-ratio	P-value
Long run equation				
P_{it}	-0.012*	0.004	-2.750	0.006
Y_{it}	0.042	0.061	0.677	0.498
BL_{it}	0.897*	0.063	14.188	0.000
Short run equation				
Error correction coefficient	-0.058*	0.017	-3.391	0.000

Source: Author's estimation

Note: Dependent variable is money supply. Maximum dependent lags: 2 (Automatic selection), Model selection method: Akaike info criterion (AIC), Dynamic regressors (2 lags, automatic): ARDL (1, 1, 1, 1) Level of significance: *p < 0.1

5. Concluding Remarks

This study investigates whether the money supply (MS) in 10 developing Asian countries is exogenous or endogenous using quarterly balanced panel data ($1980Q_1$ - $2020Q_4$). The data was carefully analyzed for cross-section dependency and stationarity. Various panel cointegration techniques were applied to explore the long-term relationship among the variables. Panel FMOLS, DOLS, and PMG methods were used for analysis. The results of the Pedroni and Westerlund panel cointegration tests suggest a long-term linkage among the variables. The panel FMOLS, DOLS, and PMG results indicate a significant positive impact of bank lending and income on the *MS* growth rate in the sample countries, while the inflation rate has a negative and significant impact on *MS* growth.

The empirical findings of this study support the theoretical framework and strongly reinforce the conclusions drawn from prior research. This affirms that the *MS* is indeed endogenous rather than exogenous. This significant outcome challenges the conventional understanding that central banks can manipulate the *MS* based on exogenous theories. Instead, the findings of this study suggest that effective control is achievable through the strategic management of credit and interest rates. The study highlights the significance of recognizing the endogenous nature of the *MS* in the context of 10 developing countries in Asia, with implications extending to broader economies. The appropriate empirical strategies employed in this study, not only enhance the precision of the results but also make a substantial contribution to the theoretical literature surrounding the determinants of the *MS*. This is relevant to the debate on whether the money supply is influenced by endogenous or exogenous factors, enhancing scholarly understanding of this critical economic phenomenon. These findings suggest that a rethinking of monetary control is required, as the traditional view that central banks can directly control the *MS* through instruments like open market operations, discount rates, or reserve requirements may need to be reassessed. Economic activity, bank lending practices, credit demand, and overall economic growth all impact the *MS*. Central banks should consider the broader economic environment when formulating monetary policy and adopt a more flexible approach. Instead of targeting a fixed MS growth rate, they should focus on maintaining stability in broader economic conditions, such as managing inflation and supporting sustainable economic growth and development. Acknowledging the endogeneity of the *MS* can lead to more effective strategies that align with the actual dynamics of money creation, resulting in more constant, sustainable economic and financial outcomes.

Monetary and macroeconomic fields are highly important for maintaining economic and financial stability. With the development of econometric techniques and access to new datasets, there will likely be an increase in empirical research. The author suggests that future studies may focus more on country-specific research along with broader panel dataset to gain a deeper understanding of economic issues. While the empirical methodology used in this study is appropriate, it may evolve with improvements in data and software used for computational analysis. The author acknowledges the limitations of the present work in light of these considerations.

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