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Are Stock Prices and the Turkish Money Demand Function Related?[1]

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Hisse Senedi Fiyatları ve Türk Para Talebi Fonksiyonu İlişkili midir?[2]

Abstract

Using the Autoregressive Distributed Lag (ARDL) and Granger causality test, this study demonstrates that M1 and M2 money demand cointegrates with real income, deposit interest rate, real exchange rates, and real stock prices. Real income, deposit interest, and exchange rates are significant determinants of the Turkish economy's long-run M1 and M2 money demand. Furthermore, our findings reveal that the wealth effect of real stock prices outweighs the substitution effect within the Turkish economy. The impact of real stock prices on M1 and M2 money demand is positive and statistically significant in the long run. While M2 is more responsive to changes in real stock prices, M1 exhibits greater stability than M2. Therefore, policymakers must recognise the significant role of the stock market in the long-run money demand function within the Turkish economy and its impact on the effective implementation of monetary policy.

Keywords : Money Demand, ARDL, Stock Prices, Türkiye.

JEL Classification Codes : E41, C32, G10, N14.

Öz

Bu çalışma, Otoregresif Dağıtılmış Gecikme (ARDL) ve Granger nedensellik testi kullanarak hem M1 hem de M2 para talebinin reel gelir, mevduat faiz oranı, reel döviz kurları ve reel hisse senedi fiyatları ile eşbütünleşme ilişkisi sergilediğini göstermektedir. Reel gelir, mevduat faiz oranı ve reel döviz kuru, Türkiye ekonomisinde uzun dönemli M1 ve M2 para talebinin önemli belirleyicileridir. Ayrıca, bulgularımız Türkiye ekonomisinde reel hisse senedi fiyatlarının servet etkisinin ikame etkisinden daha ağır bastığını ortaya koymaktadır. Reel hisse senedi fiyatlarının M1 ve M2 para talebi üzerindeki etkisi uzun dönemde pozitif ve istatistiksel olarak anlamlıdır. M2 reel hisse senedi fiyatlarındaki değişimlere daha duyarlı iken, M1 daha istikrarlı bir görünüm sergilemektedir. Bu nedenle politika yapıcıların, hisse senedi piyasasının Türkiye ekonomisindeki uzun dönem para talebi fonksiyonundaki önemli rolünü ve para politikasının etkin bir şekilde uygulanması üzerindeki etkisini kabul etmeleri zorunludur.

Anahtar Sözcükler : Para Talebi, ARDL, Hisse Senedi Fiyatları, Türkiye.

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1. Introduction

Money demand is a crucial topic in monetary economics that researchers and policymakers have extensively investigated. The literature on this topic is vast, theoretically and empirically, aiming to understand the dynamics of money demand and identify its key determinants. Empirical research has identified essential factors other than those specified by theories that explain the behaviour of money demand. For example, empirical evidence shows that oil prices, exchange rates, asset prices, and inflation are key elements that define the variation in money demand in selected economies. Friedman (1988) identified stock prices as an additional factor affecting the demand for money that might positively or negatively impact money demand.

In recent years, stock markets have emerged as significant mediums for storing wealth, particularly in emerging markets such as Türkiye. Institutions within the private and public sectors utilise the stock market to mobilise financial resources for investment and savings by trading secondary securities such as bonds, equities, and other public sector debt securities with varying maturities. Furthermore, advancements in internet trading and innovations within the mutual fund industry have reduced transaction costs, potentially increasing the substitutability between equities and money (Carpenter & Lange, 2003). As a result, stock markets enhance the culture of savings and provide a foundation for households and firms to diversify their portfolios across financial and non-financial assets held as stores of wealth (Mwanzia et al., 2015).

Consequently, two issues may arise. Firstly, the decisions of firms and households regarding optimising their wealth portfolios are heavily dependent on interest rates, given that stock markets serve as a platform for competition between financial and non-financial assets subject to varying risk returns. Secondly, competition for these assets may impact the conduct of monetary policy as agents adjust their portfolios towards safer assets such as money - particularly in developing markets such as Türkiye, where cash holdings feature prominently in agent portfolios - thus forming the basis of the monetary policy regime through money targeting. Therefore, the development of the stock market may lead to the substitution of money balances in favour of stocks, potentially resulting in non-tenability in targeted money supply growth rates required to achieve desired macroeconomic objectives (Mwanzia et al., 2015).

The literature on the relationship between stock prices and money demand emerged following Friedman’s (1988) paper in which he proposed four pass-through channels for the impact of stock prices on money demand through wealth or substitution effects. According to Friedman, the wealth effect can arise due to three reasons: firstly, a bull stock market can lead to an increase in nominal income throughout the economy, increasing daily transaction volume; secondly, strong performance by a stock market index can lead to an increase in expected returns on risky assets relative to safe assets; thirdly, an increase in stock prices may increase transaction volume within the financial market, necessitating the need for more cash holdings by agents to facilitate operations. The substitution effect posits that as stock markets perform well and equity returns become more attractive relative to other financial market components, such as money, there is a shift from cash towards shares.

To this end, the Turkish stock market has experienced remarkable growth since the 2000s. Incorporating a stock market index into the money demand function could provide valuable policy recommendations for economic development and policy formulation. The primary objective of this study is to assess the impact of real stock prices (through wealth or substitution effects) on real money demand within the Turkish economy. This aspect has yet to be considered by prior studies. The study also examines the long-term stability of the Turkish money demand function by including stock prices in the money demand function. The Autoregressive Distributed Lag (ARDL) model, bounds cointegration, and Granger causality tests are employed to achieve these aims. The results of this study contribute to the existing literature by revealing that the wealth effect dominates. Real M1 and M2 money demand significantly respond positively to changes in real stock prices in the long run. Comparatively, M2 money demand appears to be more responsive to changes in real stock prices. However, M1 money demand shows more stability than M2. Therefore, regulators must understand the importance of the stock market in the long-term need for money in Türkiye’s economy and how it affects the successful execution of monetary policy.

The remainder of the paper is organised as follows: Section 2 examines the previous money demand literature related to stock prices and the lacuna in Turkish literature. Section 3 explains the money demand model and its theoretical relationship. Section 4 describes the data and its sources. Section 5 discusses the methodology. Section 6 presents and discusses the results. Section 7 presents conclusions and policy recommendations.

2. Literature Review

Numerous authors have extensively investigated the impact of equity returns on money demand in developed and developing countries. For instance, Friedman (1988) examined the effect of stock prices on the money demand function within a developed country such as the United States. The results indicated positive effects of lagged values of equity returns and contemporary adverse effects on money demand. According to Friedman (1988), lagged equity returns have a wealth effect on the real quantity of money, while a substitution effect exists contemporaneously.

In Germany, Thornton (1998) employed the Johansen cointegration technique and error correction representation of data to explain the short-run dynamics of money demand. The findings revealed that an increase in real stock prices significantly positively affected long-run M1 money demand from 1960-1989. Similarly, Caruso (2006) demonstrated that stock prices, including dividends, had a positive wealth effect on the money demand function in Italy between 1913-1980, indicating the wealth effect of stock returns on money demand within the country. This study showed that the wealth effect prevailed and was stable only in the short run; thus, the stock market only explained temporary movements in money demand. According to Caruso (2006), the positive effect of stock prices on money demand was confirmed by a shorter-period analysis (1938-2003). Choudhry's (1996) findings indicated that stock prices played an important role in determining stationary long-run real M1 and M2 demand functions in the United States and Canada. Definitions of money and country chose the magnitude and direction of the role of stock prices.

Additionally, some authors have argued that including stock prices in the money demand function may improve stability. To determine whether money demand in the Euro area underwent structural change at the end of 2001 following considerable overshooting of the M3 money growth reference value set by the European Central Bank, Carstensen (2006) found evidence indicating that stability of the long-run money demand function for the European Monetary Union increased considerably when stock returns, and stock market volatility were included in the function. Thus, specifying the money demand function without having stock prices on the right-hand side rendered it unstable. Carpenter & Lange (2003) also found evidence that inserting stock prices into the money demand function reduced errors - thereby improving stability - and significantly affected cash holdings. Carpenter & Lange (2003) also conducted out-of-sample forecasting and found that forecasting could be improved by including stock price variables.

In developing countries, empirical evidence has shown both wealth and substitution effects of equity returns on money demand. Tule et al. (2018) used the ARDL bounds testing procedure to reassess Nigeria's money demand function by including stock prices as an independent variable. The evidence showed a long-run relationship between gross domestic product (GDP), stock prices, foreign interest rates, and real exchange rates. Furthermore, results indicated that stock prices positively affected long-run M2 broad money demand in Nigeria. Kumari & Mahakud (2012) used a vector error correction model (VECM) and Juselius cointegration approach to understand how stock prices affected India's money demand function from 1996:1 to 2010:8. They obtained evidence indicating that money demand was responsive to stock prices. Further, Granger causality tests showed unidirectional causality between India's stock prices and money demand.

McCornac (1991) conducted a study replicating Freedman's (1988) investigation into the relationship between stock prices and money demand within the Japanese economy. The findings indicated that real stock returns had a wealth and risk-spreading effect on money demand. Mwanzia et al. (2015) explored the impact of stock prices on money demand in Kenya using cointegration and an error correction model (ECM). The findings showed that Kenya's stock market positively and significantly affected money holdings. Al Rasasi et al. (2020) used cointegration and an ECM to investigate the potential effect of stock prices on money demand in Saudi Arabia. The results revealed that an increase in stock prices led to a significant increase in cash demand, indicating a wealth effect. Abdul-Rahman et al. (2020) found, using ARDL and ECM, that stock prices positively and significantly influenced the money demand equation in Ghana in both the short and long run, indicating a wealth effect within the Ghanaian economy.

In contrast, other researchers have found a negative impact of stock prices on money demand in developing countries. Baharumshah (2004) found a significant negative substitution effect of stock prices on short- and long-run broad money demand in Malaysia, with stock prices Granger-causing broad money demand. Baharumshah et al. (2009) employed cointegration methods for China and found a significant substitution effect of stock prices on money demand. Akinlo & Emmanuel (2017) demonstrated that stock prices had a substitution effect on Nigeria's money demand function and could lead to misspecification if omitted from the function. However, Hsing (2007), in a study exploring the relationship between equity returns and money demand in Poland, concluded that stock prices could not determine the need for money function.

There is considerable debate and controversy surrounding the Turkish money demand function. Al (2019) highlights the dichotomy in empirical studies on the stability of money demand in Türkiye: On one hand, Dritsaki & Dritsaki (2012), Özcan & Arı (2013), and Tüzün et al. (2017) find an unstable money demand in Türkiye. On the other hand, Akıncı (2003), Doğan (2015), and Gencer & Arısoy (2013) find a stable money demand in Türkiye. Bahmani-Oskooee & Karacal (2006) and Civcir (2003) also confirm the stability of the Turkish money demand function.

Recent developments in the literature reveal similar complexities in the Turkish money demand function (see Bahmani-Oskooee et al., 2017; Siklar & Siklar, 2021; and Altunöz, 2022; among others). Specifically, Özdemir & Saygılı (2013) investigate the stability of the money demand function in Türkiye when uncertainty variables are included, using Nymblom-type tests on cointegrated vector autoregression (VAR) money demand systems. They find that the uncertainty measure helps to estimate a stable and consistent money demand function for Türkiye. Özdemir & Saygılı's (2013) variables of interest are real M2Y, real GDP, the spread between the treasury rate and the rate of return on M2Y, and a vector of variables as a proxy for macroeconomic uncertainty.

Furthermore, Bahmani-Oskooee et al. (2017) question whether changes in the exchange rate have symmetric or asymmetric effects on money demand in Türkiye, using a nonlinear ARDL approach. They find that introducing nonlinearity produces a stable money demand. Bahmani-Oskooee et al.'s (2017) variables of interest are real M1, real M2, real GDP, 3-month deposit rate, and nominal exchange rate. Another nonlinear study of the Turkish money demand function is that of Siklar & Siklar (2021), who discovered that except when the sample of the last 35 years (1986-2020) is divided into two separate economic regimes, the demand for money is not stable within the whole study period. This is consistent with Akkus' (2019) finding when estimating a linear money demand function for M1, M2, and M3 aggregates for Türkiye from 2000-2017. Siklar & Siklar's (2021) variables of interest are M1 money stock, consumer price index, industrial production index, 90-day deposit interest rate, and the currency ratio in circulation to total deposits.

Using a nonlinear ARDL method, Altunöz (2022) also explores the stability of money demand in Türkiye from 1987-2020. Among other things, Altunöz finds that positive changes in short-term interest and real effective exchange rates strongly affect money demand more than negative changes. Altunöz’s variables of interest are M2, real GDP, the velocity of money, deposit rate, real effective exchange rate, aggregate consumption (i.e., private and government final consumption), expenditure on investment, and exports of goods and services.

These studies leave much to be desired as they need to account for the potential impact of the stock market on Turkish money demand. Özdemir & Saygılı (2013) attempt but use the volatility component of the stock market as part of a vector of variables to proxy macroeconomic uncertainty. However, based on Harvey’s (1988) intertemporal consumption-based asset-pricing model, we know that people’s demand for money may be primarily driven by their incentive to save (Idilbi-Bayaa & Qadan, 2022). Savings can occur through bonds or stocks, or both. Our study aims to fill this gap in Turkish literature by investigating the potential short-run and long-run influence of the stock market on Türkiye’s money demand function.

3. The Money Demand Model

Financial innovations are usually expected to have a more significant influence on narrow aggregates, whereas the effect of these innovations is expected to be reduced in broader monetary definitions (Mutluer & Barlas, 2002). Thus, the choice of economic indicators varies in different countries because of the distinction between other financial systems. Accordingly, there is a tremendous amount of theoretical literature on the specification of the money demand function. They include the classical money demand theory modified by Fisher, the Cambridge approach to money demand theory (Pigou, 1917; Marshall, 1923), the liquidity preference theory (Keynes, 1936), and the monetarist approach to money demand theory. Nonetheless, the commonality among these theories is that real money balances are associated with specific scale measures, such as income or wealth, and opportunity cost indicators, including interest rates, exchange rates, and inflation rates. As highlighted above, Friedman (1988) argues that real stock prices could also affect the money demand function through several channels. Therefore, we propose the following money demand function for Türkiye:

$$\left(\frac{M}{P}\right)^{d} = f(y, intr, rex, stp) \tag{1}$$

where M represents the nominal money balance, and P indicates the general price level; $\left(\frac{M}{P}\right)^{d}$ gives the real money demand; y is the real income; $intr$ denotes the nominal short-term deposit interest rate; rex is the real effective exchange rate and stp is the real stock price. The money demand theory shows that the nominal money demand is related to the price level P. Real income indicates total wealth, which determines the transaction volume in an economy; hence is considered the main argument of the money-demand function. Where $intr$ represents the opportunity cost of holding money, the expected returns from holding other securities, such as assets and domestic and foreign bonds. The rex denotes variations in the local currency to the foreign currency. Accordingly, when specifying the money demand function for an open market with free capital flows, indicators such as the exchange rate, international interest rate, and interest rate differential must be added to the demand function of money to determine the impact of variations in the value of the domestic currency on the money demand function (Bahmani-Oskooee, 2001; Chowdhury, 1997; Khalid, 1999). Friedman (1988) suggests that the target variable in this study, stp, could affect money demand through four channels that could either have a wealth or substitution effect on money demand. The semi-log linear form of Equation 1 can be represented as.

$$l(m/p)_t = \gamma + \theta_0 ly_t + \theta_1 intr_t + \theta_2 lrex_t + \theta_3 lstp_t + e_t \quad (2)$$

where l signifies the natural logarithm sign, e_t is the assumed white noise residual process, γ is the intercept, $\theta_0, \theta_1, \theta_2,$ and θ_3 parameters measure the responsiveness of real money demand to the changes in real income, deposit interest rate, real exchange rate, and real stock prices, respectively.

The estimates of the $\theta_0, \theta_1, \theta_2\ and\ \theta_3$ parameters are expected to be as follows. $\theta_0 > 0, \theta_1 < 0, \theta_2 < 0$ if substitution effect exists, or $\theta_2 > 0$ if the wealth effect of the exchange rate exists. Additionally, θ_3 can be positive, that is, if the real stock prices (stp) have a wealth effect on real money demand, or it can be negative on the other hand, if stp has a substitution effect on the real money demand function. However, if $\theta_3 = 0$, this restricts the position of equity returns as a deciding factor for the demand for real cash.

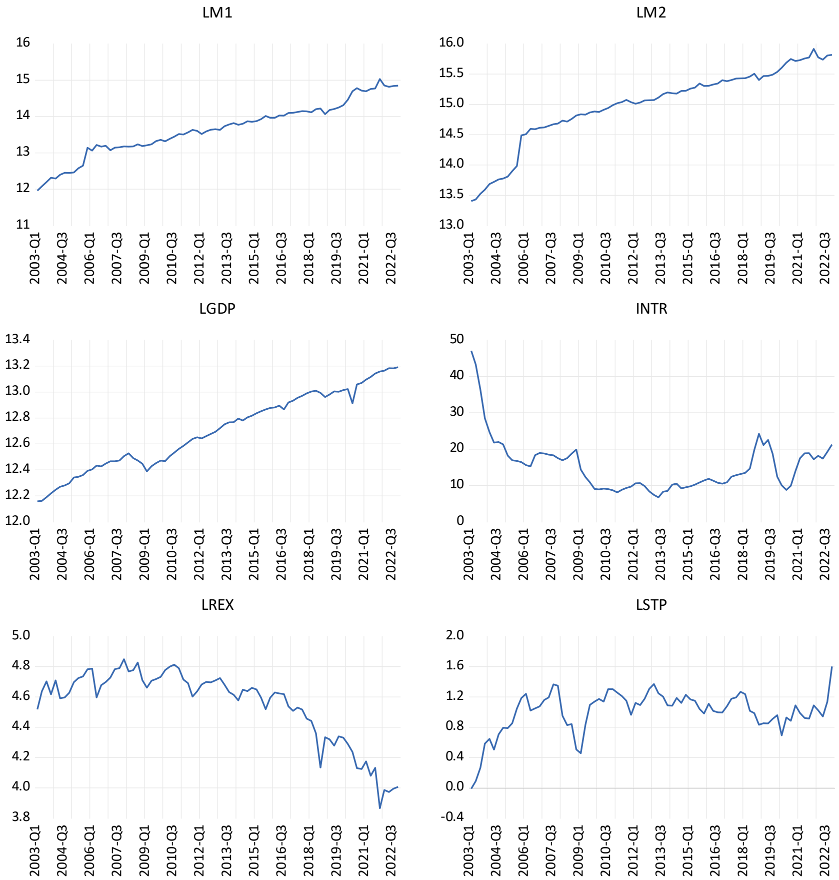
4. Data Description

This study employs quarterly data spanning 2003: Q1 to 2022: Q4 to estimate the money demand function. M1 is the dependent variable, whereas real gross domestic product (GDP), the deposit interest rate (INTR), the real exchange rate (REX), and real stock prices (STP) are the independent variables. GDP is measured in the national currency, national reference year, and seasonally adjusted. INTR is calculated using the three-month weighted average deposit interest rates (TRY Deposits, Flow Data, %). REX is measured as the CPI-based real effective exchange rate (2003=100). The STP is calculated using the BIST-100 according to the closing price. Data for monetary aggregates M1 and M2, the real effective exchange rate (REX), stock prices (STP), and consumer price index (CPI) were extracted from the Electronic Data Delivery System (EDDS) of The Central Bank of the Republic of Türkiye (CBRT, 2023)[3]. The real gross domestic product (GDP) time series was obtained from the Organization for Economic Cooperation and Development (OECD, 2023) database. To get the real values of M1, M2, and STP, they were deflated using the CPI with the following formulas: $\mathrm{LM1_t = logM1_t - logCPI_t}$ and $\mathrm{LSTP_t = logSTP_t - logCPI_t}$; where $\mathrm{LM1_t}$, $\mathrm{LSTP_t}$, and $\mathrm{CPI_t}$ denote the real money demand, real stock prices, and consumer price index, respectively. The sample range was determined based on data availability, consistency, and financial reforms in the Turkish economy since the 2000s. Figure 1 plots

[3] *The data used in the model estimations are available in an excel format and could be shared upon request.*

the graphs of all the time series included in the analysis. LM1, LM2, and LGDP are trending upward, whereas LREX has a downward trend. The INTR and LSTP time series do not exhibit any obvious trends.

Figure: 1
The Trend of The Time Series



5. Econometric Model

5.1. ARDL Model

The study employs the Autoregressive Distributed Lag (ARDL) model and bounds cointegration technique developed by Pesaran et al. (2001) to investigate the relationship between real income, the deposit interest rate, the real exchange rate, real stock prices, and real money demand. The ARDL method was selected for several reasons. First, time series are stochastic and often non-stationary; the OLS outcome will be spurious and misleading in a non-stationary series. Second, if the model contains both I(0) and I(1) variables, the robust technique is the ARDL model because it assumes that the variables are I(0) and I(1). Finally, interpreting the results is straightforward because only a single equation exists in the ARDL setting. The generalised form of the ARDL (p,q) model is given as;

$$Y_t = a_0 + \sum_{i=1}^{p} a_1 Y_{t-i} + \sum_{i=0}^{q} a_2 X_{t-i} + \varepsilon_t \tag{3}$$

where Y_t is the independent variable (LM1); a_0 is the intercept; p and q are the lag lengths of the dependent and independent variables, respectively; X_t is a vector of independent variables including LGDP, INTR, LREX, and LSTP; a_2 is the coefficient of the vector of independent variables; and ε_t is the error term assumed to be white noise. To obtain the operational form of the ARDL model with short- and long-run dynamics, Equation 3 is transformed as;

$$\Delta Y_t = b_0 + \sum_{i=1}^{p} b_1 \Delta Y_{t-i} + \sum_{i=0}^{q} b_2 \Delta X_{t-i} + \delta_1 Y_{t-1} + \delta_2 X_{t-1} + \mu_t \tag{4}$$

where b_0 is a constant, b_1 *and* b_2 are short-run coefficients, δ_1 *and* δ_2 are long-run coefficients, and μ_t is the white noise error term. We assess for the presence of a long-run relationship between the dependent and independent variables using the null hypothesis: H_0; $\delta_1 = \delta_2 = 0$ against the alternative hypothesis H_1; $\delta_1 \neq \delta_2 \neq 0$. An F-test based on the Wald test is used to conduct the cointegration test. The critical values computed by Pesaran et al. (2001) for the I(0) and I(1) bounds are compared with the calculated F-test values. If the F-test value is below the I(0) bound, we cannot reject the null hypothesis and conclude there is no cointegration relationship between the research variables. On the other hand, if the calculated F-statistic value is above I(1), we reject the null hypothesis and conclude that a cointegration relationship exists between the variables. The result is inconclusive if the F-test value falls between the I(0) and I(1) bounds.

If we cannot reject H_0, we can estimate the error-correction term with one lag (ect_{t-1}) and short-run dynamics using Equation 5. The ect_{t-1} coefficient measures the speed of adjustment of short-run deviations in the long-run, and its coefficient (φ) should be negative and less than one to ensure convergence.

$$\Delta Y_t = b_0 + \sum_{i=1}^{p} b_1 \Delta Y_{t-i} + \sum_{i=0}^{q} b_2 \Delta X_{t-i} + \varphi ect_{t-1} + \mu_t \tag{5}$$

5.2. Granger Causality Test

Using the Granger causality test, propounded by Granger (1969), the study further assesses the causality between money demand and the independent variables. Let us consider Y and X as the variables in our model, where Y is the dependent variable, X is a vector of independent variables, and Y and X are stationary time series variables. Causality is defined as the relationship between an explanatory variable X and an explained variable Y, where X is used to predict that Y results in more accurate forecasts than not using it. This type of causality is known as the Granger causality. Mathematically, the test for Granger causality involves analysing two equations for Y and X that only include lagged variables, as follows:

$$Y_t = \rho + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots \phi_p Y_{t-p} + \omega_1 X_{t-1} + \omega_2 X_{t-2} + \cdots \omega_q X_{t-q} + \eta_t \tag{6}$$

$$X_t = \lambda + \omega_1 X_{t-1} + \omega_2 X_{t-2} + \cdots \omega_q X_{t-q} + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots \phi_p Y_{t-p} + \epsilon_t \tag{7}$$

where ϕ_1 ... ϕ_p and $\omega_1 \ldots \omega_q$ are structural coefficients of both models which are estimated using the least squares method. p and q are the longest lag lengths for which the lagged values of the variables X and Y have been proven statistically significant. ρ and λ are the intercepts of the model, and η_t and ϵ_t are the random error terms. In Equations 6 and 7, all lagged values of variables X and Y that are statistically significant according to their t-statistic test in both models are retained as long as they jointly contribute to the explanatory power of the equations according to the F-statistic test.

The null hypothesis that variable X (Y) does not cause variable Y (X) in the Granger causality sense is accepted if no lagged values of variable X (Y) are retained after applying t-statistic and F-statistic tests to Equations 6 and 7. That is, $\omega_1 = \omega_2 = \cdots = \omega_q = 0$ for Equation 6; and $\phi_1 = \phi_2 = \cdots = \phi_p = 0$ for Equation 7. If this is not the case, the null hypotheses are rejected in favour of the alternative, and it is concluded that variable X (Y) Granger causes variable Y (X), meaning that the future values of variable Y (X) are dependent on the present values of variable X (Y).

6. Empirical Results and Discussions

6.1. Descriptive Statistics and Correlation Matrix

Table 1 presents the descriptive statistics for all the time series. The results show that the deposit interest rate is positively skewed, whereas the monetary aggregates (LM1 and LM2), gross domestic product (LGDP), real exchange rate (LREX), and real stock prices (LSTP) are negatively skewed. Positive skewness implies that more observations occurred above the sample mean, whereas negative skewness indicates that more observations occurred below the sample mean. The LM1 monetary aggregate and LGDP time series have less than three kurtosis values (platykurtic), indicating a normal dataset distribution. Similarly, LREX exhibits a normal distribution because its kurtosis value is approximately three. However, the kurtosis of INTR and LSTP is greater than three, indicating a non-normal distribution of observations. Finally, the Jaque-Bera statistics and associated probability values are statistically significant at the 5% level for all variables except LM1 and LGDP, indicating a non-normal distribution of observations.

Table 2 reports the correlation matrix, which shows that real income (LGDP) and real stock prices (LSTP) are positively correlated with the dependent variable (LM1), while the deposit interest rate (INTR) and real exchange rates (LREX) are positively correlated with the monetary aggregates.

Table: 1
Descriptive Statistics

Variable	LM1	LM2	LGDP	INTR	LREX	LSTP
Mean	13.64887	14.98629	12.70142	15.37236	4.548230	1.004248
Median	13.64411	15.07193	12.70787	13.73231	4.630642	1.062628
Max.	15.03253	15.91576	13.19196	47.04846	4.849762	1.602740
Min.	11.96021	13.40266	12.15790	6.743077	3.864722	-0.010780
Std. Dev.	0.736441	0.631976	0.292604	7.296423	0.242208	0.274546
Skewness	-0.253619	-0.946257	-0.050955	2.011107	-1.167074	-1.383859
Kurtosis	2.560637	3.224132	1.819154	8.629466	3.316234	5.832799
Jarque-Bera	1.501103	12.10615	4.682607	159.5637	18.49416	52.28339
Prob.	0.472106	0.002351	0.096202	0.000000	0.000096	0.000000
Obs.	80	80	80	80	80	80
The probability values are associated with Jaque-Bera statistics which is the Chi-square distribution of degree of freedom 2 for normal distribution.						

Table: 2
Correlation Matrix

Variable	LM1	LM2	LGDP	INTR	LREX	LSTP
LM1	1	0.855089	0.092882	-0.335727	-0.354641	0.135208
LM2		1	0.138578	-0.236739	-0.256614	0.121013
LGDP			1	-0.049992	-0.117430	-0.011034
INTR				1	-0.018693	-0.184256
LREX					1	0.223882
LSTP						1

Table: 3
Unit Root Test Results

	ADF at Level		ADF at First difference		
Time Series	**Constant**	**Constant and Trend**	**Intercept**	**Constant and Trend**	**Decision**
LM1	-1.819171	-3.474600**	-9.930642***	-9.997937***	I(1)
LM2	-3.066593**	-2.658943	-8.431507***	-8.949196***	I(0)
LGDP	-0.813268	-3.079970	-10.92992***	-10.89198***	I(1)
INTR	-4.527862***	-4.173110***			I(0)
LREX	0.267419	-2.725134	-11.49917***	-11.78537***	I(1)
LSTP	-3.645172***	-3.615617**			I(0)
	PP at Level		**PP at First difference**		
Time Series	**Constant**	**Constant and trend**	**Constant**	**Constant and trend**	**Decision**
LM1	-1.906117	-3.438592*	-9.909086***	-9.998928***	I(1)
LM2	-3.089457**	-2.659024	-8.457830***	-8.949196***	I(1)
LGDP	-0.815836	-3.087419	-10.89458***	-10.85888***	I(1)
INTR	-5.050897***	-4.254543***			I(0)
LREX	0.034937	-2.725134	-12.05181***	-17.21740***	I(1)
LSTP	-3.664389***	-3.670016**			I(0)
	ZA at Level		**ZA at First difference**		
Time Series	**Constant**	**Constant and trend**	**Constant**	**Constant and trend**	**Decision**
LM1	-3.791622	-4.013512	-10.96119***	-11.04634***	I(1)
LM2	-2.772378	-4.613722	-10.16562***	-9.398850***	I(1)
LGDP	-3.812840	-3.958901	-11.19818***	-12.23172***	I(1)
INTR	-5.077362**	-4.426340	-6.806237***	-7.062316***	I(0)
LREX	-2.242690	-3.264611	-6.553763***	-6.594684***	I(1)
LSTP	-4.408384	-4.107275	-7.513385***	-7.887083***	I(1)
‘*’,’**’, and ‘***’ indicate the rejection of the null hypothesis at 10%, 5%, and 1% significance levels, respectively.					

6.2. Unit Root Test Results

To check for unit roots, we used the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root procedures (Dickey & Fuller, 1979; Phillips & Perron, 1988). These tests are commonly used in the literature because of their advantages over other traditional unit root methods. Table 3 presents the ADF and PP test results. Considering the model with an intercept, the ADF and PP tests reject the unit root null hypothesis for LM2, INTR, and

LSTP at the 5% significance level. LM2, INTR, and LSTP are, therefore, level stationary series. However, considering the model with an intercept, the null hypotheses for LM1, LGDP, and LREX cannot be rejected, indicating that they are integrated of order one [I(1)].

Standard unit root tests such as ADF and PP may reject the null hypothesis incorrectly if a time series has an endogenous structural break. To ensure the robustness of the unit root outcome, we use the Zivot-Andrews (ZA) tests introduced by Zivot & Andrews (2002) to complement the ADF and PP tests. ZA tests account for an endogenous structural break in the series. The ZA unit root test results (Table 3) are similar to those of the ADF and PP tests. According to the model with an intercept, LM1, LM2, LGDP, LREX, and LSTP are integrated of order one [I(1)], whereas INTR is integrated of order zero [I(0)].

Since none of the series was found to be I(2) according to the ADF, PP, and ZA unit root test results, we applied the bounds test approach to cointegration in the next section. If an I(2) time series is included in the model, the bounds test yields unreliable results.

6.3. Bounds Cointegration Test

To evaluate the presence of a cointegration relationship between the monetary aggregates (LM1 and LM2) and the explanatory variables (LGDP, INTR, LREX, and LSTP), we specified the optimal lag length by imposing four lags manually, considering the sample size, and then allowed the Akaike Information Criterion (AIC) to determine the optimal lag length for each explanatory variable in the ARDL setting. ARDL (1,3,0,4,0) and ARDL (1,3,0,1,0) are specified for equations LM1 and LM2, respectively. Second, Equation 4 is estimated, and model diagnostic tests are performed to ensure serially uncorrelated and homoscedastic residuals. Finally, we used the Wald test-based cointegration technique to measure the cointegration relationship between the monetary aggregates and independent variables. The null hypothesis $\delta_1 = \delta_2 = 0$ is tested against the alternative $\delta_1 \neq \delta_2 \neq 0$. The F-statistics for the LM1 and LM2 equations were computed. Table 4 presents the results. The F-statistic values are compared with those reported by Pesaran et al. (2001) I(0) and I(1) table critical values at the 5% significance level.

Table: 4
Bounds Cointegration Test Results

Model	**F-statistics (F_{PSS})**	**5% Bounds Critical Value**		**Decision**
Sample (2003Q1-2022Q4)		I(0)	I(1)	
LM1=F(LGDP,INTR,LREX,LSTP) k=4	**4.30**	**2.86**	**4.01**	Cointegration
LM2=F(LGDP,INTR,LREX,LSTP) k=4	**5.31**			Cointegration

I(0) and I(1) are F-bounds critical values at a 5% significance level computed by Pesaran et al. (2001) for Case III-unrestricted constant and no trend.

The measured F-statistic values for the LM1 and LM2 models (4.30 and 5.31, respectively) are greater than the I(1) bound critical value at a 5% significance level. Therefore, the null hypothesis of no cointegration relationship is rejected for the LM1 and LM2 equations. Hence, there are long-run associations between real income, deposit interest rate, real exchange rate, and real stock prices and LM1 and LM2. The following section presents the short- and long-run analysis.

6.4. Long-Run Coefficients and Unrestricted Error Correction Model Estimations

Table 5 presents the long-run estimates for the LM1 and LM2 money demand models. All estimated long-run coefficients are statistically significant in explaining the variations in long-run LM1 money demand. Real income (LGDP) and real stock prices (LSTP) are positively and significantly related to LM1’s long-term money demand. A 1% increase in real income results in a 1.14% increase in the LM1 monetary aggregate at a 1% significance level. Theoretically, when real income increases in developing countries like Türkiye, economic agents require more cash to handle daily operations, increasing demand for real balances. A 1% increase in real stock prices results in a 0.43% increase in M1’s money demand at the 1% significance level. The positive estimate of real stock prices indicates a wealth effect consistent with theoretical predictions. This may imply that transaction volume increases as stock prices rise, leading to a greater demand for cash to carry out market operations. Additionally, the positive estimate of LSTP may reflect portfolio adjustments towards money balances as safer assets amid increases in returns on risky assets in the financial market. This significant and positive relationship is because stock prices are a general indicator of financial wealth. In the long run, assets in the stock market function as stores of value for monetary aggregates. The evidence of the wealth effect is consistent with earlier works by Friedman (1988), McCornac (1991), and Thornton (1998), as well as recent empirical findings by Tule et al. (2018), Al Rasasi et al. (2020), Kumari & Mahakud (2012), Abdul-Rahman et al. (2020), and Mwanzia et al. (2015). However, the findings contradict those of Baharumshah et al. (2009), Baharumshah (2004), and Akinlo & Emmanuel (2017) found substitution effects in their respective studies.

Table: 5
Long-Run Results

Variable	LM1 Equation	LM2 Equation
Constant	1.811887 (1.674695)	-0.043817 (1.283737)
LGDP	1.140010*** (0.342426)	1.250433*** (0.323234)
INTR	-0.037189*** (0.010390)	-0.019630** (0.009249)
LREX	-1.494116*** (0.536204)	-0.167949 (0.428246)
LSTP	0.427667* (0.229563)	0.575449** (0.250149)

‘*’ ‘**’ and ‘***’ indicate the significance of coefficients at 10%, 5%, and 1% level, respectively.
Numbers in braces are the standard errors.

In the long run, the deposits interest rate (INTR) and real exchange rate (LREX) significantly decreased LM1 demand at the 1% level. Both INTR and LREX are negatively related to LM1 real money demand. A 1% increase in INTR results in a 0.04 unit decrease in real demand for the LM1 monetary aggregate. The negative coefficient of deposit interest rate represents the opportunity cost of holding money, which is consistent with economic theory. High-interest returns on deposits discourage agents from holding cash and encourage them to benefit from the high interest paid on bank deposits. A 1% increase in LREX results in a 1.49% decrease in the real demand for the LM1 monetary aggregate. The significance of the real exchange rate estimate suggests that currency substitution occurred in Türkiye.

Table 6 reports the unrestricted error correction representation results for the LM1 and LM2 money demand functions. In the short run, the direction of the independent variables’ impact on LM1 demand remains unchanged. Real income (LGDP) and real stock prices (LSTP) positively but insignificantly affected LM1 demand. The deposit interest rate (INTR) and real exchange rate (LREX) negatively impact LM1 demand, but only LREX has a statistically significant impact at the 5% level. A 1%unit increase suppresses LM1 demand by 0.36% in the short run, further confirming the existence of currency substitution.

The coefficient of the one-period lag of the error correction term (ect_{t-1}) is negative (-0.232) and statistically significant at the 1% level. The significance of ect_{t-1}reflects the robustness of the cointegration result (Banerjee et al., 1998), indicating that the LM1 monetary aggregate is cointegrated with INTR, LGDP, LREX, and LSTP. This implies that short-run shocks in the system adjust back to equilibrium at a rate of 23.2% in the long run.

Table: 6
The Unrestricted Error Correction Representation of M1 and M2 Money Demand Equations

Variable	LM1 equation: ARDL (1,3,0,4,0)	LM2 equation: ARDL (1,3,0,1,0)
Constant	0.055042*** (0.017926)	0.029512** (0.013552)
D(LM1(-1))	-0.096913 (0.129373)	0.098462 (0.118549)
D(LRGDP)	0.161820 (0.350572)	0.091704 (0.279394)
D(LGDP(-1))	-0.596300 (0.373782)	-0.427554 (0.315431)
D(LGDP(-2))	-0.326853 (0.414109)	-0.292598 (0.371439)
D(LGDP(-3))	-0.404405 (0.496393)	0.301041 (0.454515)
D(INTR)	-0.003304 (0.006413)	-0.006160 (0.004862)
D(LREX)	-0.360782** (0.166854)	-0.166422 (0.134022)
D(LREX(-1))	0.219799 (0.181250)	0.122745 (0.138380)
D(LREX(-2))	0.238929 (0.167673)	
D(LREX(-3))	0.367653** (0.167446)	
D(LREX(-4))	0.117491 (0.174293)	
D(LSTP)	0.095262 (0.079933)	0.048563 (0.065279)
ECT(-1)	-0.232065*** (0.085089)	-0.146904** (0.055327)
‘*’ ‘**’ and ‘***’ indicate the significance of coefficients at 10%, 5%, and 1% level, respectively. The numbers in braces are the standard errors.		

For robustness and comparison, real LM2 demand was incorporated into the model. The long- and short-run results are reported in Tables 5 and 6, along with the LM1 results. The long-run results indicate that real income (LGDP), deposit interest rate (INTR), and real stock prices (LSTP) have a statistically significant impact on real M2 money demand. In the long run, a percentage increase in LGDP and LSTP increases LM2 demand by 1.25% and 0.58%, respectively. Again, the wealth effect of stock prices dominates the substitution effect on LM2 demand. Additionally, a percentage increase in INTR reduces LM2 demand by 0.02 units.

The short-run results in Table 6 suggest that none of the independent variables significantly impact LM2 demand in the short run. However, as expected, the error correction term was negative (-0.147) and significant at 5%. This implies that short-run errors are corrected by 14.7% each quarter to establish a long-run equilibrium.

The diagnostic tests for both models are presented in Table 7. They indicate that the ARDL specification for both the LM1 and LM2 money demand models is valid and robust because the residuals are serially independent and homoscedastic according to the LM test and Breusch/Pagan heteroskedasticity test, respectively. Finally, the cumulative sums (CUSUM) test for both models indicate parameter stability, whereas the cumulative sum of squares (CUSUMSQ) test raises some concerns about parameter stability for both models.

Table: 7
Diagnostic Tests

	LM1 equation	**L M2 equation**
Test	Test-statistic (Prob.)	Test-statistic (Prob.)
Serial correlation LM test	7.276803 (0.1220)	4.098041 (0.2511)
Heteroscedasticity test	9.437576 (0.7392)	9.927325 (0.4469)
CUSUM	Stable	Stable
CUSUMSQ	Fairly stable	Unstable

The Granger causality test was applied to assess further the robustness and causality between money demand and independent variables. Since this test is sensitive to lag length, it was conducted by estimating Equations 6 and 7 using ordinary least squares (OLS) at lags 1, 2, 3, and 4. Table 8 presents the results. According to the findings, the deposit interest rate (INTR) Granger causes LM1 money demand in the second and fourth lags. LM1 money demand Granger causes INTR in the second, third, and fourth lags, indicating bidirectional causality between LM1 and INTR. The results also reveal unidirectional causality from LM2 money demand to INTR at lags 3 and 4. The real exchange rate (LREX) Granger causes both LM1 and LM2 at all lags, indicating unidirectional causality running from the LREX to the monetary aggregates. Unidirectional causality runs from LREX to INTR at lags 1, 2, and 3. The results show bidirectional causality between real stock prices (LSTP) and real income (LGDP). Furthermore, unidirectional causality runs from LSTP to both INTR and LREX. The block Granger causality test shows LGDP, INTR, LREX, and LSTP significantly and jointly Granger causes the demand for LM1 and LM2.

Table: 8
Pairwise and Block Granger Causality Test Results

Null Hypothesis	Lag 1	Lag 2	Lag 3	Lag 4
	F-Statistic	F-Statistic	F-Statistic	F-Statistic
D(LM1)				
DLGDP→DLM1	0.57387	0.29580	0.38232	0.28322
INTR→DLM1	0.75613	2.61462*	1.99405	2.25748*
DLREX→DLM1	9.85406***	5.96582***	4.65791***	4.37443***
DLSTP→DLM1	1.09849	0.38565	0.54093	0.77059
All→DLM1	9.804161**	15.58321**	19.09814*	20.27428
D(LM2)				
DLGDP→DLM2	0.37171	0.15441	0.43590	0.35912
INTR→DLM2	2.10128	1.28250	0.84949	0.83967
DLREX→DLM2	10.6340***	7.36381***	6.23640***	4.77819***
DLSTP→DLM2	2.25391	1.03651	0.67019	0.68224
All→DLM2	11.48357**	14.81131*	20.52635*	23.20277
D(LGDP)				
DLM1→DLGDP	0.59364	1.41057	1.08510	0.71364
DLM2→DLGDP	0.03130	0.48708	0.35817	0.23377
INTR→DLGDP	0.17692	1.57332	1.42518	1.84194
DLREX→DLGDP	2.74214	1.29582	0.84915	1.52252
DLSTP→DLGDP	35.2809***	17.2302***	13.6963***	10.7229***
All→DLGDP	39.17027***	38.89662***	67.38826***	87.16544***
INTR				
DLM1→INTR	0.03565	2.89641*	3.64310**	5.06068***
DLM2→INTR	0.01119	0.89602	2.86552**	2.46216*
DLGDP→INTR	0.55707	0.74299	0.84649	0.82934
DLREX→INTR	11.4942***	8.54001***	7.74744***	5.65303
DLSTP→INTR	2.21471	1.15101	2.29064*	2.55874**
All→INTR	13.06554**	25.17578***	43.10537***	52.68128***
D(LREX)				
DLM1→DLREX	0.23866	1.30890	0.84463	0.49468
DLM2→DLREX	0.28395	1.70845	1.24255	1.06559
DLGDP→DLREX	0.00264	0.17169	0.56383	0.26317
INTR→DLREX	2.22494	0.65087	0.65098	0.20580
DLSTP→DLREX	4.05099***	2.48699*	1.70296	1.20852
All→DLREX	7.359374	12.56704	13.70042	15.84265
D(LSTP)				
DLM1→DLSTP	1.31058	1.61034	1.26112	1.04007
DLM2→DLSTP	0.17523	0.84226	0.56203	0.48785
DLGDP→DLSTP	0.58143	2.47198*	2.02179	2.23092*
INTR→DLSTP	2.37943	2.09378	0.75763	0.55786
DLREX→DLSTP	0.35120	0.40535	0.35985	0.78815
All→DLSTP	7.183747	14.56730	18.44701	26.05243

'*' '**' and '***' indicate the significance of the F-statistics at 10%, 5%, and 1% level.
→ indicates the null hypothesis for the Granger-causality test.

6.5. Stability Test

A stability test for money demand is crucial. A stable and predictable relationship between money demand and its determinants is required to develop monetary policy strategies based on intermediate monetary targeting (Sharifi-Renani, 2007). To investigate the long-term stability of the Turkish money demand functions and test the stability of the estimated short-run parameters for the LM1 and LM2 model, we incorporated the cumulative sums (CUSUM) and cumulative sum of squares (CUSUMSQ) tests developed by Brown et al. (1975) into the error correction models. The CUSUM and CUSUMSQ plots for models LM1 and LM2 are shown in Figures 2 and 3, respectively. The CUSUM test is based on the cumulative sum of recursive residuals, whereas the CUSUMSQ test is based on the sum of the squared recursive residuals. The CUSUM test indicated the stability of the estimated short-run parameters for the LM1 and LM2 models. However, the CUSUMSQ tests for both models show a deviation from the 5% significance boundary, raising doubts about the stability of the models. Nonetheless, the LM1 model exhibited reasonably stable conditions.

Figure: 2
CUSUM and CUSUMSQ Test Plots for LM1 Model

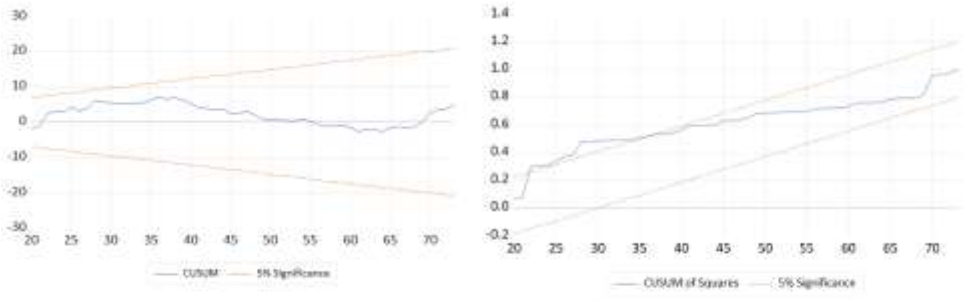
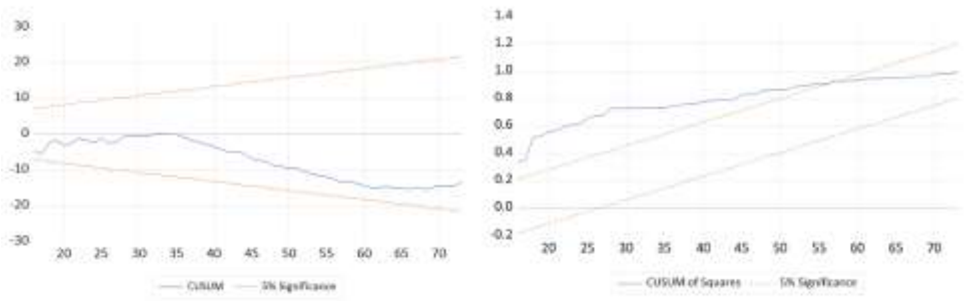


Figure: 3
CUSUM and CUSUMSQ Test Plots for LM2 Model



7. Concluding Remarks and Policy Implications

The primary objective of this study was to evaluate the role of the stock market in the Turkish money demand function and elucidate its significance in the effective implementation of monetary policy. This study used quarterly data spanning 2003: Q1 to 2022: Q4. The ARDL and bounds cointegration test framework and the Granger causality test were employed for the analysis. The independent variables included in the model were real GDP representing real income, deposit interest rate, real exchange rate, and real stock prices. LM1 was the dependent variable, while LM2 was used for robustness control.

The empirical results indicate that the LM1 monetary aggregate has long-run cointegration relationships with the deposit interest rate, real income, the real exchange rate, and real stock prices. All independent variables are significant determinants of LM1 real money demand in the long run. In the short run, only the real exchange rate had a statistically significant impact on LM1 demand. The primary finding of this study is that real stock prices have a significantly positive impact on LM1 money demand, indicating a wealth effect in the Turkish economy. The wealth effect implies that a positive relationship represents the value function of the monetary aggregate, and the level of stock prices primarily constitutes a significant proxy for financial capital. This finding supports the theoretical prediction of a positive impact and is consistent with previous studies.

Incorporating M2 demand into the model reveals a similar influence of real stock prices on the LM2 money demand in Türkiye. A cointegration relationship exists between LM2 demand and the independent variables. All the variables in the model have a statistically significant impact on LM2 money demand in the long run, except for the real exchange rate. Comparatively, LM2 money demand appears more responsive to real stock prices than LM1 money demand. The Granger causality test indicates that deposit interest rate Granger causes LM1 demand. A unidirectional causality was also observed between the real exchange rate and the monetary aggregates. The block Granger causality test confirms that the independent variables have a joint significant causal effect on the demand for LM1 and LM2. The results further indicate that the long-run estimated parameters for the LM1 and LM2 money demand equations are stable within the sample period according to the CUSUM test; however, the CUSUMSQ test raises some concerns about model stability. Nonetheless, LM1 money demand exhibits greater stability than LM2 demand.

Based on these findings, policymakers should recognise the significant role of the stock market in the Turkish long-run money demand function and its impact on the effective implementation of monetary policy. Policymakers should consider this relationship when formulating a monetary policy. Because high stock prices may increase real output and shift the aggregate demand curve upward, policymakers can implement policies that support the stock market to boost real output growth. Since LM1 money demand exhibits greater stability than LM2 demand, the Central Bank of the Republic of Türkiye (CBRT) can implement feasible LM1 monetary targeting, provided it can control the stock index. The CBRT must introduce policies to mitigate downturns and volatility within the stock market to achieve precise money targeting. Additionally, regulators should prevent downturns in the stock market to ensure stable real output growth in Türkiye.

One significant limitation of this study is that its applicability is restricted to Türkiye, and the findings cannot be extrapolated to other economies. In this regard, future research can employ a panel approach, such as panel cointegration, panel causality, or time-varying causality approaches, to a group of countries with characteristics similar to those of Türkiye, providing an intriguing avenue for exploration. Additionally, the Central Bank of the Republic of Türkiye (CBRT) reports various variants of monetary aggregates, and this study only compared the response of M1 and M2 to real stock prices. Therefore, future research could investigate alternative monetary aggregates and utilise different econometric approaches to understand better the relationship between Türkiye's stock market and money demand. Furthermore, our study captured linear relationships; hence, considering nonlinearities in the relationship between money demand and stock prices may provide an exciting avenue for future investigations. Finally, model stability concerns raised by the CUSUMSQ test necessitate further investigation and validation of the results. Therefore, future research should further investigate money demand stability while also considering the presence of structural breaks.

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