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Money Demand Function in Ghana: Does Stock Prices Matter?

ABSTRACT

This study aims to investigate the impact of stock prices on money demand in Ghana. Quarterly data is utilized between 1999Q:1 and 2017Q:4, where the broad monetary aggregate (M2) is the dependent variable and the independent variables included real income, short-term interest rate, real effective exchange rate, and real stock prices. The study employed Autoregressive Distributed Lag (ARDL) and bounds cointegration techniques. The bounds test outcome indicated the existence of a long-run equilibrium relationship between M2, real income, short-term interest rate, real effective exchange rate, and real stock prices. The results show that real income and real stock prices affect real M2 demand positively and significantly in both the short-run and long-run. Hence, the wealth effect is dominant for the Ghanaian economy. Further, the study recorded a negative influence of short-term interest rate and real effective exchange rate on M2 demand but only the former affects M2 demand significantly in the short-run and long-run. The important policy implication derived from the results is that, if the Bank of Ghana can prevent downturns and volatility of the stock market, a sound monetary targeting could be achieved.

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Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

Knowing the right argument for the money demand function will ensure a stable function of money demand which could be useful for the successful initiation of monetary policy, as it will give guidance in selecting the right policy instruments and targets. However, a money demand function that has been stable could become unstable with changes in economic conditions. As such, financial development, financial reforms and innovations, and greater financial integration have been related to several financial and economic crises. Such financial innovations might impact monetary transmission processes and significantly change the determinants of monetary aggregate (Alsamara & Mrabet, 2019). Besides, internet trading together with development and inventions in the mutual fund industry led to the reduction of cost of transactions and thus might increase the substitutability between equities and money (Carpenter & Lange, 2003). That is, ease in internet trading coupled with innovations and development of financial markets and general happenings in an economy might have increased the role of the stock market in economic development as well as its role in monetary policy formulation.

In Ghana, the stock market has transformed into a significant medium for storing wealth in recent years. It has become a platform where secondary securities such as bonds, shares, and other public sector debt securities, which are subjected to varying maturity periods are traded by the citizens-the public, private, and institutions to mobilize financial resources for saving and investment purposes by either with initial public offer or improvement on the pre-existing capital base. In that sense, stock markets can be said to improve the culture of saving, which is an essential indicator as far as economic development is concerned. Nevertheless, the stock markets set the basis for households and firms to diversify their portfolios for both financial and non-financial assets which are held as a store of wealth (Mwanzia *et al*., 2015).

However, in a highly volatile stock market like the Ghanaian stock market, the optimization of wealth portfolios depends crucially on the interest rates, given that the stock markets issue a variety of competing for financial and non-financial assets which are subjected to varying risk returns. Due to the high volatility and high-risk premia, portfolio adjustment might occur in favor of safer assets which might include real money balances. In this case, the happenings in the stock market can significantly affect the conduct of monetary policy via affecting real money demand. In a developing country like Ghana where the holding of cash balances is prominent in the portfolio of firms and households, money targeting forms the basis of the monetary policy regime. Therefore, money targeting fails if the impact of the stock market is not taken into consideration. In a nutshell, stock market development can lead to the substitution of money balances in favor of or against stocks which in turn may cause non-tenability of the growth rates of money supply targeted to achieve the desired macroeconomic objectives (Mwanzia *et al*., 2015).

From Friedman (1988) paper, money demand and stock price linkage can be positive or negative. The positive link of stock prices with money demand indicates a wealth effect while the negative effect indicates a substitution effect. Friedman (1988) proposed three reasons that may account for the wealth effect. Firstly, relatively well-doing stock markets mean a rise in nominal incomes, and therefore extra cash will be needed for daily operations. Secondly, in a well-doing stock market, the expected returns for risky assets may increase about safe assets. If this happens, there might be a substitution of assets with money which may be seen as a safe asset. Thirdly, an increase in stock prices may raise the transaction volume of the financial market, hence participants will need more cash in hand to carry out operations. On the other hand, the substitution effect asserts that as stock markets perform well, equity returns become attractive compared to other financial market components such as money, as an asset, hence a shift from money to shares.

To this end, the Ghanaian money demand equation has been widely examined, however, none of the previous authors has incorporated the real stock prices into the equation to test Friedman's argument (Nkalu, 2020; Ahiawodzi, 2013; Abasimi & Khan, 2019; Tweneboah & Alagidede, 2018; Ange-Patrick & Hervé, 2017; Nchor & Adamec, 2016; Baidoo & Yusif, 2019; Asiedu *et al*. 2020; among others). To cover this gap, this study is set up to find out which effect (wealth or substitution effect) dominates the Ghanaian

economy. This objective is achieved by using the Auto-regressive Distributed Lag (ARDL) model proposed by Pesaran *et al*. (2001) and the bounds cointegration test to explore the short and long-run effects of the real stock prices on the Ghanaian money demand function. Nonetheless, understanding the direction of the impact of the stock market on money demand could help the policymaker to improve the success of money targeting-based monetary policy initiations in the Ghanaian economy.

The remainder of the article is organized as follows. Section 2 explains the money demand model and the significance of the determinants added to the model. Section 3 summarizes the previous relevant literature. Section 4 describes the data and the econometric model used for the analysis. Section 5 presents the estimation results and interpretations. Finally, section 6 gives conclusions and policy recommendations.

2. THE MONEY DEMAND MODEL

Despite Taylor's rule disregarding the role of money demand in monetary policy, its role is still recognized by scholars in the successful conduct of monetary policy. About the theory of money demand, to model the money demand function one must include a scale variable that represents the transaction volume in an economy, and an opportunity cost variable as the main independent variables. In addition to the scale variable and the opportunity cost determinants of money demand, following Friedman (1988), Choudhry (1996), and Baharumshah *et al*. (2009) the money demand function can be specified by including stock prices as given below:

$$(M/P)^d = f(y, ir, ex, sp) \tag{1}$$

where, $(M/P)^d$ is the real money demand with M being nominal demand for money and P is the price level, y is real income, which has been proven to be the most significant determinant of money demand in the literature. ir denotes the short-term nominal interest rate, ex is the exchange rate and sp is the real stock price[1]. Theory shows that nominal demand for money has a direct relation with the price level P, hence the ratio of the former to the latter gives the real money demand. The scale variable which is y indicates transaction volume and wealth in an economy. Friedman (1959) stressed the importance of returns on alternative assets to the money demand function. Heller (1965) also argued for a short-term interest rate as being more important to the money demand function than the long-term interest rate. Hence, the short-term interest rate is included to represent the opportunity cost of holding money. The ex variable denotes variations in the local currency with foreign currency (ex). It is argued that to see the impact of variations in the value of the domestic currency on the money demand function in the free market economy, a variable representing the relative return of the foreign currency to the domestic currency, such as the exchange rate, international interest rate or interest rate differential, must be added in the demand function of money (Bahmani-Oskooee, 2001; Chowdhury, 1997; Civcir, 2003; Khalid, 1999). Stock prices (sp), according to Friedman (1988) might have wealth or a substitution effect on money demand. The semi-log linear form of Equation (1) can be written as:

$$l(m-p)_t = \beta_0 + \beta_1 ly_t + \beta_2 ir_t + \beta_3 lex_t + \beta_4 lsp_t + e_t \tag{2}$$

where l signifies the natural logarithm symbol, e_t is the assumed white noise error process, β_0 is the intercept, $\beta_1, \beta_2, \beta_3$, and β_4 indicate how much real money demand responds to the explanatory variables. Theoretically, the estimate of the β_1 *to* β_4 parameters should be as; $\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 < 0$ if substitution effect exists, or $\beta_3 > 0$ if wealth effect exists, β_4 will be positive if sp has a wealth effect on money demand, or negative on the other hand if sp has a substitution effect on the money demand function. For the coefficient of real income, β_1 is expected to be positive. If $\beta_1 = 1$ the theory of quantity money demand is

[1] Since stock prices measures wealth effects it should be in real terms rather than nominal values (Friedman, 1988)

applicable; if $\beta_1 = 0.5$, the inventory theory of Baumol–Tobin could be applied; and if $\beta_1 > 1$ money is regarded as a luxury which means that the wealth effect of real income is neglected (Baharumshah *et al*., 2009; Ball, 2001).

3. LITERATURE REVIEW

The literature review was conducted in two parts. The first part tried to review all related studies which have previously analyzed the Ghanaian money demand function. The second part of the literature review was aimed at reviewing all relevant studies on stock prices' relationship with money demand in both advanced and emerging economies. The literature survey is organized as follows.

3.1. Part I

Previous researchers employed various econometric techniques to analyze the Ghanaian money demand function. Nkalu (2020) employ the Pedroni Residual Cointegration Test and Panel Two-Stage Estimated Generalized Least Squares with instrumental variables to study money demand equations for Ghana and Nigeria within the range of 1970 and 2014. The obtained results show proof of liquidity preference theory, in which the included variables–official exchange rates, real interest rates, and inflation were significant economically except real income. Ahiawodzi (2013) analyze the impact of interest rate on money holdings in the Ghanaian economy with the Ordinary Least Squares (OLS) and Engel and Granger two-step technique. The study utilized annual data and explored the mentioned relationship which covered the period from 1970 to 2010. Based on the OLS results the authors concluded that the broad money demand (M2+) is responsive to the interest rate both in the short and long run, and stable as well.

Similarly, Abasimi and Khan (2019) study the money demand function by comparing estimation outcomes from OLS and ARDL approaches using annual data between 1983 to2013. The obtained evidence shows that real GDP, exchange rate, and inflation have robust and significant short-run and long-run impacts on demand for money. By considering the outcome of the several breakpoint tests, the study concludes that money demand was stable. Ghartey (1998) explores the relations of exchange rate risk, exchange rate, real income, and prices with nominal money stock, with the application of OLS and Johansen's full information maximum-likelihood method to time series ranging from 1970:4 to 1992:4. The results show a cointegration relationship exists in the variables, and that the short-run deviations are adjusted slowly to long-run equilibrium by 6%. Further, the obtained evidence shows demand function for money and the estimated parameters are significant and stable. Apart from the OLS approach, other methods are also employed in analyzing the money demand function.

The ARDL for example is another widely used technique for investigating the nexus between money demand and its determinants. Baidoo and Yusif (2019) attempt to analyze the effect of the interest rate on demand money in the Ghanaian economy by using the ARDL and bounds cointegration techniques. Yearly data of broad monetary aggregate (M2+), 91-day treasury bill rate, income, inflation, and exchange rate were used for the analysis from 1980 to 2016. The authors obtained evidence that the interest rate does not have a significant impact on the demand for M2+ in Ghana. Further, income (inflation rate) was found to have a significantly positive (negative) effect on the money demand function.

Similarly, Tweneboah and Alagidede (2018) applied the ARDL unrestricted error correction technique and the bounds cointegration test to test the presence of currency substitution in Ghana, using annual data from 1960 to 2013. The results reveal that the income elasticity for M1 is close to one but less than unity for M2. The findings further show that the home interest rate is affecting M1 and M2 negatively and positively, respectively. The study findings also show a negative and positive impact of returns on foreign bonds and exchange rate, respectively, on M1 and M2 money. Hence, the authors concluded that currency substitution does not exist. Also, Ange-Patrick and Hervé (2017) used annual data from Ghana and Cote d'Ivoire and

conducted a comparative analysis of demand for money, over the range of 1980-2015, with the ARDL and bounds cointegration procedures where exchange rate, output, interest rate, and inflation were included as regressors. For Ghana, the reported results show that output, inflation, and interest are long-run significant indicators of M2 money demand within the period. However, insignificant coefficients were reported for the short-run dynamics, and the demand for money function was shown to be stable.

Moreover, Dagher and Kovanen (2011) re-estimated the demand for cash for Ghana in a period where the economy underwent a series of reforms by employing the ARDL and the bounds cointegration test from 1990:Q1 to 2009:Q4. The broad money demand M2+ was regressed on real income, exchange rate, and interest rate. The exchange rate and real income derive M2+ demand in Ghana, and the demand for money within that period was also stable. Iyke and Ho (2017) also used quarterly data from the period 1990:Q1 to 2016:Q3, with the ARDL framework to test the Friedman hypothesis for the Ghanaian economy. The study investigated monetary uncertainty relations with money demand by differentiating between short-run and long-run impacts. The results indicate that positive increases in monetary uncertainty reduce money holdings in both runs, thereby refuting Friedman's hypothesis. The study also showed that within the examined period money demand is constant.

Asiedu *et al*. (2020) used both the ARDL and vector error correction model (VECM) to study the Ghanaian money demand function and the outcome reveals money demand function is stable if real income, exchange rate, inflation, domestic interest rate, and foreign interest rate are used as its arguments. Thus, there exists a short and long-run relationship between money demand and its determinants.

Besides OLS and ARDL techniques, the Johansen cointegration and the ECM are also employed by some authors to study money demand and its determinants for Ghana. Nchor and Adamec (2016) analyze the long-run stability and linkage of income and interest rate with real money demand (M1 and M2+) from 1990 to 2014 by using the VECM. The findings show a long-run effect of real income and a short-run effect interest rate on demand for money. The findings also show M1 and M2+ demand are stable with real income and interest rate as explanatory variables and based on the Chow test no structural breaks exist within the period.

A similar technique was used by Havi *et al*. (2014) to investigate the Ghanaian money demand function using M2 as the dependent and real GDP, 91-day treasury bill rate, nominal exchange rate, expected inflation, and international interest rate. The findings show a stable cointegration relationship between the regressors and M2 money demand. The reported results further show for the long run, expected inflation and nominal international interest rate are important indicators of demand for money, while for the short run, nominal exchange rate and real income are seen to be important determinants of M2 holdings in the Ghanaian economy. Also, in 21 African countries including Ghana, Bahmani-oskooee (2009) used the error correction model and bounds cointegration test to investigate money demand constancy between 1971 and 2004 with quarterly data. The findings reported for Ghana show real income, inflation, and exchange rate significantly affect the demand for real money, and evidence for stability was also reported over the considered period.

Besides, in the 1980s when some significant macroeconomic adjustments occurred in the Ghanaian economy which included privatization, removal of foreign exchange controls, and so on, Andoh and Chappell (2002) tested the destabilization of demand for money function by including real per capita consumption and inflation into the function, and broad M2 monetary aggregate was the dependent variable. They reported evidence indicating that between 1960 and 1996 there exists a systematic break in the Ghanaian money demand function which occurred in 1983. Finally, Kallon (1992) tested the appropriateness of the neoclassical money demand theory using real M1 monetary aggregate for the economy of Ghana. The study used quarterly data which covered the period between 1966 and 1986. The reported results indicate that in the Ghanaian economy people view interest-earning financial assets as

attractive alternatives to real money balances, although the relationship is weak. The obtained evidence also shows that Ghanaians adjust their short-term cash holdings in real terms and their real Ml holdings in nominal terms.

3.2. Part II

The effect of equity returns on money demand has been analyzed by researchers for both industrialized and emerging countries. For a developed country like the US, Friedman (1988) addressed the influence stock prices have on money demand function. The results showed positive effects of lagged values of equity returns and negative contemporary effects on holdings of money. In Friedman (1988) view, the lagged equity returns have a wealth effect on the real quantity of money, whereas the substitution effect exists contemporaneously. Thornton (1998) for Germany, used the Johansen cointegration technique for his research, and to explain the dynamics of demand for money in the short run the error correction form of the data was also considered. The findings show that an increase in real returns of stocks has affected the long-run M1 holdings for the period of 1960-1989. By using data from Italy, Caruso (2006) demonstrates that stock prices which include dividends have a positive influence on the demand for function between 1913-1980, indicating the wealth effect of stock returns on money demand in Italy. The study shows that the wealth effect only prevails and is stable in the short run-thus stock market only explains the temporary movement of money demand. Jung and Villanova (2020) show that stock prices are positively related to M3 money demand in the Euro area.

Also, some authors argue that the inclusion of stock prices into the money demand function may improve stability. In an effort made by Carstensen (2006) to answer the question if the behavior of money demand underwent a structural change at the end of 2001, following the considerable overshooting of M3 money growth reference value set by the European Central Bank. The evidence provided indicates that the long-run money demand function for European Monetary Union has increased considerably in terms of stability when stock returns and stock market volatility were included in the function. Thus, specifying the money demand function without stock prices at the right-hand side renders it unstable. Carpenter and Lange (2003) also for the US find evidence that inserting stock prices into the money demand function reduces errors, that is, it improves stability and affects cash holdings significantly. Carpenter and Lange (2003) also conduct out-of-sample forecasting and the findings indicate that forecasting can also be improved by including stock price variables. The money demand and stock price relations are quite similar in developing countries too, a mixed evidence has been reported.

In developing countries, the empirical evidence shows both the wealth and substitution effect of equity returns on money demand. Tule *et al*. (2018) use the ARDL bounds testing procedure to scrutinize the function of money demand for Nigeria by including stock prices as an independent variable. The obtained evidence shows the existence of a long-run relationship between GDP, stock prices, foreign interest rate, and real exchange rate. Further, the results show returns on the stock have a significant increasing effect on broad M2 holdings in the long-term. To understand how stock prices affect the Indian money demand function within the period of 1996:1 to 2010:8. Kumari and Mahakud (2012) use the VECM and the Juselius cointegration approach to obtain evidence that money demand is responsive to stock prices. Further, they conduct Granger causality tests, and the obtained results show that stock prices unidirectionally cause money demand.

McCornac (1991) conducted a study on how stock prices influence money demand for the Japanese economy—a replication of Friedman (1988) study. The findings present evidence of real stock returns' positive impact on money demand and risk-spreading effect on money demand. Mwanzia *et al*. (2015) explore the impact stock prices might display on money demand in the Kenyan economy by using cointegration and the VECM. The findings show that the stock market of Kenya positively and significantly affects money holdings in the economy. Al Rasasi *et al*. (2020) use Johansen cointegration test and the VECM to investigate the potential effect of stock prices on demand for money in Saudi Arabia. The results

reveal that an increase in stock prices causes an increase in cash holdings significantly, hence the existence of the wealth effect. Omar and Hussein (2020) scrutinize the impact of stock prices on the equation of money demand in South Africa. They reported that, though there is a significant positive long-run impact on money demand, the equation is however unstable.

Contrary to the pre-mentioned studies, for emerging countries, other researchers find an inverse relationship of stock prices with the demand for money function. Baharumshah (2004) finds a negative significant substitution effect of stock prices on short-run and long-run broad money holdings for Malaysia and thus, stock prices Granger cause broad money demand. Baharumshah *et al*. (2009) for China, employ the cointegration method and find a significant substitute effect of stock prices on money demand. Akinlo and Emmanuel (2017) demonstrate that stock prices have a substitution effect on the Nigerian money demand function and can lead to misspecification if omitted from the function. Nevertheless, in the study aimed at exploring the relationship between equity returns and money demand in Poland, Hsing (2007) concluded that stock prices do not influence the function of money demand.

The previous literature indicates the Ghanaian money demand function is determined by real income, interest rate, exchange rate, and inflation. Most of the previous authors found these indicators to have significant impacts on the money demand function in Ghana. In addition to those determinants, Havi *et al*. (2014) and Tweneboah and Alagidede (2018) added foreign interest rate as an explanatory variable, and they found that international interest rate is another important indicator of money demand in Ghana. Finally, Iyke and Ho (2020) also added monetary uncertainty as independent variables in their study and they reported a significant response of money demand to monetary uncertainty. The current study will extend stock prices money demand nexus to the Ghanaian economy as it is lacking in the Ghanaian literature. This study aims to investigate the long run and short run nexus between real money demand and stock prices which could be useful for money targeting-based monetary policy formulation.

4. DATA AND ECONOMETRIC METHOD

4.1. Data

The study utilizes quarterly data ranging from 1999:Q1 to 2017:Q4. The lower limit of the study span is decided by data accessibility for the M2 monetary aggregate which is the dependent variable, and the upper limit is determined by considering the closure of seven financial institutions in early 2018, which were part of listed firms in Ghana Stock Exchange (GSE) index. Extending the sample beyond 2018 may yield unreliable results. The independent variables include real stock prices (SP) which is the target variable, real gross domestic product (GDP) for real income, short-term interest rate (TBR), and real effective exchange rate (RER). Real money balances and Real stock prices (SP) were calculated as the ratio of the nominal values to the consumer price index (CPI)—a proxy for general price levels. The short-term interest rate which is the opportunity cost variable is represented by the 91-day treasury bill rate. The real income variable (GDP) is measured in Ghanaian cedis with 2010 fixed prices which were collected from World Development Indicators (WDI). The CPI and real effective exchange rate data were collected from the International Monetary Fund (IMF) International Financial Statistics (IFS) database. Data for M2 monetary aggregate and 91-day treasury bill rate (TBR) were extracted from the Bank of Ghana (BoG) time-series database. Finally, the SP data series is the average quarterly data and was extracted from the GSE market reports.

The graphical representations of all the series are presented in Figure A (Appendix A). Also, the nominal SP data series is plotted in Figure B (Appendix A). In Figure B, it can be seen that there is a sharp drop corresponding to the beginning of 2011 (2011:Q1) which marks the era where the GSE index was transformed from the All Share Index (ASI) to Composite Index (CI). Therefore, to capture the effect of the structural break a dummy variable (D0) is incorporated into the model. It can also be seen from Fig. B.

a continued decline of the GSE index —approximately corresponding to the commencement of 2018— when seven listed financial institutions in the Ghanaian stock exchange market were closed down. Therefore, to avoid misleading regression results, the study span is limited to the range between 1999:Q1 and 2017:Q4.

4.2. Econometric Model

The ARDL method and the bounds test are employed to study the long-run and short-run relationships of real income, interest rate, real effective exchange rate, and real stock prices with real monetary aggregate (M2). The ARDL method is seen as appropriate for examining the money demand equation in the previous literature because it yields robust results in non-stationary time-series data, or when the stationarity test results show the mixture of I(0) and I(1) series. This is because the ARDL approach takes its basis from the assumption that variables are $I(0)$ and $I(1)$, and also interpretation is quite straightforward because it involves a single equation. The long-run money demand model is:

$$LM_t = b_0 + b_1 LGDP_t + b_2 TBR_t + b_3 LRER_t + b_4 LSP_t + \varepsilon_t \qquad (3)$$

where L is the symbol of the natural logarithm, M_t is real money demand, GDP is real gross domestic product representing real income, TBR is the 91-day treasury bill rate, RER denotes real effective exchange rate, SP is real stock prices, $b_1, b_2, b_3 and\ b_4$ are long-run money demand elasticities corresponding to real income, interest rate, real exchange rate, and stock prices, respectively. ε_t is the error term. b_0 is the intercept. The expected signs of the elasticities are discussed in section 2. Based on the aim of this study, introducing short-run and long-run dynamics into equation (3) yields ARDL representation of equation 3 as follows:

$$\Delta LM_t = a_{01} + \sum_{i=1}^{p} a_1 \Delta LM_{t-i} + \sum_{i=1}^{q_1} a_2 \Delta LGDP_{t-i} + \sum_{i=1}^{q_2} a_3 \Delta TBR_{t-i} + \sum_{i=1}^{q_3} a_4 \Delta LRER_{t-i} + \sum_{i=1}^{q_4} a_5 \Delta SP_{t-i} + b_1 LM_{t-1} + b_2 LGDP_{t-1} + b_3 TBR_{t-1} + b_4 LRER_{t-1} + b_5 LSP_{t-1} + \varepsilon_t \qquad (4)$$

where α_{01} is the intercept term; b_1, b_2, b_3, b_4 and b_5 are long-run elasticities; α_1, α_2, α_3, α_4 and α_5 are the short-run elasticities; Δ is the difference operator. The bounds test is employed to test the null hypothesis, H_0; $b_1 = b_2 = b_3 = b_4 = b_5 = 0$, which means no long-run relationship, and it is tested against the alternative H_1; $b_1 \neq b_2 \neq b_3 \neq b_4 \neq b_5 \neq 0$, which indicates a cointegration relationship prevails among the series. In this case, the decision is guided by the Wald test-based F-statistic for cointegration test—where the F-statistic value is compared with a set of $I(0)$ and $I(1)$ table values (Pesaran *et al*., 2001). The H_0 cannot be rejected if the calculated F-statistics value is lower than $I(0)$ bound critical value, therefore, the outcome will be no long-run associations among the series. On the other hand, if the computed F-statistic exceeds the upper set $[I(1)]$ critical value, H_0 will be rejected, indicating a long-run relationship. However, the decision is inconclusive if the calculated value falls between $I(0)$ and $I(1)$ bounds table values.

Replacing $b_1 LM_{t-1} + b_2 LGDP_{t-1} + b_3 TBR_{t-1} + b_4 LRER_{t-1} + b_5 LSP_{t-1}$ in equation Equation (4) with φect_{t-1} gives the error correction specification in an ARDL setting, as in Equation (5). If cointegration exists Eq. (6) will be estimated.

$$\Delta LM_t = \alpha_{02} + \sum_{i=1}^{p} \alpha_1 \Delta LM_{t-i} + \sum_{i=1}^{q_1} \alpha_2 \Delta LGDP_{t-i} + \sum_{i=1}^{q_2} \alpha_3 \Delta TBR_{t-i} + \sum_{i=1}^{q_3} \alpha_4 \Delta LRER_{t-i} + \sum_{i=1}^{q_4} \alpha_5 LSP_{t-i} + \varphi ect_{t-1} + \varepsilon_t \qquad (5)$$

where ε_t is the disturbance term which is white-noise. φ is the error correction term (ect_{t-1}) coefficient, it is the component that measures the rate of correction of deviations in the long run, and it should bear a negative sign and must be less than 1 to ensure convergence.

5. RESULTS AND INTERPRETATIONS

5.1. Descriptive statistics and correlation properties of time series

The descriptive statistics are reported in Table 1. It is shown in the table that the degree of asymmetry of data observations which is measured by the skewness value is positive (long right-tailed) for all the variables except LM2. In the concept of skewness, a zero (0) value indicates symmetry. Therefore, we can conclude from the table that, to the nearest whole number, all the variables but interest rate exhibit symmetry. The peakedness or flatness of a distribution is measured by the kurtosis value. In concept, a mesokurtic distribution should have a kurtosis value of three (3). In that sense, to the nearest whole number, the LRER and TBR are mesokurtic and the rest are platykurtic. The Jarque-Bera statistics and the associated probability values indicate only the LRER has a normal distribution considering a 5% level of significance.

Table 1: Descriptive statistics

Variable	LM2	TBR	LGDP	LRER	LSP
Mean	4.3094	20.6737	25.2159	4.5018	3.4161
Median	4.2946	20.2700	25.1737	4.5438	3.5772
Max.	5.5186	46.6800	25.8504	5.0405	5.0203
Min.	3.0000	9.3900	24.6363	4.0564	2.0516
Std. Dev.	0.8174	8.8369	0.3812	0.1996	0.9853
Skewness	-0.1521	0.8846	0.0543	0.1357	0.0464
Kurtosis	1.6417	3.4429	1.5927	3.1488	1.5022
Jarque-Bera	6.7810	11.6410	6.9726	0.3354	7.8817
Prob.	0.0337	0.0030	0.0306	0.8456	0.0194

Note: The probability values are associated with Jaque-Bera statistics which follows a Chi-square distribution with 2 degrees of freedom.

Table 2 reports the correlation coefficients among the time series. The dependent variable (LM2) is positively correlated with LGDP and LSP, whilst negatively correlated with TBR and LRER. The LGDP and LSP have the highest correlation coefficient (-52.5%), and the lowest correlation coefficient (-2.1%) is displayed by TBR and LGDP. A high correlation between independent variables can lead to multicollinearity which can inflate the coefficient of determination and cause the estimate of parameters to be highly significant. The correlation coefficients among the independent variables show the possibility of encountering multicollinearity problems is minimal.

Table 2: Correlation coefficients between the time series

Time Series	LM2	LGDP	TBR	LRER	LSP
LM2	1.0000	0.0734	-0.2255	-0.0140	0.0984
LGDP	0.0734	1.0000	-0.0206	0.0273	-0.5252
TBR	-0.2255	-0.0206	1.0000	-0.4511	-0.0122
LRER	-0.0140	0.0273	-0.4511	1.0000	0.0254
LSP	0.0984	-0.5252	-0.0122	0.0254	1.0000

5.2. Unit Root Test

Non-stationarity is a common feature of time series data. So to know the stationarity properties of the series, the Augmented Dicke-Fuller (ADF) (Dickey & Fuller, 1979) and Phillip-Perron (PP) (Phillip & Perron, 1988) traditional unit root tests are used to conduct a unit root test, and they are complemented with the Ziot-Andrews (ZA) (Zivot & Andrews, 1992) structural break unit root test. This is deemed necessary because the traditional unit root might spuriously reject or accept a unit root null hypothesis if there is a structural break in the data. In Table 3, the results of the traditional unit root tests are presented. It is seen

that both the ADF and the PP tests could not reject the unit root null hypothesis at levels for all the time series, hence, LM2, LGDP, TBR, LRER, and LSP are integrated of order one [I(1)].

Table 3: ADF and PP unit root tests results

Time Series	ADF at levels		ADF at first difference		Conclusion
	Constant	Linear Time Trend	Constant	Linear Time Trend	
$LM2$	-0.7366	-1.7453	-9.8278***	-9.8101***	I(1)
$LGDP$	0.7970	-1.9146	-8.0756***	-8.1035***	I(1)
TBR	-2.3404	-2.6843	-6.4893***	-6.4484***	I(1)
$LRER$	-2.2986	-2.5906	-6.6460***	-6.6799***	I(1)
LSP	-0.7338	-1.7460	-8.1069***	-8.1133***	I(1)
	PP at levels		PP at first difference		
$LM2$	-0.8008	-1.5903	-9.8552***	-9.8492***	I(1)
$LGDP$	0.6653	-2.0749	-8.1356***	-8.1618***	I(1)
TBR	-2.0958	-2.3499	-6.5082***	-6.4676***	I(1)
$LRER$	-2.3685	-2.9159	-6.6526***	-6.6774***	I(1)
LSP	-0.9394	-1.9739	-8.1325***	-8.1385***	I(1)

Note: '*','**' and '***' indicate the rejection of the null hypothesis of unit root at 10%, 5%, and 1% significance level, respectively.

The results of the ZA unit root test are tabulated in Table 4. It can be seen that with the model with only intercept the ZA test outcomes are the same as the traditional stationarity tests for LM2, LGDP, and TBR, given a 5% level of significance. Thus, the ZA test confirms that these variables are I(1). The remainder of the variables (LSP and LRER) seem to be an order zero [I(0)] according to the ZA test results. This indicates that, the existence of either a spike or a slut which the conventional tests could not capture led to the spurious acceptance of the unit root null hypothesis for LSP and LRER by ADF and PP tests.

Based on the obtained results from the stationary tests, the series are an amalgamation of I(0) and I(1). This shows that applying OLS will yield spurious estimates of the parameters. Therefore, we resort to the ARDL framework to carry out the analysis.

Table 4: ZA unit root test results

Time Series	ZA at levels		ZA at first difference		Conclusion
	Constant	Linear Time Trend	Constant	Linear Time Trend	
$LM2$	3.7691	-5.7049***	-5.0589**	-4.9225*	I(1)
$LGDP$	-4.6513	-5.2777**	-9.7068***	-9.7737***	I(1)
TBR	-4.5681	-4.7005	-6.5814***		I(1)
$LRER$	-5.0910**	-5.3284**	-6.9259***		I(0)
LSP	-5.5130***	-5.1704**			I(0)

Note: '*','**' and '***' indicate the rejection of null hypothesis of unit root at 10%, 5% and 1% significance level, respectively

5.3. Bounds cointegration test.

A robust bounds cointegration test outcome in an ARDL setting can be achieved if an appropriate lag length is determined because ARDL modeling is sensitive to the lag length. The Schwarz criterion (SIC) is used to select the lag length because it is argued that a SIC-based ARDL turns to give reliable results in relatively small samples. A maximum of six lags are imposed manually and the SIC determined the appropriate optimal lag length. An ARDL (1, 0, 0, 0, 0) model is determined by SIC, which means one lag order for the LM2, and zero lag order for each of the rest (LGDP, TBR, LRER, and LSP). The structural break stationary test results show a break in the SP data series, so a dummy variable (D0) is incorporated into the model as

a fixed regressor, where it takes a value of one for 2010 and 2011 and zero for other years. Estimating equation 4 with lag order (1, 0, 0, 0, 0), the H_0 the hypothesis is tested against the H_1 as the alternative hypothesis by using the bounds test. Table 5 contains the outcome of the bounds test. As seen in the table, the calculated F-statistics is slightly above the upper bound table critical value, hence the null hypothesis is rejected. Therefore, the real monetary aggregate (LM2) is associated with the LGDP, TBR, LRER, and LSP in the long run. Based on the bounds test outcome, the study proceeds and obtains the long-run coefficients.

Table 5: Bounds cointegration test results

Dependent Variable: LM2	F-statistics (F_{PSS})	Bounds critical value		Outcome
Sample (1999:Q1-2017:Q4)		I(0)	I(1)	
$LM2 = f(LGDP, TBR, LRER, LSP)$ k=4	4.18	2.86	4.01	Cointegration

Note: 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.

5.4. Long run Estimation Results

The outcome of the estimated parameters for the long run and diagnostic tests are tabulated in Table 6. From the table, the real income variable (LGDP) is positively related to real money demand. We expected this outcome theoretically, an increase in real income of citizens should lead to an increase in real money demand according to the money demand theory. The estimate of LGDP is statistically significant at a 1% level. A percentage increase in real income results in a 2.21% increase in demand for real money in the Ghanaian economy. In the previous literature, authors including Dagher and Kovanen (2011), Nchor and Adamec (2016), Tweneboah and Alagidede (2018), Abasimi and Khan (2019), Baidoo and Yusif (2019), and Asiedu *et al*. (2020) found a similarly significant positive impact of real income on broad M2 demand for the Ghanaian economy.

Table 6: ARDL Long-run Estimates (Dependent variable: LM2)

Variable	$Coefficients$	$Standard\ Error$	t-statistics	$P\ values$
Constant	-20.1634	5.3237	-3.7875	0.0003
$LGDP_t$	2.2123	0.0879	25.1695	0.0000
TBR_t	-0.0055	0.0022	-2.4614	0.0164
$LRER_t$	-0.0412	0.1239	-0.3322	0.7408
LSP_t	0.0595	0.0205	2.9047	0.0050
Diagnostics and stability tests				
Test	F-statistic (Prob)		Regression statistics	
Serial correlation LM test	5.4082 (0.2479)		$R^2 = 0.9974$	
Heteroscedasticity test	19.3200 (0.7347)		Adjusted R^2 =0.9972	
Normality test	6.2296 (0.0441)		Durbin Watson stat=1.968	
CUSUM	stable		F-statistics=4376.972	
CUSUMSQ	stable		Prob= 0.000	
EC = LM2 - (2.2123*LGDP -0.0055*TBR -0.0412*LRER + 0.0595*LSP)				

The most important independent variable in this study is the log of the stock price (LSP), which according to the results in Table 6, has a significant positive influence on the broad M2 demand, at a 1% significant level in the long run. Theoretically, the positive wealth impact of stock prices on money demand is expected. The wealth effect implies that an increase in stock market volume in Ghana will serve as an incentive to hold more cash to either trade in the stocks, or because nominal incomes of citizens might have increased, and citizens will demand more cash to run daily transactions. Also, the positive impact could be accounted for by the fact that, given the risky and volatile nature of developing stock markets like the Ghanaian own, if expected returns on risky asset increases as compare to safe assets, there might be a switch from financial assets to money balances, as it might be deemed as a safe asset. The finding shares some similarities with

extant findings including Tule *et al*. (2018), Kumari and Mahakud (2012), Mwanzia *et al*. (2015), Al Rasasi *et al*. (2020), and Omar and Hussein (2020) who have also reported a positive influence of stock price on demand for money in emerging countries. The results however contradict the findings of Baharumshah (2004), Baharumshah *et al*. (2009), Akinlo and Emmanuel (2017), who reported a negative relationship between the former and the latter.

The short-term interest rate (TBR) which was defined by the 91-day treasury bill rate, and the real effective exchange rate (LRER) have a long-run negative impact on the broad money demand. Theoretically, for both variables, we expected a negative impact. For the TBR, if returns on alternative assets such as government bonds and other financial security increases, holdings of money will decrease in turn. However, only the interest rate affects broad M2 demand significantly at a 5% level. Authors such as Nkalu (2020), Ange-Patrick and Hervé (2017), Nchor and Adamec (2016), and Havi *et al*. (2014) report a similar significant negative impact of interest rate on money demand in Ghana which supports our results. However, it is in disagreement with Tweneboah and Alagidede (2018), who reported a positive but insignificant impact of TBR on money demand.

Some diagnostic and stability tests were carried out on the estimated model. Breusch-Godfrey serial correlation LM test, White heteroskedasticity test, and Jaque-Bera normality test were conducted. The model seemed to pass LM and White tests but failed the Jaque-Bera test at a 5% level of significance, hence the residuals from the regression do not have a normal distribution.

5.5. The Unrestricted Error Correction Model

Because cointegration exists between broad M2 and the determinants understudy, the unrestricted error correction specification as in Eq. 5 is estimated, and the short-run and the ect_t estimates are tabulated in Table 7. From the table, it can be seen that all the variables bear the expected signs. Real income and stock price variables have a positive sign and are statistically significant at 5% and 10% level, respectively. The short-run significant estimate of real income is in line with previous findings including Abasimi and Khan (2019), Havi *et al*. (2014), and Bahmani-Oskooee (2009) for the Ghanaian economy. On the other hand, interest rate and real effective exchange rate bear negative signs, and only the interest rate affects money holdings significantly at a 10% level.

Table 7. Unrestricted error correction form for ARDL(1, 0, 0, 0, 0) model (Dependent variable: ΔLM2)

Variable	*Coefficients*	*Standard Error*	*t-statistics*	*P values*
Constant	0.0137	0.0093	1.4657	0.1474
$\Delta LM2_{t-1}$	0.0130	0.1275	0.1022	0.9189
$\Delta LGDP_t$	1.1809	0.5296	2.2299	0.0291
ΔTBR_t	-0.0030	0.0017	-1.7628	0.0825
$\Delta LRER_t$	-0.0799	0.0961	-0.8311	0.4089
ΔLSP_t	0.0412	0.0223	1.8457	0.0694
ect_{t-1}	-0.3855	0.1200	-3.2121	0.0020
Diagnostics and stability tests				
Test	F-statistic (Prob)		Regression statistics	
Serial correlation LM test	1.2159 (0.2702)		$R^2 = 0.2365$	
Heteroscedasticity test	28.4867 (0.3862)		Adjusted R^2 =0.1681	
Normality test	4.1035(0.1285)		Durbin Watson stat=2.0270	
CUSUM	stable		F-statistics=3.4582	
CUSUMSQ	stable		Prob= 0.0049	

The estimate of the error correction term is negative and statistically significant at a 1% level. The negative sign indicates the correction of errors in the long-run which might have been caused by short-run deviations. The estimate of ect_t the term shows the errors in the system are moderately adjusted by 39% in the long run. The unrestricted error correction model passed the LM serial correlation test, White heteroskedasticity test, and normality tests.

5.6. Stability Test

The cumulative sums (CUSUM) and cumulative sum of square (CUSUMSQ) stability tests are incorporated into the estimated unrestricted model in Table 7. Accordingly, this is necessary because destabilization might occur due to unsuitable short-run dynamics modeling which characterizes long-run deviations (Bahmani-Oskooee, 2001; Laidler, 1993; Sharifi-Renani, 2008). These tests were invented by Brown *et al*. (1975) and they are used to determine the constancy of parameters in an estimated regression model. The graphical plots of the stability tests as in Figures 1 and 2 show the stability of the parameters within the 5% significance boundary. Hence, both tests confirm the stability of the estimated M2 money demand equation for the considered period.

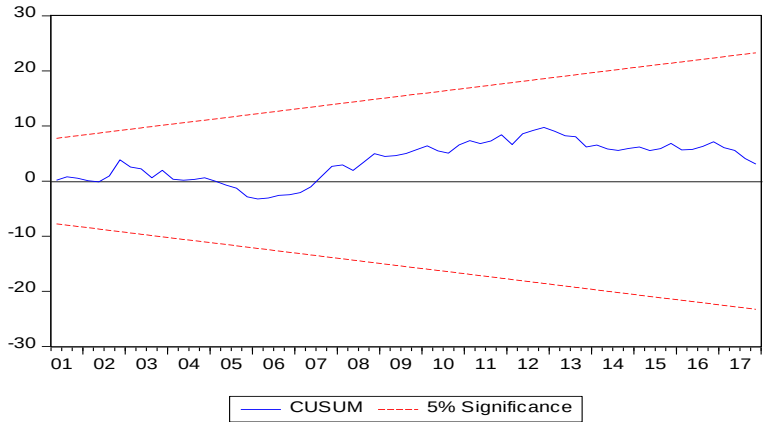

Figure 1: CUSUM test graph

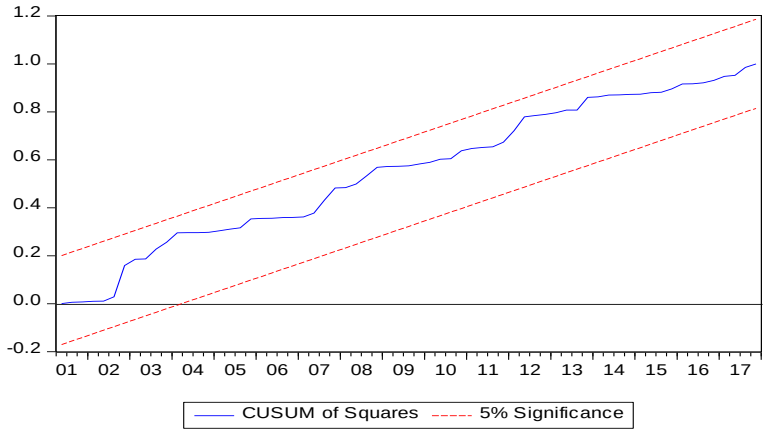

Figure 2: CUSUMSQ test graph

6. CONCLUSION

Friedman (1988) proposed and tested empirically the impact of stock returns on money demand for the US. Several other researchers did the same by using sampled data from different countries, both advanced and

emerging countries, and mostly obtained significant relationships between stock prices and money demand. This study aimed to replicate the previous studies by using data from Ghana to explore which effect (wealth or substitution) dominates the Ghanaian economy. The ARDL modeling and the bounds cointegration test were used to investigate the impact of stock prices on broad M2 demand, and covered the period between 1999:Q1 and 2017:Q4. The results show stock prices do matter for the Ghanaian money demand function, and thus the wealth effect dominates. Hence, the inclusion of real stock prices is necessary for the analyzed period.

The bounds test result shows a cointegration relation between broad M2 demand and real income, short-term interest rest, real effective exchange rate, and real stock prices. The results indicate that real income and real stock prices have a significant positive impact on broad M2 demand in both the short-run and long-run. The positive effect of stock prices indicates the wealth effect, meaning that the value function of the monetary aggregate is expressed by a positive relation, and the level of share prices predominantly forms a major proxy of financial capital. Further, the estimation results show that the short-term interest rate and real effective exchange rate have negative effects on broad M2 demand, but only the estimate of the short-term interest is statistically significant in both the short-run and long run. The CUSUM and CUSUMSQ tests indicate the stability of money demand with the regressors.

Providing evidence that stock price is a significant determinant for the broad M2 demand in Ghana can offer useful policy recommendations. This means that the BoG can initiate feasible monetary targeting if it can control the GSE index. For accurate money targeting, the BoG should initiate policies that will prevent downturns and volatility of the stock market. Also, by putting measures in place to stabilize the short-term interest rate BoG can control the demand for broad M2, then feasible money targeting can be achieved. Future researchers can use more sophisticated econometric techniques such as nonlinear ARDL or techniques that can account for structural breaks to get a clearer picture of the impact of stock prices on demand for real money balances in Ghana.

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Appendix A:

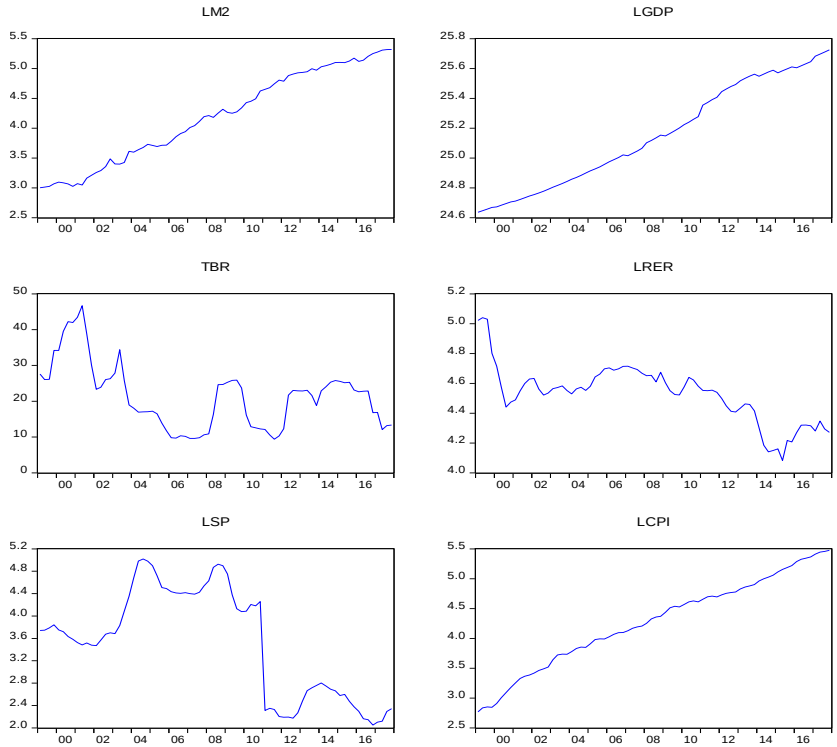

Figure A: The graphical representation of the time-series data used for the analysis

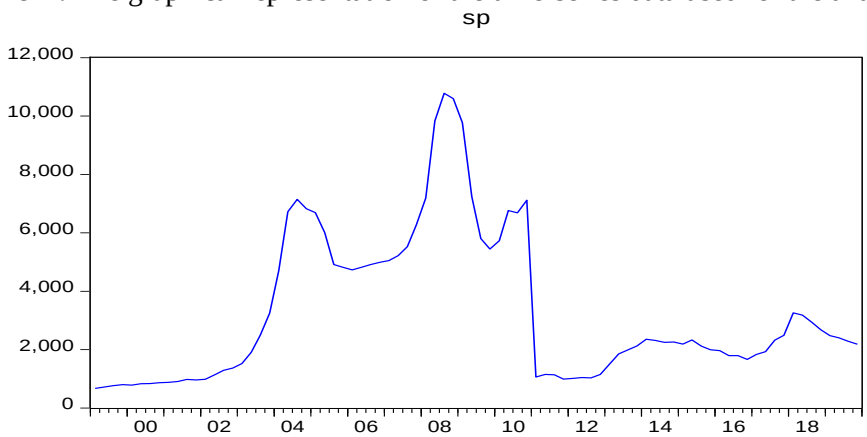

Figure B: The plot of quarterly nominal GSE index (SP) from 1999:Q1-2019:Q4

M2: It constitutes the narrow money (M1) plus quasi money. The BoG also announces the M2+ which constitutes M2 plus foreign currency deposit. M2 is used for the analysis because of inconsistency in the time series data for M2+.

GDP: The data for this variable was not quarterly available, so the yearly data series was converted to quarterly series by using Eviews software.

SP: There are two components to the stock price data set. To replace the previous All-Share index, the GSE launched the Composite index in 2011. This suggests that there were two indices for the GSE within the sample set at different times; the GSE All-Share index covering the period 1999:Q1 to 2010:Q4, and the GSE Composite index covering the period 2011:Q1 to 2017:Q4. Since the GSE Composite index was adopted, the method of measuring the closing prices of shares is different from that used under the GSE All-Share index regime.