The demand for money in selected African countries

Ohiomoje Iyemifokhae Abubakar
Department of Economics
School of Economics and Management Sciences
University of Ibadan, Ibadan, Oyo State, Nigeria

Keywords
Money Demand, Autoregressive Distributed Lag, Panel Data Analysis, Vector Error Correction, Elasticity.

Abstracts

This study examines the factors affecting people's desire to hold money in liquid form (relative to investing it) in sixteen countries in Africa. Earlier studies on this subject matter examined the connection between the demand for money and income, exchange rate, price and interest rate. This study extends this work by including debt and population. The method of analysis of this study is unprecedented as it incorporates the Auto-regressive Distributed Lag technique, Panel Data and Elasticity concepts. Furthermore, most studies on the demand for money made use of data of almost a decade ago. The world is evolving and studies on money demand should be contemporaneous with this trend. The study found out that debt service, income and population significantly affect money demand. With the exception of population, there is no short run causality of all the regressors and the outcome variable. However, they become cointegrated in the long run at -0.1918. Furthermore, there is no problem of serial correlation, heteroscedacity and poor distribution of residuals in the model. All variables are tested at 5% level of significance.

Corresponding author: Ohiomoje Iyemifokhae
Email address for corresponding author: ohiomoje@yahoo.com
First submission received: 10th July 2022
Revised submission received: 6th November 2023
Accepted: 5th April 2023

1. Introduction

The demand for money is the desire to hold money as opposed to investing it. This demand metamorphoses from the fundamental roles money play in a typical economy. In the first place, money serves as a medium of exchange. Secondly, it is a means of maintaining value. Households, firms and governments may hold money in its liquid state as well as in assets form. There are several variables that may affect the holders' choice of this resource. When financial assets, for example, become non-lucrative due to decline in interest rates, speculators may prefer to store their assets in liquid form which increases the demand for money and vice versa. The level of income is another important variable that affects the demand for money. The higher the profits of firms, revenues of governments and incomes of households, the greater will be the desire to hold money in near cash and vice versa. Although not axiomatic in the literature, the size of the population is fundamental in determining the level of money demand. A household with fewer members, ceteris paribus, will require less money (in near cash) relative to another household with more members. Similar arguments may hold for firms and governments. The exchange rate between a country's currency and those of other countries (especially her major trading partners) is also crucial as rational economic agents would want to leverage on the gains that will spill from such

expectations. Inflationary rate is also vital when considering the determinants of money demand in an economy.

Most economies in Sub Saharan Africa (SSA) are considered to be emerging and are confronted with the problems of poor investments climate, inadequate infrastructures, price instability, low per capita income and declining growth rate. Furthermore, the financial sectors are not inclusive in most countries in this sub region. Most of the potential customers of these institutions either lack the basic skills required to access their services or they are located far away from areas where such services are provided. Thus, this group (customers) may prefer to keep a large chunk of its resources in liquid form rather than leveraging on the opportunities available in the financial sectors of their respective economies. Therefore, the expectation is that money demand will soar in the region. However, with the likelihood of high inflationary rate in Sub Saharan Africa, most people (who may be aversed to banking services) will explore other investment windows as a store of value.

There are three schools of thoughts on the demand for money. We have the Keynesian, Post-Keynesians and the Classical schools.

The Classical economists expressed their views through the quantity theory of money in the Fisher's equation of exchange. The equation is

$$MV = PQ$$

Where M = total amount of money; V = means of transmission; P = price level.
T = total quantity of goods and services

In this equation, PQ is money demand and MV denotes money supply. The quantity theory of money assumes that people hold money mainly to buy goods and services (transactional purposes). The criticism of this theory is that money is also kept to earn interests and for unforeseen circumstances.

The Cambridge version came up with the cash balance approach. The equation is expressed as

$$M_d = kPY$$

Where: M_d = demand for money which equates money supply at equilibrium
k = fraction of real money income (PY); P = price level; Y = aggregate real Income.

The cash balance approach was criticized because it only considers money as a medium of exchange. Money is assumed to be barren and earns no interest if stored in the form of wealth.

According to Keynes, the transactionary and precautionary motives of holding money depend on the level of income ($L_T = f(Y)$). The speculative desire of holding money is influenced by the rate of interest ($L_S = f(i)$). Thus, the aggregate demand for money is given as:

$$L_{MD} = L_T + L_S = f(Y, i)$$

Keynes visualised a situation where drifts in *M* may have no impact (entirely) on *P*. This is the liquidity trap region, and it occurs when the rate of interest is very low such that speculators prefer to hold idle balances in liquid state rather than leveraging on potential rewards from the financial market. Thus, the investment curve of money is infinitely elastic.

Although the Keynesian approach opined that the transactionary motive of holding money is influenced by the income horizon and the graph is linear and proportional, proponents of the post-Keynesian school argued that the relationship does not follow suit. Rather, variations in income generate less than proportionate drifts in the demand for money for transactional purposes. The Post-Keynesian economists, Tobin to be precise, brought in the portfolio theory. Here, it is argued that it is possible for individuals to hold money and bond at the same time, rather than either of them as argued by Keynes. Money is risk-free and confers no return on its holders unlike bond whose gains is uncertain. The requisite mathematical equation involves

R = B (r +g) where $0 \leq B \leq 1$

Where R = Return on Portfolio; B = Bond; R = current interest rate on bond.
g = expected capital gain or loss
The expected return on portfolio is: RE = γR = Br

The portfolio's risk is the standard deviation of R (σR). There are three kinds of investors. Firstly, there are the risk lovers. They derive pleasures in putting all their resources in securities to maximize risk. The second set are plungers. They prefer to keep all their wealth either in cash or securities. In other words, they take risk in its totality or abstain from it completely. Thirdly, are the risk averters. They diversify their portfolio, holding both cash and securities based on their risk-returns trade-off.

Most literature on the demand for money made use of the Keynesian analysis in which money demand is subjects to the level of income and interest rates. However, the Keynesian theory is a short run analysis which assumed a given stock of capital, level of income and size of the population. Infact, all these variables change in the short run. This makes the analysis to be unrealistic. The study of this subject matter is incomplete without considering the long run effect of these variables. Earlier studies on the demand for money included Nikolaos, D. (2011); Akinlo, A. (2006); Hamori Shigeyyuki (2008) and Afees et. al (2013). These studies, to a larger extent, furthered the Keynesian approach in analysing the demand for money with respect to its key variables like income, interest rates, exchange rates and price level. This research is unique in that it shall be examining other important variables that may affect the demand for money like government debt and population in the selected countries in Africa. The methodology deployed by this study is also unprecedented in arriving at its result. Furthermore, the study made use of the most recent data from the World Development Indicators in its analysis.

2. Model Specification

A conventional money demand function may look like

$$M_t = a_0 + a_1 y_t + a_2 i_t \quad \ldots\ldots (1)$$

Where M_t is the long run or desired real money balances demanded in period t, y_t is the real income in period t and i_t is one or more opportunity cost variables in t period. The money market is presumed to be in equilibrium at the initial level. When this condition is disturbed, either income or interest rate or both are necessary to adjust to bring back the money market to its equilibrium position such that the desired money balances equilibrate the actual money stock as contained in statistical literature (Boorman, 1976). The existence of portfolio adjustment cost prevents a full adjustment of actual money demand to the desired levels (Goldfeld, 1973) and it is assumed to take place through a partial process (Chow, 1966). Thus, the money demand adjusts to the gap between the long run demand for money and that of the previous time such that

$$M_t - M_{t-1} = d\,(M_t - M_{t-1}) \quad \ldots\ldots (2)$$

Where M_t is the actual money demand in real terms in time t, d is the partial adjustment coefficient with $0 < d < 1$. All variables are expressed in natural logarithms. Adding equations (1) and (2) gives

$$M_t + (M_t - M_{t-1}) = d\,((a_0 + a_1 y_t + a_2 i_t) - M_{t-1}) \quad (\text{where } M_t = a_0 + a_1 y_t + a_2 i_t) \quad (3)$$

Equation (3) further translates to:

$$M_t = da_0 + da_1 y_t\, da_2 i_t + (1-d)\, M_{t-1} \quad \ldots\ldots (4)$$

Where a_1 and a_2 are the long run elasticity of holding money in near cash (relative to investing it) with respect to the level of income and interest rates respectively, da_1 and da_2 are short run elasticities with $0 < (1 - d) < 1$.

Explicitly, the variables used in the model can be stated as follows.

$$\frac{M_2}{P} = f\ (Y_{it}, R_{it}, P_{it}, EX_{it}, D_{it}, PN_{it}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (5)$$

Where M_2 is broad money supply, Y_{it} is the income level of individuals in selected countries, R_{it} is the rate of interest, P_{it} is the price level, EX_{it} is the exchange rate, D_{it} is government debt service and PN_{it} is the size of the population in the selected countries in Africa. Both sides of equation (5) are expressed in logarithm form.

Equation (5) can be written in panel form in econometrics as:

$$(M_{2i} - P_{it}) = \alpha_0 + \beta_{1i}Y_{it} + \beta_{2i}R_{it} + \beta_{3i}EX_{it} + \beta_{4i}P_{it} + \beta_{5i}FI_{it} + \beta_{6i}D_{it} + \beta_{7i}CM_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (6)$$

Equation (6) can further be represented to indicate first difference parameter as

$$\Delta (M_{2i} - P_{it}) = \alpha_0 + \sum_{i=1}^{n} \beta_{1i}\Delta Y_{it-1} + \sum_{i=1}^{n} \beta_{2i}\Delta R_{it-1} + \sum_{i=1}^{n}\beta_{3i}\Delta Ex_{it-1} + \sum_{i=1}^{n}\beta_{4i}\Delta P_{it-1} + \sum_{i=1}^{n}\beta_{5i}\Delta FL_{it-1} + \sum_{i=1}^{n}\beta_{6i}\Delta D_{it-1} + \sum_{i=1}^{n}\beta_{7i}\Delta CM_{it-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (7)$$

The long run dynamic of this model can be expressed as:

$$\Delta (M_{2i} - P_{it}) = \alpha_0 + \sum_{i=1}^{n} \beta_{1i}\Delta Y_{it-1} + \sum_{i=1}^{n} \beta_{2i}\Delta R_{it-1} + \sum_{i=1}^{n}\beta_{3i}\Delta Ex_{it-1} + \sum_{i=1}^{n}\beta_{4i}\Delta P_{it-1} + \sum_{i=1}^{n}\beta_{5i}\Delta FL_{it-1} + \sum_{i=1}^{n}\beta_{6i}\Delta D_{it-1} + \sum_{i=1}^{n}\beta_{7i}\Delta CM_{it-1} + \Omega\ £_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (8)$$

Where Ω depicts the speed of adjustment parameter and $£_t$ is the residual from the co-integrating equation.

3. Data

The source of data of this study is the world development indicator (WDI).The WDI is very comprehensive as it is inclusive of all relevant variables across the globe. This study is circumscribed to data that relates to the selected countries in Sub Saharan Africa. The countries are Angola, Benin, Botswana, Cameroon, Congo, Coted'voire, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Madagascar, Kenya, Nigeria, South Africa and Uganda. The sample period is between 2001 and 2019. The study made use of Eviews to perform its statistical analysis.

4. Estimation Procedure

The study adopts Panel data analysis and Autoregressive Distributed Lag (ARDL) in its estimations. The dependent variable is broad money demand while the independent variables are exchange rate, interest rate, income, inflation, debt service and population. In the Panel data analysis, the Pooled Regression is estimated assuming that each of the countries considered does not exhibit specific characteristic. This assumption is not true in reality. However, if we consider a case of heterogeneity or different welfare, geo-graphical and environmental factors across the selected African countries, the study estimated the Fixed Effects. In this case, although the intercepts for each selected country vary, it is time invariant. If all the identified countries have common mean value for the intercepts, the study estimated the Random Effects. In the second approach, the ARDL has proved to be very instrumental in money demand research. The ARDL method has the advantage that it does not require all variables to be

stationary as required by the Johansen cointegration test. The data used in this study is the most recent compared to similar studies on money demand in the African continent.

5. Results and discussions

The study found out that lag 2 had the lowest Akaike Information Criteron of all the lag lengths considered. The study also checked on the suitability of the series by doing serial correlation, normality and heteroscedacity tests. To test for the presence of autocorrelation in our series, the Breusch Godfrey Serial Correlation LM Test was performed in Table 7 of the appendix. The initial estimates showed the presence of serial correlation (with a probability value of less than 5%) in the model. This serial correlation was corrected by adjusting the lag length to 3. In the subsequent result, the probability of chi square was 6.73 which exceeded 5%. This indicates that we accept the null hypothesis that there is no autocorrelation in the model. A similar test of Breusch Godfrey on heteroscedacity (in Table 8) revealed that the model was homogenous as the probability of Chi square was 70.48% which was beyond 5% probability level. Thus, the study accepted the null hypothesis, suggesting that there was no presence of heteroscedacity in the model. The probability of Jacque Bera was 41.75%. This was above 5% benchmark in figure 1 in the appendix. Therefore, the null hypothesis that the series was normally distributed was validated. In order to access whether the model was stable or not, the blue line (representing money demand) of the CUSUM test (in figure 2 in the appendix) fell in-between the red or critical lines in the stability graph, thus re-affirming the hypothesis that the model was stable. However, the CUSUMSQ stability test (in figure 3 in the appendix) showed some instabilities in money demand as the blue line marginally crosses a critical line.

On the elasticities of the regressors on the outcome variable (money demand), it can be seen from the Vector Error Correction (VEC) estimates (in Table 1 in the appendix) that a 1%variation in debt service led to a 1.2178% declined in money demand. The rate of change was high or elastic. Also, a unit change in exchange rate led to a 0.68% reduction in money demand. Thus, the rate of change in money demand was less than a proportionate change in exchange rate in the selected African countries. Thirdly, a unit change in income resulted to a 1.8611% increase in money demand. The income elasticity of money demand was highly elastic in the group (selected African countries). When interest rate changed by 1%, money demand soared by 0.1127% which was less than the rate of change in the former. Furthermore, a unit change in population led to 0.7371% decreased in money demand. Thus, growth in population grew less than proportionate change in money demand.

On short run causality, it was only C(8) (in Table 2 in the appendix) which represented population that had a probability value of less than 5% level of significance (0.0055), meaning that we rejected the null hypothesis that there was no short run causality between population and money demand. All other regressors' probability values (debt service- 0.5633, exchange rate-0.9646, income-0.2174, inflation-0.0936 and interest rate-0.3960) were more than 5% level of significance. This shows that the study accepted the null hypothesis that there was no short run cointegration between debt service, exchange rate, income, inflation and interest on the one hand and the outcome variable (money demand) on the other hand. On the lower part of the VEC result, the speed of adjustment was -0.1918. This means that it took all the regressors to cointegrate in the long run at the rate of 19.18%. The negative sign of this speed of adjustment as well as it's probability value of 0.0221 (which was less than 5% level of significance) was a clear indication of the existence of long run equilibrium in the model.

On the Panel data analysis, three estimates were considered. These were the Pooled regression, Fixed Effects and Random Effects regressions. If the study assumed that all the selected African Countries had homogenous features, the Pooled Regression would be carried out. The result from Table 3 in the appendix indicated that it was only debt service, income and population that affected the demand for

money. These three independent variables had direct relationship with the demand for money. Alternatively, increases in debt service, income and the population of the selected African countries led to rise in the demand for money. This result aligns with economic theories that if income rises, the rational economic agents tend to keep more money in their possessions. At the micro level, if the size of household increases, more mouths have to be fed. This leads to a rise in the demand for money. This argument extends to the selected African countries at the macro level. Furthermore, a debtor country needs more money to service its debts as well as carry on with other obligations typical of a sovereign nation. Generally, the estimates from the pooled regression were not water tight as the socio-economic and demographic conditions of the selected African Countries cannot be the same in reality.

The socio-economic conditions of countries are heterogenous. If these factors are not taken into consideration, it may affect the ordinary least squares estimates from the pooled regression. In this regard, the study considered fixed effects regression. This was used to control unobserved characteristics of each country. The estimates from the fixed effect regression (in Table 4 in the appendix) showed that none of the explanatory variables (debtor service, exchange rate, income, interest rates, inflation and population) was significant in explaining the changes in money demand.

A further test of the cross-sectional data using the random effect regression (in Table 5 in the appendix) showed that debt service, income and population significantly affected the demand for money. An increase of debt service by 20.3% soared money demand, ceteris paribus. Also, if the income of consumers increased by 79.2%, this led to a percentage and positive change in the broad money demand. An increase in the size of the population by 43% led to a unit rise in the demand for money in affected economy. All the estimates of the Random Effects occured at less than 1% level of significance.

To verify whether the study should hinge its findings on fixed rffects or random effects, the Hausman Test was conducted in Table 6 (in the appendix). The H_0 of the Hausman Test stated that the random effectwais appropriate whereas, the alternative hypothesis, H_1, assumed that the fixed effect was the better estimates. The probability value of Chi square statistics was less than 5% in the Hausman Test. This meant that the study accepted the null hypothesis that opined that the random effects estimates were the most appropriate. This means that it was only debt service, income and population that affected the demand for money. This is a mileage achieved by this study in comparison to similar studies on the factors affecting the demand for money. It had been established in this study that debt service, income and population had positive relationship with the desire of holding money in liquid form as against investing the resource. Previous studies on the subject matter have neglected these important variables- debt service and population. At the micro level, people tend to have more money in their possession when they have larger households' size. This argument has also manifested at the macro level (in the selected African countries) with the estimates of this study. The coefficient's estimates of population stated that as the size of population rises by 43%, the demand for money increased by a percentage, ceteris paribus. Also, a 20.34% growth in debt service led to a percentage rise in money demand, ceteris paribus. This means that debtor nations who are willing to service their debts will prefer to hold more money in their possessions than the non-debtor ones or those that are not willing to service their debts. In consonance with the dictates of economic theories, as income rises, the demand for money also increases. This is shown in the sign of the coefficients of income in the random effects' estimates. The need to hold more money increased per unit when income soared by 79.21%. In the random effect, the R^2 or goodness of the fit was 51.8% which was indicative of a fairly good fit. The F-Statistics of 15.6045 had a probability of less than 5%, meaning that the model was well fitted.

6. Conclusion

Based on the result of the random estimates of this study, it can be categorically stated that population, debt service and income are very fundamental in determining variations to the demand for money. Earlier studies on the subject matter viz Afees, et al (2013), Akinlo (2006) and Hamoris (2008) have neglected population (as a variable) in their framework. Population is an important regressor that significantly affect the demand for money. Population has direct relationship with the demand for money in the sample countries in Sub Saharan Africa. To be precise, 43% increases in the population of the sample countries generates a unit increase in the demand for money. Also, debt service is not included in the variables of the models of Afees et al. (2013) and Akinlo (2006). This study found in its empirics that debtor nations that are willing to service their debts have greater tendency of holding more money in liquid form than defaulting or non-debtor ones within the sample countries. The nexus of debt service is 20.34% with the demand for money. However, it is also important to state that this study aligns with economic theories and earlier studies (Afees, et al (2013), Akinlo (2006), Hamoris (2008)) that income have positive relationship with the demand for money. Implicitly, as individuals' incomes rise in the selected countries in Africa, the need to hold money in its liquid form also increases and vice versa. Similarly, and in re-iteration, indebted countries that wish to service their debts hold more money in near cash than their counterparts which are hesitant. The robust methods of analysis of this study (incorporating the Autoregressive Distributed Lag Approach, Panel Data and the Vector Error Correction estimates) give a dynamic and elaborate view of the subject matter. The significance of this study, therefore, is that it has added robustness to the existing literature that debt service, population and income are inclusive in the variables that affect the demand for money in Africa.

7. Limitations of the Study

The sample period was initially intended to cover 2020. The lockdown that occurred globally due to the corona virus pandemic circumscribe the sample period to 2019.

References

Afees S., Idris A. and Basiru Fatai (2013), "Modeling the Demand for Money in Sub Saharan Africa". Economics Bulletins, Vol. 33 (1).

Akinlo Enisan (2006), "The Stability of Money Demand in Nigeria: An Autoregressive Distributed Lag Approach". Journal of Policy Model, 28 (4), page 445-452.

Boorman, J. T. (1976), Monetary Theory and Practices. Arlington Heights, IL (USA) AHM Publisher.

Chow (1966), Monetary Dynamics: An Application of Cointegration and Error Correction Modeling. Journal of Money, Credit and Banking, Vol. 23 (2). The Ohio State University Press.

Goldfeld M. S. (1973), The Demand for Money Revisited. Economic Activity, Vol. 1973 (3): 577-646. Brookings Institution Press.

Hamoris Shigeyyuki (2008), "Empirical Analysis of the Money Demand Function in Sub Saharan Africa". Economic Bulletin 15: 1-15, Resource Version Publisher.

Nikolaos Dritsakis (2011), The Demand for Money in Hungary: An ARDL Approach. Review of Economics and Finance, University of Macedonian, Greece.

Pesaran M. H. and Shin, Y. (1999), "An Autoregressive Distributed Lag Modeling Approach to Co-integration Analysis". Contenial Volume of Rangar Frisch, Cambridge University Press, Cambridge.

APPENDICES

Table 1: Vector Error Correction Estimates

Sample (adjusted): 2003-2019	
Included observations: 75 after adjustments	

Cointegrating Eq:	CointEq1
BROAD_MONEY(-1)	1.000000
DEBT_SERVICE(-1)	-1.217826 (0.22401) [-5.43656]
EXCHANGE_RATE(-1)	-0.684191 (2.75857) [-0.24802]
INCOME(-1)	1.861084 (0.66690) [2.79065]
INFLATION(-1)	2.334675 (0.48361) [4.82757]
INTEREST_RATE(-1)	0.112725 (0.47144) [0.23911]
POPULATION(-1)	-0.737080 (0.58712) [-1.25542]
C	-0.627242

Error Correction:	D(BROAD_MONEY)	D(DEBT_SERVICE)	D(EXCHANGE_RATE)	D(INCOME)	D(INFLATION)	D(INTEREST_RATE)	POPULATION)
CointEq1	-0.191816 (0.08635) [-2.22147]	0.138762 (0.06017) [2.30633]	0.007076 (0.01278) [0.55365]	-0.010402 (0.01048) [-0.99244]	-0.183713 (0.04381) [-4.19322]	-0.006515 (0.00979) [-0.66578]	0.053160 (0.04039) [1.31601]
D(BROAD_MONEY(-1))	-0.361152 (0.11022) [-3.27667]	-0.124714 (0.07680) [-1.62388]	0.014953 (0.01631) [0.91655]	-0.022978 (0.01338) [-1.71741]	0.116691 (0.05592) [2.08657]	-0.004007 (0.01249) [-0.32083]	0.112381 (0.05156) [2.17949]

D(DEBT_SERVICE(-1))	-0.141943	-0.301412	0.002186	-0.026313	-0.031975	-0.006215	0.106404
	(0.16532)	(0.11519)	(0.02447)	(0.02007)	(0.08388)	(0.01873)	(0.07734)
	[-0.85860]	[-2.61658]	[0.08933]	[-1.31117]	[-0.38119]	[-0.33174]	[1.37581]
D(EXCHANGE_RATE(-1))	1.856247	1.218789	-0.313150	0.216014	-3.162628	-0.183455	-0.951664
	(2.35573)	(1.64146)	(0.34870)	(0.28596)	(1.19529)	(0.26696)	(1.10206)
	[0.78797]	[0.74250]	[-0.89805]	[0.75539]	[-2.64592]	[-0.68719]	[-0.86353]
D(INCOME(-1))	0.700764	-0.294991	-0.000224	0.175626	-0.009503	0.138693	0.543635
	(1.17338)	(0.81761)	(0.17369)	(0.14244)	(0.59537)	(0.13297)	(0.54893)
	[0.59722]	[-0.36080]	[-0.00129]	[1.23300]	[-0.01596]	[1.04301]	[0.99035]
D(INFLATION(-1))	0.321860	-0.143372	-0.017415	-0.011518	-0.216042	0.007061	-0.054281
	(0.21170)	(0.14751)	(0.03134)	(0.02570)	(0.10741)	(0.02399)	(0.09904)
	[1.52039]	[-0.97196]	[-0.55576]	[-0.44823]	[-2.01131]	[0.29433]	[-0.54810]
D(INTEREST_RATE(-1))	0.540590	-0.125333	0.092305	-0.090827	0.091760	-0.005082	-0.041723
	(0.60485)	(0.42146)	(0.08953)	(0.07342)	(0.30690)	(0.06855)	(0.28296)
	[0.89376]	[-0.29738]	[1.03098]	[-1.23702]	[0.29899]	[-0.07415]	[-0.14745]
D(POPULATION(-1))	-0.538189	0.283412	-0.011908	-0.011313	-0.059719	0.006014	-0.438392
	(0.20228)	(0.14095)	(0.02994)	(0.02456)	(0.10264)	(0.02292)	(0.09463)
	[-2.66060]	[2.01075]	[-0.39769]	[-0.46073]	[-0.58185]	[0.26237]	[-4.63263]
C	0.010609	0.075423	-0.012078	0.021323	-0.033966	-0.012701	-0.009558
	(0.06828)	(0.04758)	(0.01011)	(0.00829)	(0.03465)	(0.00774)	(0.03194)
	[0.15536]	[1.58518]	[-1.19489]	[2.57236]	[-0.98035]	[-1.64125]	[-0.29922]
R-squared	0.361913	0.276237	0.061798	0.162029	0.399029	0.033882	0.325803
Adj. R-squared	0.284569	0.188509	-0.051923	0.060457	0.326184	-0.083223	0.244083
Sum sq. resids	18.48517	8.974984	0.405023	0.272393	4.759009	0.237400	4.045592
S.E. equation	0.529224	0.368761	0.078337	0.064243	0.268526	0.059975	0.247582
F-statistic	4.679274	3.148766	0.543416	1.595211	5.477783	0.289329	3.986788
Log likelihood	-53.90092	-26.80613	89.37832	104.2545	-3.016065	109.4107	3.074366
Akaike AIC	1.677358	0.954830	-2.143422	-2.540121	0.320428	-2.677620	0.158017
Schwarz SC	1.955457	1.232929	-1.865323	-2.262022	0.598527	-2.399521	0.436115
Mean dependent	0.009587	0.062077	-0.010701	0.024601	-0.021002	-0.009335	0.011060
S.D. dependent	0.625685	0.409358	0.076379	0.066278	0.327126	0.057625	0.284762

Determinant resid covariance (dof adj.)	8.98E-12
Determinant resid covariance	3.67E-12
Log likelihood	242.4436
Akaike information criterion	-4.598496
Schwarz criterion	-2.435507
Number of coefficients	70

Table 2. Probability Values of the VEC
Sample: 2003-2019
Included observations: 83

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.173974	0.075805	-2.295020	0.0221
C(2)	-0.342252	0.103353	-3.311475	0.0010
C(3)	-0.084975	0.146941	-0.578293	0.5633
C(4)	0.038689	0.871042	0.044417	0.9646
C(5)	1.205911	0.976481	1.234956	0.2174
C(6)	0.318860	0.189832	1.679699	0.0936
C(7)	0.487289	0.573594	0.849537	0.3960
C(8)	-0.539902	0.193785	-2.786089	0.0055
C(9)	-0.003354	0.061656	-0.054396	0.9566
C(10)	0.102043	0.057080	1.787716	0.0744
C(11)	-0.089282	0.077780	-1.147867	0.2516
C(12)	-0.278465	0.110579	-2.518237	0.0121
C(13)	0.443163	0.656842	0.674687	0.5002
C(14)	-0.020565	0.734848	-0.027985	0.9777
C(15)	-0.137270	0.142961	-0.960191	0.3374
C(16)	-0.173282	0.431670	-0.401423	0.6883
C(17)	0.272912	0.145833	1.871398	0.0619
C(18)	0.095490	0.046648	2.047047	0.0412
C(19)	0.004182	0.011506	0.363461	0.7164
C(20)	0.015839	0.015687	1.009698	0.3131
C(21)	-0.001656	0.022303	-0.074264	0.9408
C(22)	-0.874098	0.132210	-6.611453	0.0000
C(23)	0.154489	0.148214	1.042339	0.2977
C(24)	-0.020807	0.028813	-0.722130	0.4705
C(25)	0.070120	0.087062	0.805400	0.4210
C(26)	-0.013994	0.029413	-0.475780	0.6344
C(27)	-0.013474	0.009358	-1.439817	0.1505
C(28)	-0.007409	0.009432	-0.785508	0.4325
C(29)	-0.023793	0.013106	-1.815431	0.0700
C(30)	-0.025473	0.019242	-1.323817	0.1862
C(31)	0.081377	0.108460	0.750296	0.4534
C(32)	0.251781	0.121446	2.073194	0.0387
C(33)	-0.011286	0.023701	-0.476157	0.6342
C(34)	-0.096694	0.071446	-1.353386	0.1765
C(35)	-0.011355	0.024073	-0.471682	0.6374
C(36)	0.019154	0.007725	2.479457	0.0135
C(37)	-0.189015	0.042556	-4.441542	0.0000
C(38)	0.093310	0.058024	1.608118	0.1084
C(39)	-0.084921	0.082494	-1.029423	0.3038
C(40)	-0.721986	0.491092	-1.470164	0.1421
C(41)	-0.654184	0.555079	-1.178543	0.2391
C(42)	-0.285117	0.106628	-2.673937	0.0077
C(43)	0.218808	0.322090	0.679338	0.4972

C(44)	-0.057844	0.108789	-0.531708	0.5952
C(45)	-0.026427	0.034652	-0.762658	0.4460
C(46)	-0.006125	0.008913	-0.687220	0.4923
C(47)	-0.003119	0.011807	-0.264200	0.7917
C(48)	-0.003959	0.016796	-0.235681	0.8138
C(49)	-0.172372	0.252823	-0.681789	0.4957
C(50)	0.139696	0.125782	1.110617	0.2673
C(51)	0.006888	0.021770	0.316409	0.7518
C(52)	-0.003655	0.065893	-0.055476	0.9558
C(53)	0.006055	0.022106	0.273925	0.7843
C(54)	-0.012604	0.007287	-1.729688	0.0843
C(55)	0.049958	0.037447	1.334096	0.1828
C(56)	0.105006	0.048665	2.157738	0.0314
C(57)	0.091161	0.070841	1.286833	0.1987
C(58)	0.155153	0.411318	0.377210	0.7062
C(59)	0.237732	0.462381	0.514147	0.6074
C(60)	-0.042556	0.094637	-0.449677	0.6531
C(61)	-0.015717	0.270408	-0.058125	0.9537
C(62)	-0.435184	0.091317	-4.765625	0.0000
C(63)	-0.001016	0.029122	-0.034889	0.9722
Determinant residual covariance		3.94E-12		

Equation: D(BROAD_MONEY) = C(1)*(BROAD_MONEY(-1) - 1.21782567296*DEBT_SERVICE(-1) - 0.684190783323 *EXCHANGE_RATE(-1) + 1.86108397428*INCOME(-1) + 2.3346749098*INFLATION(-1) + 0.112725176831*INTEREST_RATE(-1) - 0.737079645223*POPULATION(-1) - 0.627242236631) + C(2) *D(BROAD_MONEY(-1)) + C(3)*D(DEBT_SERVICE(-1)) + C(4) *D(EXCHANGE_RATE(-1)) + C(5)*D(INCOME(-1)) + C(6) *D(INFLATION(-1)) + C(7)*D(INTEREST_RATE(-1)) + C(8) *D(POPULATION(-1)) + C(9)

Observations: 83

R-squared	0.341601	Mean dependent var	0.011099
Adjusted R-squared	0.270422	S.D. dependent var	0.594471
S.E. of regression	0.507769	Sum squared resid	19.07936
Durbin-Watson stat	2.488473		

Table 3. Pooled Regression

Dependent Variable: BROAD_MONEY
Method: Panel Least Squares
Sample: 2001-2019
Periods included: 19
Cross-sections included: 7
Total panel (unbalanced) observations: 94

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEBT_SERVICE	0.242988	0.082034	2.962032	0.0039
EXCHANGE_RATE	0.604379	0.437976	1.379934	0.1711
INCOME	0.804228	0.259754	3.096118	0.0026
INFLATION	0.016053	0.163651	0.098091	0.9221
INTEREST_RATE	-0.329354	0.166944	-1.972838	0.0517
POPULATION	0.595898	0.156954	3.796649	0.0003

R-squared	0.486534	Mean dependent var	10.02978
Adjusted R-squared	0.457360	S.D. dependent var	0.733878
S.E. of regression	0.540605	Akaike info criterion	1.669445
Sum squared resid	25.71831	Schwarz criterion	1.831783
Log likelihood	-72.46391	Hannan-Quinn criter.	1.735018
Durbin-Watson stat	1.443862		

Table 4. FIXED EFFECTS ESTIMATES

Dependent Variable: BROAD_MONEY
Method: Panel Least Squares
Sample: 2001-2019
Periods included: 19
Cross-sections included: 7
Total panel (unbalanced) observations: 94

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.114746	2.428210	3.753690	0.0003
DEBT_SERVICE	0.077914	0.135216	0.576217	0.5661
EXCHANGE_RATE	-0.412574	0.701302	-0.588297	0.5580
INCOME	0.369058	0.264266	1.396541	0.1664
INFLATION	-0.080431	0.181687	-0.442688	0.6592
INTEREST_RATE	0.137596	0.471415	0.291878	0.7711
POPULATION	-0.026563	0.243659	-0.109016	0.9135

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.649794	Mean dependent var	10.02978
Adjusted R-squared	0.597911	S.D. dependent var	0.733878
S.E. of regression	0.465355	Akaike info criterion	1.435720
Sum squared resid	17.54101	Schwarz criterion	1.787452
Log likelihood	-54.47882	Hannan-Quinn criter.	1.577794
F-statistic	12.52436	Durbin-Watson stat	1.875425
Prob(F-statistic)	0.000000		

Table 5: Random Effects Regression

Dependent Variable: BROAD_MONEY

Method: Panel EGLS (Cross-section random effects)
Sample: 2001-2019
Periods included: 19
Cross-sections included: 7
Total panel (unbalanced) observations: 94

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.327478	1.595421	2.712436	0.0080
DEBT_SERVICE	0.203350	0.072112	2.819934	0.0059
EXCHANGE_RATE	-0.826785	0.648485	-1.274950	0.2057
INCOME	0.792066	0.223642	3.541664	0.0006
INFLATION	0.009653	0.140891	0.068516	0.9455
INTEREST_RATE	-0.196465	0.151828	-1.293997	0.1991
POPULATION	0.430133	0.148285	2.900709	0.0047

Effects Specification	S.D.	Rho
Cross-section random	0.000000	0.0000
Idiosyncratic random	0.465355	1.0000

Weighted Statistics

R-squared	0.518344	Mean dependent var	10.02978
Adjusted R-squared	0.485126	S.D. dependent var	0.733878
S.E. of regression	0.526592	Sum squared resid	24.12504
F-statistic	15.60445	Durbin-Watson stat	1.426833
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.518344	Mean dependent var	10.02978
Sum squared resid	24.12504	Durbin-Watson stat	1.426833

Test cross-section random effects

Table 6. Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	30.403403	6	0.0000

** WARNING: estimated cross-section random effects variance is zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.

DEBT_SERVICE	0.077914	0.203350	0.013083	0.2728
EXCHANGE_RATE	-0.412574	-0.826785	0.071293	0.1208
INCOME	0.369058	0.792066	0.019821	0.0027
INFLATION	-0.080431	0.009653	0.013160	0.4323
INTEREST_RATE	0.137596	-0.196465	0.199181	0.4541
POPULATION	-0.026563	0.430133	0.037381	0.0182

Cross-section random effects test equation:
Dependent Variable: BROAD_MONEY
Method: Panel Least Squares
Period: 2001-2019

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.114746	2.428210	3.753690	0.0003
DEBT_SERVICE	0.077914	0.135216	0.576217	0.5661
EXCHANGE_RATE	-0.412574	0.701302	-0.588297	0.5580
INCOME	0.369058	0.264266	1.396541	0.1664
INFLATION	-0.080431	0.181687	-0.442688	0.6592
INTEREST_RATE	0.137596	0.471415	0.291878	0.7711
POPULATION	-0.026563	0.243659	-0.109016	0.9135

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.649794	Mean dependent var	10.02978
Adjusted R-squared	0.597911	S.D. dependent var	0.733878
S.E. of regression	0.465355	Akaike info criterion	1.435720
Sum squared resid	17.54101	Schwarz criterion	1.787452
Log likelihood	-54.47882	Hannan-Quinn criter.	1.577794
F-statistic	12.52436	Durbin-Watson stat	1.875425
Prob(F-statistic)	0.000000		

Table 7. Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.197979	Prob. F(3,22)	0.1169
Obs*R-squared	7.148789	Prob. Chi-Square(3)	0.0673

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Sample: 59 117
Included observations: 31
Presample and interior missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEBT_SERVICE	17.86360	13.58444	1.315004	0.2021
EXCHANGE_RATE	32464705	33369496	0.972886	0.3412
INCOME	-2606338.	1980403.	-1.316065	0.2017
INFLATION	-51149743	2.75E+08	-0.186223	0.8540
INTEREST_RATE	-37136262	1.96E+08	-0.189893	0.8511
POPULATION	3.480910	14.38946	0.241907	0.8111
RESID(-1)	-0.031543	0.255961	-0.123235	0.9030
RESID(-2)	0.551143	0.313866	1.755982	0.0930
RESID(-3)	0.335890	0.411310	0.816635	0.4229

R-squared	0.230606	Mean dependent var	-627971.6
Adjusted R-squared	-0.049174	S.D. dependent var	1.89E+09
S.E. of regression	1.94E+09	Akaike info criterion	45.84395
Sum squared resid	8.25E+19	Schwarz criterion	46.26027
Log likelihood	-701.5813	Hannan-Quinn criter.	45.97966
Durbin-Watson stat	1.617696		

Table 8. Breusch-Pagan-Godfrey Heteroskedasticity Test

F-statistic	2.010901	Prob. F(6,24)	0.1036
Obs*R-squared	10.37081	Prob. Chi-Square(6)	0.1099
Scaled explained SS	3.792163	Prob. Chi-Square(6)	0.7048

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample: 59 117
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.95E+19	2.34E+19	2.114231	0.0451
DEBT_SERVICE	-98830796	2.17E+10	-0.004548	0.9964
EXCHANGE_RATE	-3.94E+17	2.15E+17	-1.837630	0.0785
INCOME	-1.38E+15	3.37E+15	-0.408606	0.6865
INFLATION	-2.98E+17	4.51E+17	-0.661083	0.5149
INTEREST_RATE	-5.86E+17	3.32E+17	-1.767981	0.0898
POPULATION	-2.53E+10	2.29E+10	-1.108412	0.2787

R-squared	0.334542	Mean dependent var	3.46E+18
Adjusted R-squared	0.168178	S.D. dependent var	3.73E+18
S.E. of regression	3.40E+18	Akaike info criterion	88.37469
Sum squared resid	2.78E+38	Schwarz criterion	88.69849
Log likelihood	-1362.808	Hannan-Quinn criter.	88.48024
F-statistic	2.010901	Durbin-Watson stat	1.143816
Prob(F-statistic)	0.103648		

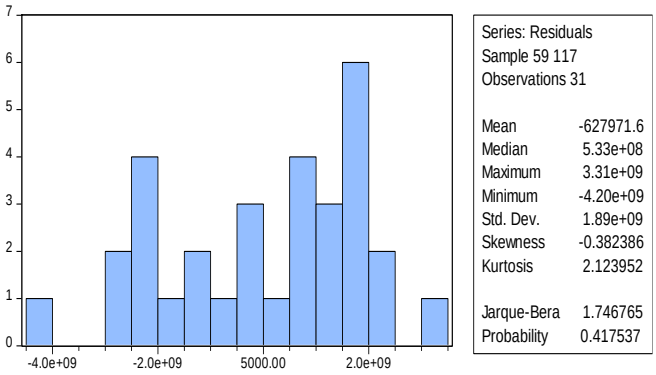

Figure 1. Normality Chart.
Source: Author's Computation.

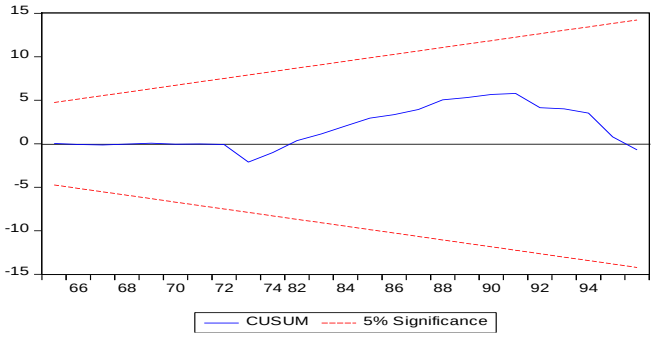

Figure 2. CUSUM Stability Graph; Source: Author's Computation.

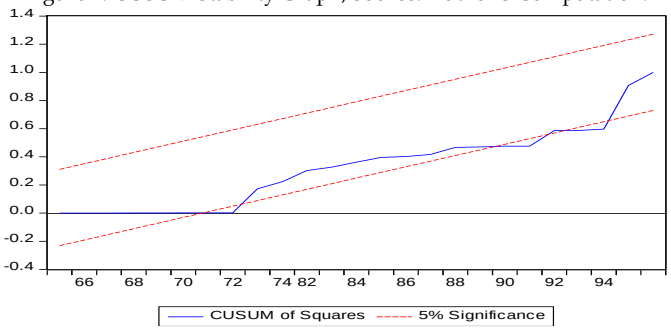

Figure 3. CUSUM of Squares Stability Graph; Source: Author's Computation.