INTERNATIONAL JOURNAL OF ECONOMICS AND FINANCE STUDIES
Vol: 15 **No:** 03 **Year:** 2023 **ISSN:** 1309-8055 (Online) (**pp.** 108-139) **Doi:** 10.34109/ijefs.202315305
Received: 25.04.2023 | **Accepted:** 21.07.2023 | **Published Online:** 07.09.2023

-RESEARCH ARTICLE-

MODELLING THE ASYMMETRIC EFFECT OF MACROECONOMIC VARIABLES ON SOUTH AFRICA'S MONEY SUPPLY

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─Abstract─

The management of the money supply holds significant importance as it enables the central bank to effectively exert control over inflationary pressures within the economy. An excessive expansion of the money supply has the potential to result in demand-pull inflation. The objective of this study is to examine the unequal influence of macroeconomic factors on money supply in South Africa, utilising a yearly dataset covering the period from 1971 to 2020. The parameters were estimated in this study using the NARDL bounds cointegration technique. The findings of the study provided empirical evidence supporting the existence of a sustained correlation between the money supply and various macroeconomic indicators. The findings suggest a linear association between GDP and money supply, as the latter exhibits a response solely to negative values of GDP. Consequently, a decline in GDP results in a reduction in the money supply. Moreover, it is worth noting that interest rates exhibit a non-linear impact on the money supply. An increase in interest rates results in a decrease in the money supply, whereas a decrease in interest rates leads to an increase in the money supply. The research findings have substantiated the assertion that the inflation rate exerts a non-linear influence on the money supply. An increase in inflation corresponds to a decrease in the money supply, whereas a decrease in inflation is associated with a reduction in the money supply. The findings of this study provide additional evidence supporting the existence of a linear correlation between exchange rates and the money supply. Specifically, the analysis reveals that changes in the money supply are solely

Citation (APA): Stungwa, S., Hlongwane, N. W., Khobai, H. (2023). Modelling The Asymmetric Effect of Macroeconomic Variables on South Africa's Money Supply. *International Journal of Economics and Finance Studies, 15*(03), 108-139. doi:10.34109/ijefs.202315305

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influenced by negative shocks in the exchange rate. Consequently, a reduction in the exchange rate results in an expansion of the money supply. It is imperative for South African policymakers to closely monitor macroeconomic variables, as indicated by this study, as they exert a substantial influence on the determination of the money supply level within the South African economy.

Keywords: Money supply, macroeconomic variables, Nonlinear autoregressive distributed lag, South Africa

JEL Specifications: E40 E51, E52, F43

1. INTRODUCTION

The manipulation of a country's monetary base is of utmost importance in shaping its economic environment and exerting an impact on a range of macroeconomic indicators. Within the context of South Africa, a nation characterised by a dynamic and progressing economy, the intricate relationship between macroeconomic factors and the money supply holds considerable ramifications for the formulation and implementation of monetary policies, the attainment of economic stability, and the overall trajectory of growth. The objective of this study is to examine and assess the influence of significant macroeconomic factors on the money supply within the context of South Africa.

The monetary aggregate, commonly denoted as M1, M2, or M3, serves as a quantitative measure of the overall quantity of money in circulation within a specific economy during a particular period. The concept encompasses a range of monetary instruments, including tangible banknotes, electronic funds held in demand deposit accounts, and other highly liquid assets. A comprehensive comprehension of the determinants that impact the money supply is of utmost importance for policymakers, central banks, and investors who aim to make well-informed judgements pertaining to monetary policy, inflation control, and overall economic equilibrium. According to Friedman's theory of money supply, the accessibility of funds is a crucial macroeconomic element that impacts a country's ability to foster economic growth. In accordance with Friedman's monetarist theory, alterations in the money supply constitute the primary determinant of the pace at which the economy expands (Buthelezi, 2023). The viewpoint held by conventional or neo-liberal economists, with a specific emphasis on monetarists, posits that the money supply is endogenous in nature, thereby making it susceptible to regulation by monetary authorities. Furthermore, it is their contention that modifications to the money supply yield a favourable influence on the rate of inflation. Within the given context, the present chapter delves into the examination of the interrelation between the money supply and macroeconomic factors within the South African context.

The economic growth rate of a country is a significant macroeconomic variable that has a notable impact on the money supply (Dingela & Khobai, 2017; Hussain & Haque,

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2017; Khabo & Harmse, 2005). The GDP growth rate of South Africa plays a crucial role in influencing fluctuations in the money supply. As the economy undergoes growth, it is common for there to be a rise in the need for money, encompassing both investment activities and routine financial transactions. As a result, the central bank may opt to implement measures in order to facilitate the heightened demand by augmenting the money supply. This can be achieved through various means, such as engaging in open market operations or modifying reserve requirements. According to the findings of his study conducted in 2017, the author proposed that a positive correlation exists between the supply of money and economic growth. Specifically, the author argued that an augmentation in the money supply leads to a corresponding increase in economic growth. Mugableh (2019) reported similar findings in Jordan, while Cheng et al. (2019) conducted a study in China and found comparable results. Additionally, Akalpler and Duhok (2018) conducted research in Malaysia and reported similar findings.

In South Africa, inflation is a macroeconomic variable of considerable importance that exerts a substantial influence on the money supply (Amassoma, Sunday, & Onyedikachi, 2018; Denbel, Ayen, & Regasa, 2016; Munyeka, 2014). As the cost of goods and services increases over a period of time, the ability of money to purchase these items diminishes, resulting in an increased need for money to facilitate economic transactions. In order to mitigate this impact, the central bank may opt to implement contractionary monetary policies with the aim of diminishing the growth of the money supply and restraining inflation. In contrast, in instances of deflation characterised by a decrease in prices, the central bank may opt to implement expansionary measures aimed at stimulating economic activity through the augmentation of the money supply. The study conducted by Onyeiwu (2012) in Nigeria demonstrated a negative correlation between inflation and the money supply. The study conducted by Aslam and Awan (2018) demonstrated a negative correlation between inflation and economic growth in the context of Pakistan.

The determination of interest rates, which is influenced by the monetary policy decisions of the central bank, is a significant factor in shaping the dynamics of the money supply (Kaplan & Gungor, 2017). In the context of South Africa, alterations in interest rates exert a direct influence on the expenses associated with borrowing, determinations regarding investment, and patterns of consumer expenditure. When the central bank reduces interest rates, it stimulates borrowing, investment, and consumption, thereby facilitating an increase in the money supply. On the other hand, an increase in interest rates has the potential to reduce borrowing and investment, leading to a decrease in the overall money supply. In their study, Tan, Mohamed, Habibullah, and Chin (2020) examined the relationship between interest rates and economic growth in Malaysia, Singapore, and Thailand. Their findings revealed a negative association between interest rates and economic growth in these countries. The study conducted by Ichwani and Nisa (2021) demonstrated that there exists a positive and statistically significant relationship between the repo rate and the money supply in the context of Indonesia.

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In addition, it should be noted that the exchange rate, which signifies the relative value of the South African rand in comparison to other currencies, exerts an influence on the money supply by affecting both trade and capital flows (Mpofu, 2011). The impact of exchange rate fluctuations extends to various aspects such as import and export levels, foreign direct investment, and the demand for domestic currency. The alterations can have subsequent effects on the growth of the money supply, as the central bank engages in interventions within the foreign exchange market with the aim of preserving stability or overseeing the competitiveness of the economy.

The aforementioned findings were derived from studies that were conducted in the Republic of South Africa. Dingela and Khobai (2017) demonstrated a positive correlation between the money supply and economic growth in the context of South Africa. Khabo and Harmse (2005) and Munyeka (2014) observed that there exists a noteworthy relationship between money supply, inflation, and economic growth. Ndou, Gumata, Ndou, and Gumata (2017) reported comparable findings. According to Phiri's (2018) findings, there exists a threshold of 5.3% that delineates the relationship between inflation and economic growth. Below this threshold, the study observed a negative association between inflation and economic growth, while above the threshold, a positive correlation was identified. In contrast, the study conducted by Precious and Makhetha-Kosi (2014) revealed that there is no statistically significant association between money supply, repo rate, exchange rates, and economic growth within the context of South Africa. Our paper aims to investigate the relationship between money supply and macroeconomic factors in South Africa by employing the non-linear autoregressive distributed lag (NARDL) technique. This study is motivated by the contrasting findings observed in previous research.

Due to the implementation of an expansionary monetary policy and an increase in government spending, South Africa experienced a period of notable economic expansion in the 1960s. Consequently, there was a notable increase in the money supply, which subsequently resulted in an upward trend in inflation levels. In response, the South African Reserve Bank (SARB) implemented more stringent monetary controls and introduced measures aimed at achieving currency stabilisation.

During the 1980s and 1990s, South Africa experienced notable transformations in its economic landscape and monetary framework. The nation underwent a shift from a fixed exchange rate system to a more adaptable one, enabling the South African Rand to engage in unrestricted floating. The South African Reserve Bank (SARB) redirected its attention towards the objective of inflation targeting and implemented a monetary policy framework that emphasised greater independence.

In the early 2000s, South Africa encountered a range of obstacles, including elevated levels of unemployment, disparities in income distribution, and volatility in commodity

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prices. The South African Reserve Bank (SARB) has implemented a range of monetary policy measures aimed at fostering economic growth and maintaining stability. These measures encompass the adjustment of interest rates and the management of money supply growth. Presently, the South African Reserve Bank (SARB) remains pivotal in its efforts to uphold price stability and effectively regulate the money supply within the country. The central bank diligently observes macroeconomic indicators, including inflation, interest rates, and economic growth, in order to make well-informed policy choices. The monetary policy framework of the nation endeavours to achieve a harmonious equilibrium between fostering economic expansion and guaranteeing price stability, with the ultimate objective of enhancing the welfare of South Africa's economy and its populace.

Presently, South Africa faces a multitude of challenges that pose significant risks to its economic and social stability. These challenges include escalating infrastructure and logistical bottlenecks, an unparalleled energy crisis, a less advantageous external environment, and the adverse impacts of climate shocks. Despite the fact that employment levels have not yet returned to their pre-pandemic state and unemployment rates are currently at near-record highs, the services sector's revival in 2022 has stimulated the generation of new employment opportunities. This development is particularly significant given the existing high levels of poverty and inequality. Moreover, it is worth noting that the economy remains susceptible to external disturbances, such as unpredictable capital movements and volatile commodity prices, due to Russia's engagement in the Ukrainian conflict.

In summary, the correlation between macroeconomic indicators and money supply in the context of South Africa is intricate and multifaceted. Economic growth, inflation, interest rates, and exchange rates all have a big impact on the dynamics of the money supply. Comprehending these interconnections is of utmost importance for policymakers, central banks, and investors alike, as it facilitates well-informed decision-making concerning monetary policy, inflation targeting, and the broader realm of economic stability. The objectives of this study are as follows: The primary objective of this study is to elucidate the complex correlation between macroeconomic indicators and the money supply in South Africa while also offering valuable perspectives on the determinants that influence the country's monetary environment. Additionally, the objective of this study is to examine whether there exists a symmetric or asymmetric correlation between the money supply and macroeconomic variables. Finally, this study intends to examine the presence of nonlinearity in the variables being investigated in order to prevent potential errors in model specification.

The present paper is organised in the following manner: In the second section, an examination is conducted on the existing body of literature pertaining to the relationship between macroeconomic factors and the supply of money. In the third section, the study

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presents the data and modelling techniques that were employed. The findings are presented and discussed in the fourth section. The final section of this paper serves as a conclusion, offering recommendations for future research endeavours as well as acknowledging the limitations of the present study.

2. LITERATURE REVIEW

This section comprises a theoretical literature review that encompasses the variables to be utilised in this study. The subsequent analysis provides a comprehensive examination of various studies that concentrate on macroeconomic variables and money supply. Subsequently, an evaluation of studies pertaining to monetary policy is presented, encompassing research conducted in both developed and developing nations. He (2017) proposes that there exists a positive relationship between a nation's money supply and its economic growth, whereby an increase in the former leads to a corresponding expansion in the latter, and conversely. Monetary theory is guided by a fundamental equation, as proposed by Friedman (1989), which states that the product of the money supply (M) and its velocity (V) is equal to the price level (P) multiplied by the quantity of goods and services produced (Q). The variable M represents the money supply, while V denotes the velocity (the number of times the average rand is spent per year), P represent the price of goods and services, and Q represent the quantity of goods and services. Under the assumption of constant V, an increase in M leads to an increase in either P, Q, or both P and Q. In periods of near full employment within the economy, there is a tendency for general price levels to exhibit a faster rate of growth compared to the output of goods and services.

Based on monetary theory, it is posited that during periods of economic slack, the growth rate of output (Q) will surpass the growth rate of prices (P). In numerous emerging economies, the central government exercises authority over monetary theory and assumes primary responsibility for formulating and implementing monetary policy decisions. In the context of South Africa, it is observed that the South African Reserve Bank (SARB) exercises the authority to establish and implement monetary policy independently, without direct government intervention (Habanabakize & Meyer, 2018). The South African Reserve Bank (SARB) adheres to a monetary theory framework that prioritises the preservation of price stability by keeping inflation levels low, promoting full employment, and fostering sustained growth in Gross Domestic Product (GDP) (Hlongwane & Daw, 2022). The prevailing belief is that optimal market functioning occurs when the economy exhibits a consistent trajectory, characterised by stable price levels and convenient availability of capital for both firms and individuals. The objective of this study is to examine the influence of macroeconomic variables on the money supply in South Africa.

This paper presents a comprehensive review of existing studies that examine the impact of macroeconomic variables on the money supply. In a study conducted by He (2017),

an examination was undertaken to explore the correlation between money supply and macroeconomic variables within the context of China. Through the application of a vector autoregressive (VAR) model on a time series dataset covering the years 2000–2016, the investigation revealed a positive association between real gross domestic product (RGDP) and consumer price index (CPI) and money supply. Conversely, the study observed a negative impact of the deposit interest rate on the money supply. In a study conducted by Ifionu and Akinpelumi (2015), an examination was undertaken of the relationship between macroeconomic variables and money supply within the context of Nigeria. The study utilised a time series dataset covering the years 1981 to 2013. It employed an ordinary least squares (OLS) regression and Granger causality model to examine the relationship between inflation, exchange rate, money supply, and GDP. The findings indicate a negative association between inflation and the exchange rate and money supply, while GDP exhibits a positive association.

The Granger causality analysis yielded findings indicating a unidirectional causal relationship, wherein the money supply exerted a causal influence on inflation, the exchange rate influenced the money supply, and the exchange rate impacted GDP. The study by Ogunmuyiwa and Ekone (2010) looked at the connection between the money supply and economic growth in Nigeria from 1980 to 2006. The study utilised an ordinary least square (OLS) and Granger causality models to determine the presence of a negative association between the variables. In the context of their study, Olamide and Maredza (2019) utilised a dynamic regression panel approach to examine the factors influencing monetary policy and economic growth in the Southern African Development Community (SADC) region. They employed a panel autoregressive distributed lag (ARDL) model and observed that economic growth, money supply, inflation, and the oil commodity exhibit positive associations with monetary policy. Conversely, the exchange rate and oil volatility were found to have negative relationships with monetary policy in South Africa.

In their review of pertinent studies, Khabo and Harmse (2005) investigated the effects of monetary policy on the economic growth of a small open economy in South Africa. The analysis of the ADT statistic in relation to the McKinnon critical values reveals a significant relationship between money supply changes and inflation and changes in economic growth. Additionally, it is observed that while monetary authorities have the ability to influence M3 through the repo rate, they are unable to consistently maintain it within the predetermined targets. In their study, Fadiran and Edun (2013) conducted a comparative analysis of the utilisation of the repo rate in South Africa during the timeframe spanning from 1990 to 2010. They employ a structural vector autoregressive (SVAR) econometric model for their analysis. The findings of the study revealed a notable enhancement in the effectiveness of monetary policy during the repo period, which can be attributed to the adoption of an inflation-targeting framework. In a study conducted by Cheng (2007), a vector autoregression (VAR) analysis was employed to examine the monetary policy transmission mechanism in Kenya.

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The primary focus of the investigation was to assess the impact of the central bank's repo rate on the overall economy. The research employed yearly time series data, covering the period from 1997 to 2005. The research utilised a vector autoregression (VAR) model to examine the interconnections among the variables. The primary conclusions derived from the investigation suggest that exogenous short-term interest rates are typically followed by a decline in prices and a rise in nominal exchange rates, while exerting minimal influence on production and output. In a study conducted by Precious and Makhetha-Kosi (2014), an examination was undertaken to investigate the impact of monetary policy on the economic growth of South Africa. The research utilised a Vector Error Correction Model (VECM) to analyse a time series dataset covering the period from 2000 to 2010. The study revealed that the variables of money supply, repo rate, and exchange rate do not have a significant impact on economic growth in South Africa. Consequently, the study suggests that monetary policy should be employed to establish a conducive investment environment, thereby fostering sustainable economic growth.

In a study conducted by Gerlach (2011), an examination was undertaken of the European Central Bank's (ECB) repo rate setting in the context of the financial crisis. The research utilised an ordered logit model to analyse data from 1999 to 2009. This model facilitated a seamless transition between parameter sets, enabling the identification of a significant and abrupt shift in the middle of 2008. In their study, Habanabakize and Meyer (2018) examine the dynamic impact of foreign direct investment and interest rates on the gross domestic product (GDP) of South Africa. The research employed time series data ranging from 2000 to 2016 and utilised autoregressive distributed lag (ARDL) and error correction model (ECM) methodologies. The findings of the study indicate a statistically significant positive correlation between the gross domestic product and the repo rate in the context of South Africa.

Another study was conducted by Ichwani and Nisa (2021) to examine the factors influencing the BI-7-days reserve repo rate, GDP, and exchange rate in relation to the money supply in Indonesia. The research employed a linear regression analysis to examine the impact of the repo rate on the money supply in Indonesia during the period spanning from 2016 to 2019. The findings of the study revealed a significant relationship between the repo rate and the money supply. In the study conducted by Leshoro (2014), the researcher examines the impact of the repo rate on inflation within the context of South Africa, covering the period from the second quarter of 1980 to the third quarter of 2013. The research utilised a vector autoregressive (VAR) model and conducted Granger causality tests. The research conducted revealed a positive correlation between the repo rate and both gross domestic product growth and the inflation rate. Based on the findings of Higgins, Zha, and Zhong (2016), the influence of the repo rate on China's GDP and CPI during the period from 2017 to 2020 was found to be constrained when the repo rate experienced an increase.

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In the context of the research, Obeid and Awad (2017) examined the efficacy of monetary policy instruments in promoting economic growth in Jordan. The authors employed the Vector Error Correction Model (VECM) and analysed quarterly data spanning from 2005 to 2015. The results indicate a positive correlation between monetary policy and economic growth in the context of Jordan. In the work of Klee and Stebunovs (2011), it is contended that the utilisation of the target repo as a policy tool may prove to be more efficacious than relying solely on the target federal funds rate. This assertion is based on the premise that the repo market encompasses a wider range of participants, thereby enhancing its potential impact. In their study, Twinoburyo and Odhiambo (2018) undertook qualitative research to explore the relationship between monetary policy and economic growth. Their findings indicate that a significant portion of the existing literature supports a positive association between monetary policy and economic growth, particularly in financially advanced economies characterised by independent central banks.

However, this relationship appears to be less pronounced in developing nations. The study conducted by Onyeiwu (2012) investigated the relationship between monetary policy and economic growth in Nigeria during the time span of 1981 to 2008. The researcher utilised the Ordinary Least Squares (OLS) model to determine the relationship between monetary policy, as represented by the money supply, and its effects on economic growth and inflation. The findings indicate that an increase in the money supply has a positive effect on economic growth while simultaneously exerting a negative influence on inflation. The researcher proposes the implementation of a favourable monetary policy, which encompasses the manipulation of interest rates, exchange rates, and liquidity management mechanisms.

In their 2013 study, Fasanya, Onakoya, and Agboluaje (2013) look into the impact of monetary policy on Nigeria's economic expansion from 1975 to 2010. The researchers utilised an error correction model (ECM) to determine the influential monetary policy instruments that contribute to economic growth in Nigeria. They identified the inflation rate, exchange rate, and external reserves as significant factors. Furthermore, they propose the utilisation of primary and secondary bond markets as a means to enhance the effectiveness of monetary policy.

The study conducted by Adefeso and Mobolaji (2010) investigates the impact of fiscal and monetary policy on the economic growth of Nigeria. The researchers employ an error correction model (ECM) to analyse data from the years 1970 to 2007. The findings of the study indicate that there is a significant relationship between monetary policy and economic growth in Nigeria. It is therefore recommended that greater attention be given to monetary policy in order to foster economic development in the country. The study conducted by Nouri and Samimi (2011) investigates the correlation between money supply and economic growth in Iran during the time span of 1974 to 2008. The study

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utilised the Ordinary Least Squares (OLS) method and employed the Levine and Renelt model to examine the relationship between money supply and economic growth in Iran. The findings indicated a statistically significant positive association between these two variables.

Additionally, Bhattacharya, Haslag, and Martin (2009) examine the relationship between optimal monetary policy and economic growth. Their findings indicate that the Friedman rule is suboptimal, regardless of the level of risk aversion. The study conducted by Akalpler and Duhok (2018) examines the influence of monetary policy on the economic growth of Malaysia. The researchers employ an Ordinary Least Squares (OLS) model to analyse the data and conclude that a positive correlation exists between money supply and economic growth. In their study, Ufoeze, Odimgbe, Ezeabalisi, and Alajekwu (2018) examined the impact of monetary policy on the economic growth of Nigeria during the timeframe spanning from 1986 to 2016. Their findings indicate a statistically significant positive relationship between the monetary policy rate, money supply, and economic growth. According to the findings of Anowor and Okorie (2016), the utilisation of monetary policy tools is suggested as a means to stimulate economic growth in Nigeria. This recommendation is based on their application of an error correction model (ECM) to analyse data from 1982 to 2013.

Likewise, Mugableh (2019) conducted a study examining the effects of monetary policy on the Jordanian economy during the time span of 1990 to 2017. The researcher utilised the ARDL and VECM models to determine the impact of monetary policy on economic growth in Jordan. The findings indicate a positive relationship between monetary policy and economic growth, as well as a bidirectional causality between money supply and economic growth. In a study conducted by Cheng et al. (2019), it was observed that the implementation of monetary policy shocks in China yielded a positive impact on the country's economic growth.

In their study on monetary policy in Russia, Kuvalin, Moiseev, and Shirov (2020) emphasise the utilisation of the inflation targeting mechanism by the central bank. The study conducted by Dingela and Khobai (2017) examined the dynamic effects of money supply on economic growth in South Africa over the period spanning from 1980 to 2016. The researchers utilised an autoregressive distributed lag (ARDL) model to examine the relationship between money supply and economic growth, as well as the relationship between interest rates and economic growth. The findings of the study indicate a positive association between the money supply and economic growth, while interest rates exhibit a negative association with economic growth. The findings additionally demonstrated a positive correlation between inflation and economic growth in the short run while indicating a negative correlation between inflation and economic growth in the long run.

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The research by Ndou, Gumata, Ndou, and Gumata (2017) examined the asymmetric effects of repo rate and inflation rate shocks on South Africa's economic growth. The research utilised a threshold vector autoregression (VAR) methodology to analyse quarterly data from the period of 1995 Q1 to 2014 Q4. The findings of the study indicate that an escalation in both the inflation rate and the repo rate exerts a detrimental impact on overall economic growth. According to Munyeka's (2014) study, an examination of quarterly data and the implementation of an OLS model revealed a negative correlation between inflation and economic growth in South Africa during the period spanning from 1993 to 2011.

In their research study, Kamaan and Nyamongo (2014) investigate the quantitative evaluation of the influence of monetary policy on the economic growth of Kenya. Their findings indicate that the influence of monetary policy shock exhibits a statistically insignificant negative effect during the initial two-month period, which subsequently transitions to a positive and statistically insignificant effect over the subsequent four months. The researchers propose a reduction in interest rates to an optimal level in order to foster economic growth and strive for minimal inflation rates. Abata, Kehinde, and Bolarinwa (2012) advocate for the implementation of fiscal prudence in Nigeria as a means to address issues of fiscal indiscipline. A study was conducted by Amarasekara (2008) to examine the influence of monetary policy on the economic growth of Sri Lanka during the time frame spanning from 1978 to 2005.

This research utilises a vector autoregression (VAR) model and demonstrates that a decrease in economic growth is linked to expected policy changes with a short delay. Aslam and Awan (2018) conducted an empirical investigation to examine the effects of monetary policy on economic growth in Pakistan over a time frame extending from 1973 to 2014. The utilisation of an ARDL model yielded findings indicating that interest rates and inflation exert a negative influence on economic growth, whereas money supply and exchange rates have a positive impact on economic growth. In their study, Tan, Mohamed, Habibullah, and Chin (2020) utilised various econometric models, including ARDL, FMOLS, CCR, and DOLS, to examine the relationship between interest rates and economic growth in Malaysia, Singapore, and Thailand. The analysis covered the time period from the first quarter of 1980 to the first quarter of 2017. The findings indicated a negative association between interest rates and economic growth in these countries.

Fry (2019) looked into the connections between the financial system, monetary policy, and economic growth in four East Asian economies: Hong Kong, Singapore, Taiwan, and South Korea. The study focused on the time frame spanning from 1960 to 1983. The findings indicated that the implementation of monetary policy in the four countries did not have a negative impact on economic growth or hinder export activities. In a study conducted by Meyer (2017), an examination was undertaken to analyse the

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impacts of economic growth on employment in South Africa, both in the short and long term. This investigation employed a VAR (vector autoregression) model and a Granger causality model. The study employed a dataset covering the years 2002–2016 and observed a significant relationship between economic growth, the repo rate, and changes in employment.

In a study conducted by Phiri (2018), quarterly data from 2001 Q1 to 2016 Q2 in South Africa was analysed using a smooth transition regression (STR) model. The findings revealed that there exists a threshold of 5.30% at which the relationship between inflation and economic growth becomes positive. However, below this threshold, inflation tends to have detrimental effects on economic growth. The study by Monamodi and Choga (2022) looks at the impact of monetary and fiscal policies on economic growth in the Southern African Customs Union (SACU) from 1980 to 2017. The researchers employ panel ARDL and pooled mean group estimator models to analyse the data. The study revealed that there exists a causal relationship between government expenditure, real interest rates, inflation, the official exchange rate, and economic growth in the Southern African Customs Union (SACU).

The existing body of literature extensively examines the correlation between money supply and economic growth, wherein money supply is employed as an explanatory factor. The present analysis has identified a notable deficiency in the existing body of literature pertaining to studies that employ money supply as a dependent variable. Additionally, a methodological gap has been observed, wherein there is a scarcity of studies utilising a nonlinear autoregressive distributed lag (ARDL) model to examine the effects of macroeconomic factors on money supply. Previous research conducted by Dingela and Khobai (2017); Olamide and Maredza (2019); Precious and Makhetha-Kosi (2014) did not employ the nonlinear autoregressive distributed lag (NARDL) approach to examine potential nonlinear relationships between variables.

This is primarily due to the fact that the majority of these studies primarily concentrated on linear models. Limited research has been conducted regarding the impact of determinants and macroeconomic factors on the money supply in South Africa. Consequently, the purpose of this study is to assess the impact of macroeconomic factors on the money supply in South Africa by employing a nonlinear autoregressive distributed lag (ARDL) model. One of the benefits associated with employing the NARDL approach is its ability to effectively and concurrently capture asymmetries in both the fundamental long-term relationship and the adjustment patterns (Shin, Yu, & Greenwood-Nimmo, 2014). Additionally, this study presents asymmetric cumulative dynamic multipliers that allow for the observation of asymmetric adjustment patterns in response to positive and negative shocks to the explanatory variables. Also, it examines the evolution of these patterns in both the short and long term.

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3. DATA AND METHODOLOGY

This section of the study presents a comprehensive account of the data and methodology employed in the research. The data for all the variables used in this study were sourced from the South African World Bank. The research utilised time series data spanning from 1971 to 2020. The variable of interest, money supply (M2), is derived from the research conducted by Ifionu and Akinpelumi (2015) as well as He (2017). However, given the scarcity of research examining this association, the explanatory variables utilised in this study are derived exclusively from three prior studies: He (2017); Ifionu and Akinpelumi (2015); Ogunmuyiwa and Ekone (2010). Explanatory variables commonly considered in economic analysis include gross domestic product (GDP), exchange rates, real interest rates, and inflation. The following table, Table 1, presents a comprehensive description of the variables.

3.1. Model specification

The model specification employed in this study aims to examine the influence of macroeconomic variables on the money supply in South Africa. This analysis adopts a multivariate framework, wherein the relationship is expressed as follows:

$$M2_t = \propto_0 + \propto_1 GDP_t + \propto_2 IR_t + \propto_3 INF_t + \propto_4 EXR_t + \varepsilon_t \quad (1)$$

In this context, M2 represents the monetary supply of the country, GDP represents the gross domestic product, IR represents the interest rate, INF represents the inflation rate, EXR represents the exchange rate, and ε_t represents the stochastic component. The symbol ∝_0 denotes a constant, while ∝_1 to ∝_4 represent the coefficients associated with the variables. A positive correlation is anticipated between the M2 money supply and GDP. The phenomenon of economic growth frequently engenders a heightened sense of assurance among financial institutions and individuals seeking loans. Banks demonstrate a willingness to provide loans, whereas businesses exhibit a desire to secure borrowing in order to finance their respective ventures. As a consequence, the generation of additional loans leads to the expansion of the money supply. Nevertheless, in periods of low interest rates, both businesses and consumers benefit from reduced borrowing costs. This would result in a greater influx of funds into the economy through the provision of loans. As a result, the money supply exhibits a tendency to expand.

In accordance with the quantity theory of money, alterations in the money supply exhibit a direct and proportional relationship with variations in the general price level, commonly referred to as inflation, over an extended period of time. When the money supply is expanding faster than the economy as a whole, there is an excess of money in the system, which causes an increase in the price of a fixed amount of goods and services. This surplus money exerts upward pressure on prices, ultimately resulting in inflation. Moreover, in the event that a nation's currency experiences excessive

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appreciation, the central bank may opt to engage in the sale of its currency within the foreign exchange market, thereby acquiring foreign currencies. The augmentation of the money supply within the domestic economy occurs when the central bank allocates newly obtained foreign currency reserves to the domestic banking system.

The current study utilises a nonlinear modelling approach and specifically employs the non-linear autoregressive distributed lag (NARDL) co-integration technique. This technique, developed by Shin, Yu, and Greenwood-Nimmo (2014), is employed to examine the asymmetric relationship between the variables of interest. NARDL is an asymmetric version of the ARDL model developed by Pesaran, Shin, and Smith (2001), this "approach aims to capture both long-run and short-run asymmetries in the variable of interest. Since NARDL is an upgraded version of the original ARDL model, the study first re-adjust (Eq. 1) to convert it into an error correction system by capturing both long-run and short-run dynamics in accordance with the ARDL (Pesaran, Shin, & Smith, 2001). The error correction of the ARDL model can be written mathematically as follows:"

$$\Delta M2_t = \propto_0 + \sum_{k=1}^{p} \propto_1 \Delta M2_{t-k} + \sum_{k=0}^{p} \propto_2 \Delta GDP_{t-k} + \sum_{k=0}^{p} \propto_3 \Delta IR_{t-k} + \sum_{k=0}^{p} \propto_4 \Delta INF_{t-k} + \sum_{k=0}^{p} \propto_5 \Delta EXR_{t-k} + \emptyset_1 M2_{t-k} + \emptyset_2 GDP_{t-1} + \emptyset_3 IR_{t-1} + \emptyset_4 INF_{t-1} + \emptyset_5 EXR_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta M2_t = \gamma_0 + \sum_{k=1}^{p} \gamma_1 \Delta M2_{t-k} + \sum_{k=0}^{p} \gamma_2 \Delta GDP_{t-k} + \sum_{k=0}^{p} \gamma_3 \Delta IR_{t-k} + \sum_{k=0}^{p} \gamma_4 \Delta INF_{t-k} + \sum_{k=0}^{p} \gamma_5 \Delta EXR_{t-k} + \pi_0 ECM_t + \varepsilon_t \quad (3)$$

In this context, the symbol Δ represents the first difference, while the symbol k represents the lagged values. The symbols ∝_1 to ∝_5 and γ_1 to γ_5 refer to short-term coefficients, while ∅_1 to ∅_5 represent long-term coefficients. Lastly, ε_t denotes the residual term. The Bounds test is employed to ascertain the existence of a long-term relationship among variables. The null hypothesis, indicating no cointegration, is $H_0: \emptyset_1 = \emptyset_2 = \emptyset_3 = \emptyset_4 = \emptyset_5 = 0$, whereas the alternative hypothesis is $H_0: \emptyset_1 \neq \emptyset_2 \neq \emptyset_3 \neq \emptyset_4 \neq \emptyset_5 \neq 0$. The null hypothesis is rejected if the F statistic calculated exceeds the upper limit critical value I(1) specified by Pesaran, Shin, and Smith (2001) for the number of explanatory variables (k). If the value of the F statistic is less than the critical value I (0) at the lower limit, it is not possible to reject the null hypothesis.

The existence of a F statistic comparing the integration orders of I(0) and I(1) indicates a degree of uncertainty regarding the presence of cointegration. The NARDL approach, as proposed by Shin, Yu, and Greenwood-Nimmo (2014), is selected due to its ability to capture the asymmetry in macroeconomic variables resulting from both negative and positive shocks. The ARDL model proposed by Pesaran, Shin, and Smith (2001) is presented in its entirety. Moreover, the utilisation of this co-integration framework allows for the simultaneous incorporation of asymmetric non-linearity and model co-

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integration within a singular equation, rendering it particularly well-suited for situations involving limited sample sizes. This particular approach is deemed more favourable compared to alternative methods due to its versatility in accommodating various orders of integration, including I (0), I (1), or a combination thereof.

As mentioned earlier, the NARDL approach challenges the conventional assumption in co-integration analysis that all variables included in the model should have the same order of integration. On the other hand, it is crucial to assess the unit root properties of the series as the NARDL technique cannot be applied when dealing with I(2) series. In order to examine the presence of a unit root process, this study employs the Kwiatkowski, Phillips, Schmid, and Shin (KPSS) and Zivot and Andrews (ZA) unit root tests.

The aforementioned equations are predicated on the notion that Gross Domestic Product (GDP), Interest Rate (IR), Inflation (INF), and Exchange Rate (EXR) exhibit a symmetrical relationship with M2. The primary objective is to determine if GDP, IR, INF, and EXR have a symmetric or asymmetric influence on money supply. GDP, IR, INF, and EXR are separated into two components, the first of which captures positive shocks of GDP, IR, INF, and EXR respectively ($GDP_t^+, IR_t^+, INF_t^+, and\ EXR_t^+$), and the second of which captures negative shocks of GDP, IR, INF, and EXR respectively ($GDP_t^-, IR_t^-, INF_t^-, and\ EXR_t^-$):"

$$GDP_t^+ = \sum_{j=1}^{t} \Delta GDP_j^+ = \sum_{j=1}^{t} Max(\Delta GDP_j^+, 0) \quad (4)$$

$$GDP_t^- = \sum_{j=1}^{t} \Delta GDP_j^- = \sum_{j=1}^{t} Min(\Delta GDP_j^-, 0) \quad (5)$$

$$IR_t^+ = \sum_{j=1}^{t} \Delta IR_j^+ = \sum_{j=1}^{t} Max(\Delta IR_j^+, 0) \quad (6)$$

$$IR_t^- = \sum_{j=1}^{t} \Delta IR_j^- = \sum_{j=1}^{t} Min(\Delta IR_j^-, 0) \quad (7)$$

$$INF_t^+ = \sum_{j=1}^{t} \Delta INF_j^+ = \sum_{j=1}^{t} Max\left(\Delta INF_j^+, 0\right) \quad (8)$$

$$INF_t^- = \sum_{j=1}^{t} \Delta INF_j^- = \sum_{j=1}^{t} Min(\Delta INF_j^-, 0) \quad (9)$$

$$EXR_t^+ = \sum_{j=1}^{t} \Delta EXR_j^+ = \sum_{j=1}^{t} Max(\Delta EXR_t^+, 0) \quad (10)$$

$$EXR_t^- = \sum_{j=1}^{t} \Delta EXR_j^- = \sum_{j=1}^{t} Min(\Delta EXR_t^-, 0) \quad (11)$$

INTERNATIONAL JOURNAL OF ECONOMICS AND FINANCE STUDIES
Vol: 15 **No:** 03 **Year:** 2023 **ISSN:** 1309-8055 (Online) (**pp.** 108-139) **Doi:** 10.34109/ijefs.202315305
Received: 25.04.2023 | **Accepted:** 21.07.2023 | **Published Online:** 07.09.2023

-RESEARCH ARTICLE-

In order to get non-linear ARDL equations, The study replaces GDP, IR, INF, and EXR respectively by $GDP_t^+, IR_t^+, INF_t^+, and\ EXR_t^+$ and $GDP_t^-, IR_t^-, INF_t^-, and\ EXR_t^-$ in equations 2 and 3 as follows:

$$\Delta M2_t = \propto_0 + \sum_{k=1}^{p} \propto_1 \Delta M2_{t-k} + \left(\sum_{k=0}^{p} \propto_2 \Delta GDP_{t-k}^+ + \sum_{k=0}^{p} \propto_3 \Delta GDP_{t-k}^-\right) + \left(\sum_{k=0}^{p} \propto_4 \Delta IR_{t-k}^+ + \sum_{k=0}^{p} \propto_5 \Delta IR_{t-k}^-\right) + \left(\sum_{k=0}^{p} \propto_6 \Delta INF_{t-k}^+ + \sum_{k=0}^{p} \propto_7 \Delta INF_{t-k}^+\right) + \left(\sum_{k=0}^{p} \propto_8 \Delta EXR_{t-k}^+ + \sum_{k=0}^{p} \propto_9 \Delta EXR_{t-k}^-\right) + \emptyset_1 M2_{t-k} + \emptyset_2 GDP_{t-1}^+ + \emptyset_3 GDP_{t-1}^- + \emptyset_4 IR_{t-1}^+ + \emptyset_5 IR_{t-1}^- + \emptyset_6 INF_{t-1}^+ + \emptyset_7 INF_{t-1}^- + \emptyset_8 EXR_{t-1}^+ + \emptyset_9 EXR_{t-1}^- + \varepsilon_t \quad (12)$$

$$\Delta M2_t = \gamma_0 + \sum_{k=1}^{p} \gamma_1 \Delta M2_{t-k} + \left(\sum_{k=0}^{p} \gamma_2 \Delta GDP_{t-k}^+ + \sum_{k=0}^{p} \gamma_3 \Delta GDP_{t-k}^-\right) + \left(\sum_{k=0}^{p} \gamma_4 \Delta IR_{t-k}^+ + \sum_{k=0}^{p} \gamma_5 \Delta IR_{t-k}^-\right) + \left(\sum_{k=0}^{p} \gamma_6 \Delta INF_{t-k}^+ + \sum_{k=0}^{p} \gamma_7 \Delta INF_{t-k}^+\right) + \left(\sum_{k=0}^{p} \gamma_8 \Delta EXR_{t-k}^+ + \sum_{k=0}^{p} \gamma_9 \Delta EXR_{t-k}^-\right) + \pi_0 ECM_t + \varepsilon_t \quad (13)$$

After estimating equation 12 and 13, the study carries out a Wald test to examine the short run ($^{\propto_2^+}/_{\propto_1} = {}^{\propto_3^-}/_{\propto_1}$, $^{\propto_4^+}/_{\propto_1} = {}^{\propto_5^-}/_{\propto_1}$, $^{\propto_6^+}/_{\propto_1} = {}^{\propto_7^-}/_{\propto_1}$, $^{\propto_8^+}/_{\propto_1} = {}^{\propto_9^-}/_{\propto_1}$) and long run ($^{\emptyset_2^+}/_{\emptyset_1} = {}^{\emptyset_3^-}/_{\emptyset_1}$, $^{\emptyset_4^+}/_{\emptyset_1} = {}^{\emptyset_5^-}/_{\emptyset_1}$, $^{\emptyset_6^+}/_{\emptyset_1} = {}^{\emptyset_7^-}/_{\emptyset_1}$, $^{\emptyset_8^+}/_{\emptyset_1} = {}^{\emptyset_9^-}/_{\emptyset_1}$) asymmetric effects of GDP, IR, INF, and EXR on M2.

Table 1: Description of the variables

Variables	Description	Source
$M2_t$	Money supply	South Africa Reserve Bank
IR_t	Real interest rates	World Bank
INF_t	Consumer price index	World Bank
GDP_t	Gross domestic product at market price	South Africa Reserve Bank
EXR_t	Foreign exchange rate (SA cent per USA dollar)	South Africa Reserve Bank

Source: SARB

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3.2. Descriptive statistics

The initial stage of empirical analysis involves the examination and interpretation of descriptive statistics. Table 2 presents the descriptive statistics for the variables examined in the study. The Jarque-Bera statistics, proposed by Jarque and Bera (1980), are employed to explain the concept of a normally distributed variable. The null hypothesis assumes that the variable follows a normal distribution, while the alternative hypothesis posits that the variable deviates from a normal distribution. The findings indicate that the variables of money supply, inflation, and foreign exchange rate exhibit a normal distribution over the duration of the study.

However, it is observed that the variables of real interest rate and gross domestic product do not conform to a normal distribution. The findings suggest that the mean values for M2, IR, INF, GDP, and EXR during the period from 1971 to 2020 are 14.119%, 2.984%, 8.953%, 2.212%, and -5.364%, respectively. Nevertheless, the standard deviations of the variables suggest a limited level of volatility in the observations around the mean, as illustrated in Figure 1. Table 3 displays the correlation matrix, which is utilised to examine the potential presence of relationships among the independent variables.

Table 2: Descriptive statistics

Variables	South Africa	
	Mean $\pm$ SD	Jarque-Bera Statistic
$M2_t$	14.119 $\pm$ 7.720	1.392
IR_t	2.984 $\pm$ 4.758	11.278***
INF_t	8.953 $\pm$ 2.169	1.752
GDP_t	2.212 $\pm$ 2.495	8.903**
EXR_t	-5.364 $\pm$ 11.938	23.141

Source: Authors' own computations: Significant at (*), (**), (***), represents 10%, 5%, 1% respectively

Table 3: Correlation matrix

Correlation	M2	GDP	IR	INF	EXR
M2	1.0000				
GDP	0.3719*	1.0000			
IR	-0.1207	-0.1103	1.0000		
INF	0.3827*	-0.1402	-0.3638*	1.0000	
EXR	-0.0310	0.2095	-0.2419	-0.1836	1.0000

Source: Authors' own computations: (*) indicates significance at 5%

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The correlation between the variables is depicted in Table 3. Examining the association between the variables will facilitate the identification of potential multicollinearity within the model. Multicollinearity is a crucial assumption in the classical linear regression model (CLRM) that should not be violated. The majority of the observed relationships among macroeconomic variables are found to be statistically insignificant, with the exception of interest rates, which exhibit a positive and statistically significant correlation with the inflation rate at a significance level of 5%. This statement suggests that there is an inverse relationship between inflation and interest rates, wherein an increase in inflation leads to a decrease in interest rates.

Moreover, it is observed that there exists a positive and statistically significant relationship between the money supply and both gross domestic product and inflation, with a level of significance of 5%. This outcome aligns with the anticipated findings of the study. However, it is noteworthy that all the correlations among the explanatory variables are below 0.8. Consequently, this observation suggests that the presence of multicollinearity among the macroeconomic variables is not a significant concern (Gujarati, 2010).

3.3. Non-linearity test

The primary objective of this study is to examine the asymmetric relationship between money supply and macroeconomic variables in the context of South Africa. To achieve this objective, it is imperative to investigate the potential nonlinearity of these variables. The investigation examined the nonlinearity of the variables through the utilisation of the widely recognised BDS test. The findings are summarised in Table 4. The null hypothesis regarding linearity is rejected in support of nonlinearity, as indicated by the findings presented in Table 4. The results indicate that the variables exhibit a distribution that deviates from normality, thereby indicating the presence of nonlinearity.

Table 4: BDS test for nonlinearity

Variables	Dimensions	BDS statistics
M2	2	0.022536***
	3	0.014390***
	4	0.008244***
	5	0.004379***
	6	0.002236***
GDP	2	0.002232
	3	0.005280
	4	0.007202*
	5	0.004191*

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	6	0.004334***
IR	2	0.061820***
	3	0.074978***
	4	0.069034***
	5	0.057190***
	6	0.050394***
INF	2	0.095096***
	3	0.096478***
	4	0.079305***
	5	0.061221***
	6	0.045313***
EXR	2	0.020974***
	3	0.016400**
	4	0.009211
	5	0.000920
	6	-0.002396

Source: Authors' own computations: Significant at (*), (**), (***), represents 10%, 5%, 1% respectively

3.4. Unit root tests

The next stage involves investigating the level of integration that the variables exhibit after looking at their nonlinearity. The study employed both informal and formal tests to examine the presence of a unit root. The informal test employs graphical representation to examine the presence of unit root in the variables, while the formal test is conducted using the KPSS and ZA unit root tests. Kwiatkowski, Phillips, Schmidt, and Shin (1992) came up with the Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) because it works well to find non-linear effects in the variables. But Perron (1989) said that the KPSS unit root test has a tendency to come to the wrong conclusion that the null hypothesis of stationarity is true when there are structural changes in the data.

In addition, the study utilised the ZA unit root test developed by Zivot and Andrews (2002) to identify and analyse a single structural break within a series. Table 5 displays the outcomes of the formal unit root tests, while Figure 1 exhibits the results of the informal unit root tests. The findings depicted in Figure 1 indicate that the variables exhibit stationarity at this level due to their manifestation of mean reversion characteristics. The results of the formal tests indicate that the variables under consideration are either integrated at order 0 (I(0)) or order 1 (I(1)). Hence, the NARDL model can be appropriately employed given the absence of any variable exhibiting integration at the I(2) level.

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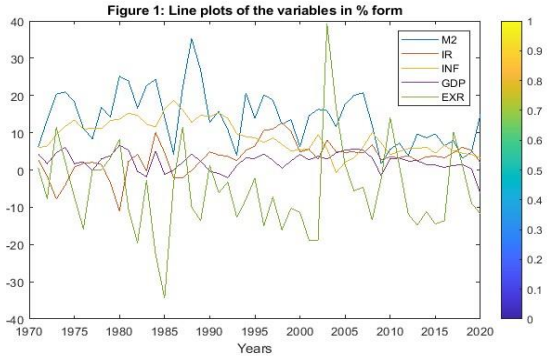

Source: Authors' own computations with data from World Bank and SARB

Table 5: Unit root test: KPSS and ZA unit root tests

Variables	KPSS				ZA unit root test			
	Intercept		Intercept & Trend		Intercept		Intercept & Trend	
	Level	Δ	Level	Δ	Level	Δ	Level	Δ
M2	0.62**	0.500**	0.12*	0.50***	-6.34*	-5.06	-	-5.26*
GDP	0.1919	0.2658*	0.1301*	0.2014**	-4.78**	-.553***	-4.82*	-5.59*
IR	0.55**	0.11	0.18**	0.10	-5.30***	-7.34**	-5.82**	-7.25**
INF	0.61**	0.50**	0.14*	0.50***	-3.62***	-7.81***	-2.62**	-7.12***
EXR	0.07	0.50**	0.07	0.50***	-7.20***	-5.95*	-7.50***	-6.17*

Source: Authors' own computations: Significant at (*), (**), (***), represents 10%, 5%, 1% respectively

4. EMPIRICAL RESULTS

Table 6: Lag selection

Lag	LogL	LR	FPE	AIC	SC	HG
0	-691.848	NA	9903613	30.298	30.497	0.372
1	-621.205	122.857*	1371429*	28.313*	29.506*	28.760*
2	-602.944	27.788	1912849	28.606	30.793	29.425
3	-583.774	25.004	2735467	28.860	32.040	30.051
4	-563.989	21.506	4243816	29.086	33.261	30.650

Source: Authors' own computations: (*) indicates significance at 5%

Table 6 displays the optimal lag, which is determined using a set of criteria including LogL, LR, FPE, AIC, SC, and HG. The findings suggest that the majority of the criteria opt for the first lag. Hence, the research employs a single lag when estimating the Nonlinear Autoregressive Distributed Lag (NARDL) model.

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4.1. Cointegration investigation

Therefore, it is imperative to evaluate the existence of a long-term relationship between the money supply and a specific set of macroeconomic variables, subsequent to confirming the integration order of said variables. The initial iteration of the cointegration test was proposed by Engle and Granger (1987), wherein they utilised the estimated residuals from a long-run regression model. Consequently, this particular model is commonly known as the residual-based test of cointegration. A number of additional cointegration procedures were introduced approximately ten years later, which encompass the ECM-based t-test devised by Banerjee, Dolado, and Mestre (1998), the ECM-based F-test formulated by Boswijk (1994), and the system-based test developed by Johansen (1988).

In contrast, varying outcomes were observed when employing different cointegration procedures, suggesting that no single cointegration test was universally optimal and impervious to all circumstances. In this study, the nonlinear autoregressive distributed lag (ARDL) bounds test approach is employed to enhance the efficacy of cointegration strategies. Table 7 presents the findings of the bounds test, which provide confirmation of a long-term relationship between the money supply and macroeconomic variables throughout the duration of the study. Hence, the findings of this study suggest that it is necessary to estimate the nonlinear autoregressive distributed lag (NARDL) model both in the short-term and long-term.

4.2. Long run parameters estimated.

Given the confirmation of non-linear cointegration through the results obtained from the bounds test, the subsequent task involves presenting the long-run coefficients of the NARDL regression. The findings are displayed in Table 8. The NARDL (1,1,1,0,1,0,0,0,0) model was chosen using the Akaike information criterion. The findings indicate that the positive shocks of gross domestic product (GDP_POS) lack statistical significance, whereas the negative shocks exhibit significant effects at a 5% level of significance. Hence, the coefficients for positive and negative shocks to GDP in the long run are estimated to be 0.485 and 1.237, respectively.

Hence, the degree of M2's responsiveness to positive shocks is comparatively lower than its responsiveness to negative shocks in GDP. The findings indicate that a marginal increase of 1% in GDP corresponds to a 0.485% increase in M2. However, it is worth noting that the coefficient remains statistically insignificant, despite its lack of significance. The findings align with the results reported by Ifionu and Akinpelumi (2015) as well as He (2017), while contradicting the findings of Ogunmuyiwa and Ekone (2010). A reduction of 1% in gross domestic product (GDP) leads to a corresponding decrease of 1.237% in the measure of money supply known as M2. This suggests that a reduction in economic growth has a negative impact on business confidence, purchasing power, borrowing, and investment intentions. This would result

in a reduced demand for currency to facilitate transactions, payments, and investments, consequently leading to a contraction in the money supply.

Both positive and negative shocks to interest rates (IR) exhibit statistical significance at a 5% level of significance. Hence, the coefficients for the long-term effects of positive and negative shocks on interest rates (IR) are -1.184 and -1.833, respectively. Therefore, the sensitivity of M2 to positive shocks is lower compared to negative shocks of interest rates. The results indicate that an increase of 1 percent in the interest rate (IR) would lead to a decrease of 1.184% in the M2 measure of money supply. These findings are consistent with the results reported by He (2017). A decrease of 1% in the interest rate (IR) results in a corresponding increase of 1.833% in the money supply (M2). This observation suggests that a decrease in interest rates is associated with a decline in the prices of financial securities, which in turn stimulates investment activity. As a result, the overall money supply within the economy experiences an increase.

Moreover, the significance levels for positive and negative shocks of the inflation rate (INF) are 5% and 10%, respectively. Hence, the coefficients for positive and negative shocks of INF in the long run are -2.000 and 1.173, respectively. Therefore, the degree of M2's responsiveness to positive shocks is higher compared to its responsiveness to negative shocks in INF. The results of this study indicate that an increase of 1 percent in INF leads to a decrease of 2 percent in M2. These findings are in line with the findings reported by Ifionu and Akinpelumi (2015). A decrease of 1% in the inflation rate (INF) results in a corresponding decrease of 1.173% in the broad money supply (M2). The Central Bank exercises meticulous management of inflation. When faced with rising inflation, the Central Bank implements contractionary monetary policy measures, such as raising interest rates and selling government securities, in order to mitigate the expansion of the money supply within the economy. Contractionary monetary policies are implemented with the objective of reducing the money supply.

In conclusion, the findings indicate that the positive shocks of exchange rates (EXR_POS) lack statistical significance, whereas the negative shocks exhibit significance at a 10% level. Hence, the coefficients in the long run for positive and negative shocks of the exchange rate (EXR) are 0.105 and -0.352, respectively. Hence, the sensitivity of M2 to positive shocks is lower compared to negative shocks in relation to GDP. The findings indicate that a marginal increase of 1% in the exchange rate (EXR) corresponds to a 0.105% increase in the money supply (M2). However, it is important to note that the coefficient associated with this relationship is deemed statistically insignificant. Nevertheless, it is worth mentioning that these results align with those reported by Ifionu and Akinpelumi (2015). A reduction of 1% in the exchange rate (EXR) leads to a corresponding increase of 0.352% in the money supply (M2). The estimated model exhibits an R-squared value that is widely accepted in the academic community. This suggests that in the event of a depreciation of the domestic currency,

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the central bank has the option to engage in currency purchases within the foreign exchange markets, leading to a reduction in the overall money supply.

4.3. Short run parameters estimated.

Following the estimation of the NARDL long-run parameters, the study proceeds to estimate the short-run parameters as well. Hence, Table 9 displays the outcomes in the short run. The study estimated short-term parameters in order to investigate the presence of any potential disequilibrium that may have occurred during the study period. This will aid in assessing the rate at which the disequilibrium adjusts to the long-run equilibrium. The error correction term (ECT (-1)) denotes the rate at which the system adjusts towards its long-term equilibrium. However, it is observed from Table 9 that the coefficient of the error correction term exhibits a statistically significant negative value. The inclusion of an error correction term in the model suggests a more rapid convergence towards long-term equilibrium. In a span of one year, a significant proportion of 76.3% of the disequilibrium observed in the previous year was effectively rectified. This implies that the process of M2 reaching equilibrium would require approximately one year and a few months.

Table 7: Cointegration: Bounds test

Country	F-statistics	Critical values					
		1%		5%		10%	
South Africa	5.236456***	I(0) 2.79	I(1) 4.1	I(0) 2.22	I(1) 3.39	I(0) 1.95	I(0) 3.06

Source: Authors' own computations: Significant at (*), (**), (***), represents 10%, 5%, 1% respectively

Table 8: NARDL long-run investigation

Variables	Coefficients	Std.Error	t-Statistics	Probability
GDP_POS	0.485	1.279	0.379	0.707
GDP_NEG	1.237	0.692	1.788	0.083*
IR_POS	-1.184	0.573	-2.065	0.046**
IR_NEG	-1.833	0.886	-2.068	0.046**
INF_POS	-2.000	0.854	-2.343	0.025**
INF_NEG	1.173	0.604	1.943	0.060*
EXR_POS	0.105	0.126	0.836	0.409
EXR_NEG	-0.352	0.180	-1.957	0.058*
R-squared = 0.655 DW= 2.181836				

Source: Authors' own computations: Significant at (*), (**), (***), represents 10%, 5%, 1% respectively

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Table 9: NARDL short-run investigation, dependent variables: Money supply (M2)

Variables	Coefficients	Std.Error	t-Statistics	Probability
M2(-1)	0.237	0.237	0.167	0.1652
GDP_POS	1.364	0.521	2.618	0.O130**
GDP_NEG	-0.127	0.429	-0.297	0.7681
GDP_POS(-1)	-0.994	0.711	-1.398	0.1710
GDP_NEG(-1)	1.072	0.701	1.529	0.1353
IR_POS	0.368	0.271	1.360	0.1825
IR_NEG	0.368	0.374	0.984	0.3317
IR_NEG(-1)	-1.767	0.536	-3.296	0.0023***
INF_POS	-1.527	0.539	-2.832	0.0076***
INF_NEG	0.896	0.522	1.714	0.0954*
EXR_POS	0.080	0.098	0.816	0.4202
EXR_NEG	-0.269	0.139	-1.939	0.0606*
Intercept	10.320	4.604	2.242	0.0314**
ECT(-1)	-0.763	0.100	-7.609	0.0000***
$R^2 = 0.649$ DW = 2.181836				

Source: Authors' own computations: Significant at (*), (**), (***), represents 10%, 5%, 1% respectively

4.4. Long run and short run asymmetry

The present study conducted further investigation to determine whether the coefficients exhibit asymmetry or symmetry. Hence, the findings of both the long run and short run are presented in Table 11. In the long term, the null hypothesis that there is no asymmetry is consistently rejected, except in the case of GDP and IR. Nevertheless, it is noteworthy that half of the variables exhibit statistical significance, indicating a substantial level of evidence supporting the existence of a long-term asymmetry between the money supply and macroeconomic variables. Moreover, the null hypothesis that there is no asymmetry is rejected in the short term, except for the case of EXR. Nevertheless, by employing the principle of majority rule, the investigation can deduce that a temporal disparity exists between the money supply and macroeconomic variables.

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Table 11: Long run and short run asymmetries

	Long run asymmetry		Short run asymmetry	
Variables	F-statistics	Conclusion	F-statistics	Conclusion
GDP	0.479	No asymmetry	5.041**	Asymmetry
IR	1.774	No asymmetry	5.873**	Asymmetry
INF	4.313**	Asymmetry	4.16*	Asymmetry
EXR	3.237*	Asymmetry	0.6764	No asymmetry

Source: Authors' own computations: Significant at (*), (**), (***), represents 10%, 5%, 1% respectively

4.4. Diagnostic test

In order to assess the resilience of the model, the investigation examines several diagnostic tests to verify that the estimated model does not violate any of them. The researchers employed the Breusch-Pagan test to assess the presence of autocorrelation and the Harvey (1976) test to examine the presence of heteroscedasticity in the model. Moreover, a significant proportion of econometric models are prone to issues related to model misspecification and endogeneity. Hence, in order to mitigate this concern, the study employs the Ramsey (1969) RESET test to assess the adequacy of the model specification. The findings are presented in Table 12. The findings indicate that the model does not contravene any of the diagnostic tests.

Table 12: Diagnostic tests

South Africa	Serial correlation	Heteroscedasticity	Ramsey's RESET test
Breusch-Pagan LM test	0.1318	2608	0.3693

Source: Authors' own computations: Significant at (**), (***), represents 5%, 1% respectively

4.5. Stability tests

The study employed a stability test with two coefficients, namely the cumulative sum of recursive residuals (CUSUM) test developed by Brown, Durbin, and Evans (1975) as well as the CUSUM squared test. Figures 2 and 3 illustrate the graphical representation of the CUSUM test and the CUSUM squared, respectively. The stability of the model can be inferred from Figures 2 and 3 for the CUSUM analysis, as the plots remain within the 5% significance level.

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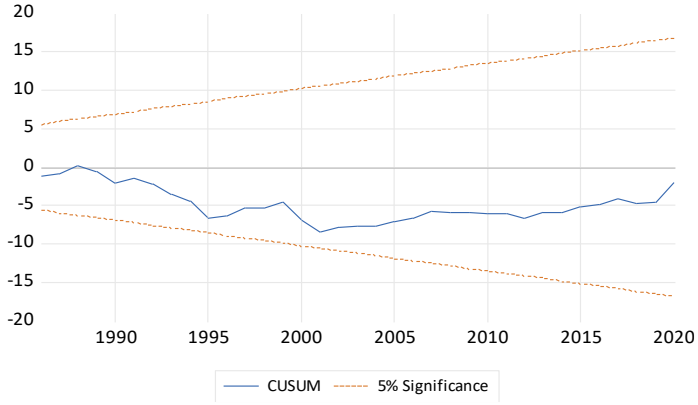

Figure 2: CUSUM test
Source: Authors' own computation

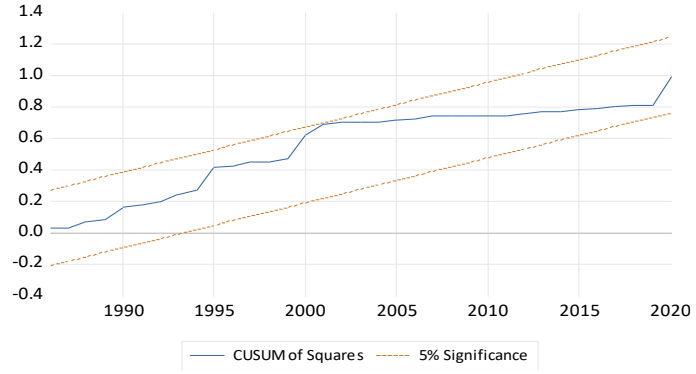

Figure 3: CUSUM squared
Source: Authors' own computation

6. CONCLUSION

The objective of this study was to analyse the differential influence of macroeconomic factors on the money supply in South Africa, utilising a time series dataset spanning from 1971 to 2020. The parameters in this study were estimated using the NARDL model. The researchers employed the unit root tests conducted by ZA and KPSS in order to examine the level of integration of the variables. The existence of a non-linear relationship between the variables in the long run was verified. The findings suggest that there is a stronger relationship between money supply and negative values of GDP compared to positive values. Additionally, the analysis reveals that positive shocks have no significant statistical impact. Consequently, a reduction in Gross Domestic Product (GDP) results in a corresponding decline in the money supply.

In addition, it can be observed that negative interest rate shocks exert a more pronounced influence on the money supply when compared to positive shocks. The

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findings of the study indicate that there is a negative relationship between interest rates and the money supply, whereby an upward adjustment in interest rates results in a reduction in the available money supply, whereas a downward adjustment in interest rates leads to an expansion of the money supply. This suggests that in order to expand the money supply, the South African Reserve Bank (SARB) should consider reducing interest rates. The reduction of interest rates stimulates borrowing and expenditure within the economy, consequently resulting in an upsurge in investment.

Consequently, this may ultimately result in an expansion of the money supply. The findings additionally demonstrated that positive fluctuations in the inflation rate have a more substantial influence on the money supply in comparison to negative fluctuations. The study revealed a negative correlation between inflation rate and money supply, indicating that an increase in inflation rate is associated with a decrease in money supply, whereas a decrease in inflation rate is associated with an increase in money supply. This implies that it is imperative for the Central Bank to exercise diligent oversight over inflation levels in order to maintain adherence to the designated target range. The findings indicate that the money supply is more responsive to negative shocks in the exchange rate, while positive shocks have limited statistical significance in explaining changes in the money supply.

Resultantly, a reduction in the exchange rate results in an expansion of the money supply. Therefore, it is imperative for policymakers at the South African Reserve Bank to prioritise the examination of macroeconomic factors that influence the money supply. This is crucial in their pursuit of achieving the objectives of maintaining price stability and fostering sustainable economic growth through the management of the money supply.

The primary objective of this study was to examine the asymmetric effects of macroeconomic variables on the money supply. This study acknowledges the presence of limitations and suggests that future research should concentrate on the following areas in order to address these gaps and contribute to the existing body of literature: The primary objective of future research should be to examine the identification of structural breaks in order to assess the potential impact of economic uncertainties on the relationship between money supply and macroeconomic variables. Furthermore, this research employed M2 as a surrogate measure for the money supply. Hence, it is possible that forthcoming research endeavours could address this constraint by employing M3 as a metric for measuring the money supply, thereby encompassing a comprehensive representation of the total amount of money circulating within the economy.

Finally, it should be noted that this study intentionally omitted certain macroeconomic variables in order to prevent the model from becoming overfitted. In order to address

this limitation, future research endeavours could potentially integrate fiscal policy variables, such as government spending and taxation, into their analyses. The money supply is indirectly influenced by government spending and taxation through their effects on overall economic activity. When fiscal policy is implemented to increase government spending and reduce taxes, it results in an expansion of aggregate demand, consequently leading to an augmentation of the money supply.

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