Impact of financial inclusion on the effectiveness of interest rate channel of monetary policy transmission in West Africa

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ABSTRACT

Monetary policy has been identified as an indispensable tool for macroeconomic stabilization. The transmission of monetary policy is conditioned on the effectiveness of the intermediate targets of which interest rate, exchange rate depreciation, and money growth are essential. Many factors have been shown to affect monetary policy, of which the role of financial inclusion is critical. However, empirical studies on the relationship between financial inclusion and the interest rate of monetary policy transmission are few; as a result, this study examined the impact of financial inclusion on the effectiveness of the interest rate channel of monetary policy transmission in West Africa. The study employed a panel dataset of 15 West African countries for 2005 and 2020. The data were from secondary sources, particularly the World Bank's World Development Indicator database. The analysis involves descriptive statistics and inferential analysis of the Generalized Method of Moments (GMM) approach. The result of the GMM showed that financial inclusion improves the effectiveness of the interest rate channel of monetary policy transmission. Based on findings, this study recommends that policy authorities in West Africa should embark on a renewed commitment to ensuring access for all in West Africa.

1. Introduction

Monetary policy is one of the essential policies through which authorities influence the macroeconomic composition of an economy to achieve the macroeconomic objectives of price stability, economic growth, reduction in deviation of unemployment from its natural rate, external balance, and exchange rate stability. Policy authorities most prefer monetary policy due to its timeliness and potency at fine-tuning the economy, that is, at responding to small unnoticeable changes in the macroeconomic composition of an economy (Dornbusch, Fisher, & Starz, 2011).

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The determinants of monetary policy effectiveness have been identified in the economic literature. In this regard, factors such as independence of the central bank, the integrity and quality of the central bank, the extent of knowledge of the macroeconomic composition of an economy by the central bank, the analytical capability of the monetary authority as well as the level of development of a nation's financial system in term of the degree of financial inclusiveness of a country have been documented. Financial inclusion is essential to monetary policy because monetary policy has to reach the most significant number of economic agents, especially those involved in informal economic activities and are primarily residents in rural areas. In this way, Khan (2011) opined that the large informal sector that characterizes economic activities in developing countries hurts monetary policy due to the financial decision of the vast volume of financially excluded who are unaffected by the central bank's monetary policies.

Monetary policy is conducted using intermediate targets. The intermediate monetary policy targets include interest rate, exchange rate, and money supply growth. These variables provide information to policymakers on the achievability or otherwise of inflation and output targets. One of the most critical challenges facing policymakers worldwide is determining how monetary policy should be conducted to meet their country's national development goals. Over the years, monetary policy has been attempted using different frameworks. These frameworks range from exchange rate targeting and aggregate monetary targeting, interest rate targeting approach, aggregate money targeting, and, recently, inflation targeting. Inflation targeting monetary policy frameworks uses interest rate as the main policy instrument (Brownbridge et al., 2017).

The relationship between financial inclusion and monetary policy takes place via the interest rate channel (Gali, López-Salido & Vallés, 2004). Interest rate affects future and recent aggregate demand decisions of households, thereby affecting policy that seeks to influence aggregate demand and, therefore, inflation. Economic theory predicts a negative relationship between interest rate and aggregate demand. However, the strength of this relationship depends mainly on the level of inclusiveness of an economy's financial system. Monetary policy works through the financial market to effect changes in aggregate demand, and therefore, inflation. As a result, financial inclusion as an effort that seeks to ensure that the most significant number of adults in an economy have access to and can effectively use financial services should improve the effectiveness of interest rate as an intermediate monetary policy target.

When it comes to the effectiveness of monetary policy in achieving macroeconomic objectives in developing countries, questions arise in that monetary policy has not been able to effectively put these countries on track in terms of inflation targeting and minimization of output volatility (Okwori & Abu, 2017). The central banks in the West Africa Region have been adopting a long-run target for inflation combined with a free float. This has not yielded the needed results as actual inflation in most countries is well above the inflation targets (Okwori & Abu, 2017). One reason that can be postulated for the poor performance of monetary policy in developing countries is the poor level of development of the financial markets in these countries.

While empirical literature is dominated with studies of the impact of financial inclusion on poverty, income inequality, and economic growth, empirical studies investigating the impact of financial inclusion on the effectiveness of interest rate channels of monetary policy transmission is very few with virtually no analysis, to the best knowledge of this study, focusing on West Africa. In this regard, the present study intends to investigate the impact of financial inclusion on the interest rate channel of monetary policy transmission for 15 West African countries between 2005 and 2020. The choice of West Africa is motivated by the fact that countries in the region share common economic and social-cultural characteristics. More so, most of the countries in the region initiated and implemented a financial inclusion plan or strategy for each of their countries almost at the same time (right after the Maya Declaration for promotion of financial inclusion in the year 2011), it is thus essential to evaluate these financial inclusion efforts. The choice of this time interval is informed by the fact that data on financial inclusion variable only existed for years from 2005 and 2020 was the most recent year for which the data were available at the time of carrying out this

study. On the other hand, West Africa's choice would help suggest policies relevant to the regional economic community.

2.   Literature review

2.1 Conceptual review

Monetary policy refers to how policy authorities vary the quantity, cost, availability, and direction of money and credit in an economy to achieve the macroeconomic objective of price stability, economic growth, and reduction in unemployment, among others. Monetary policy is based on the monetary theory that change in money supply is the primary driver of changes in economic activities. It is based on the premise that if a nation's supply of money increases, economic activities should also increase and vice versa (Friedman, 1969). The process of transmission of monetary policy comes in two stages. The first involves the transmission of changes in monetary policy through the financial system. The second stage of the transmission mechanism propagates monetary policy shocks from the financial system to the real economy (Kyari, 2015). The design of monetary policy is a series of activities that run from policy goal/ultimate target to determining the values for intermediate targets that will generate the policy goal than to set the day-to-day operating targets/instruments that the monetary policy can directly change give the intermediate targets. On the other hand, monetary policy implementation runs from setting the instrument/operating target, which authority can directly change, to achieving the targets for the intermediate target, which will eventually generate the ultimate target of inflation and economic growth.

The ultimate targets of monetary policy are the macroeconomic indicators that the monetary authorities seek to change. The ultimate target includes inflation rate, economic growth, deviation of unemployment from natural rate, exchange rate depreciation, and external balance. The choice of ultimate target often depends on the level of development of a country. While most developed countries have shown keen interest in reducing inflation volatility, most developing economies, on the other hand, give priority to increasing their national output. The monetary authority sets an explicit inflation target for inflation-targeting countries and uses various instruments to achieve this goal. In these countries, once the ultimate target of price stability is achieved, monetary policy is deemed effective (CBN, 2017).

Monetary policy has operating targets. They are economic variables vital to monetary policy outcomes but are not directly under the central bank's control. Variables used for monetary policy operating targets include interest rate, monetary aggregate, and exchange rate (CBN, 2017). The operating target sits in the middle of monetary policy implementation. They determine the achievability or otherwise of the ultimate targets, and their use depends on how effective they can stabilize the ultimate goal.

Financial inclusion refers to efforts to bring previously excluded people from the financial system into the family of the formal financial service user as a strategy to reach monetary policy and improve individual household welfare. Financial Inclusion Insights, FII (2017) defined financial inclusion as having an account with an institution that provides a full suite of financial services and comes under government regulation. These services include savings, money transfers, insurance or investment, pension, and remittances. Chibba (2009) conceives financial inclusion as an economic intervention strategy aimed at overcoming the market challenges that hinder the poor and the less privileged from having access to financial services. Financial inclusion efforts focused on the poor excluded from the financial system due to the high cost of accessing formal financial services. In this way, World Bank (2008) shows that within the non-users of financial services, there are different groups; first, there is a group of households and enterprises that are considered un-bankable by commercial, financial institutions and markets because they do not have enough income or present a high risk. Second, there might be discrimination against certain population groups based on social, religious, or ethnic grounds. Third, the legal, contractual, and informational framework might prevent

financial institutions from reaching out to particular population groups because the outreach is too costly to be commercially viable. Finally, the price of financial services may be too high, or the product features might not be appropriate for certain population groups. All these groups together are the focus of financial inclusion policies and strategies.

Interestingly, there are four dimensions to financial inclusion: access, usage, quality, and welfare. Financial access refers to all financial inclusion efforts to increase account ownership in a formal financial institution. Financial access is considered by World Bank (2008) as the gateway to other financial services. On the other hand, usage deals with the use of services provided by financial institutions. Financial usage is ensured when the most significant number of the bankable population use the product and services offered by financial institutions. Banks must provide services needed by financial services consumers most appealingly and at the least cost to facilitate usage. The experience of the consumers' measures the quality dimension demonstrated in attitudes and opinions regarding those products offered by financial service providers (Hannig & Jansen, 2010). The fourth dimension refers to how financial inclusion can improve the welfare of individuals and households. Financially included households can smoothen their consumption over time by adjusting their rate of capital accumulation as income and output fluctuate, thereby insuring them against financial shocks and improving their welfare against the financially excluded households.

2.2 Review of literature

The quantity theory of money can be considered a fundamental pillar in analyzing monetary policy theories. The quantity theory of money implies that money growth and inflation are proportionally linked in the long run. On these grounds, monetarists have argued that central banks need to steer monetary trends to achieve inflation control. Over the years, financial economists have employed different frameworks for the conduct of monetary policy. One such framework is aggregate money targeting. Under monetary targeting, the central bank moves its instruments (for instance, interest rates) to control monetary aggregates, which are considered the main determinants of inflation in the long run. Friedman (1969) argued that monetary policy should be limited to the financial rule where money is made to grow at a constant rate (Dombusch, Fisher & Starz, 2011). Critics of monetary aggregate targeting criticized the framework because accurate control of the money stock is not feasible.

Interest rate targeting framework is a procedure that targets a given level of interest rate with which the central bank seeks to influence short-term interest rate. Under this framework, a nominal interest rate stabilises inflation and economic growth since the real interest rate equals the nominal interest rate plus inflation. By increasing petty interests by more than increasing inflation, actual interest rates rise, thereby cooling off the economy in periods of high inflation (Dornbusch, Fisher & Starz, 2011). Therefore, the use of this framework involves the central bank setting interest rate at some predetermined actual margin above the inflation rate. The framework assumes that other interest rates move in tandem with the interest target. The interest rate targeting rule is regarded as simple, easy to understand and monitor by the public; it has been criticized because interest rates must rise excessively above the inflation level for inflation to be cured; it discourages investment and therefore negatively impact economic growth.

However, the theoretical prediction of the relationship between financial inclusion and monetary policy is still at its early stages. According to the neo-Keynesian postulates, monetary policy transmission is a function of private expenditure being interest elastic. Changes in interest rates would cause a change in aggregate demand, output, and inflation. In the most standard neo-Keynesian analysis of monetary policy, it is assumed that individual households have access to financial services such that consumption and savings are dependent on income and interest rates. Once this interest rate channel is broken, the effectiveness of monetary policy at controlling inflation becomes debatable (Brownbridge et al., 2017). In this way, Gali, López-Salido and Vallés, (2004) build a model that tends to study the optimality and determinacy of

Taylor's rule as a framework for monetary policy in cases where some members of the society do not have access to financial services, these set of people are named "rule-of-thumb" consumers, who neither save nor borrow but instead consume their labour income. Such consumers were shown to influence the economy under different monetary policy rules. A significant result from Gali, López-Salido and Vallés (2004) is that the range of parameter values for which a Taylor-type rule yields dynamic stability and uniqueness depends critically on the share of households with access to financial markets. Suppose the policy rule responds to contemporary values of output and inflation. In that case, a more significant response to inflation is required to generate a unique solution. The smaller is the portion of financially included households.

The point from that study is that the Taylor principle is not a good guide for policy under the condition of strong financial exclusion. The model argues that if the central bank responds to current inflation using a simple Taylor rule when the share of 'rule-of-thumb' agents is low enough, the Taylor principle is strengthened, and monetary policy is effective. On the other hand, response to inflation needs to be higher than in the benchmark model where financial inclusion is low (i. e. rule of thumb agents is high).

2.3 Review of empirical literature

A handful of studies have examined the empirical relationship of the impact of financial inclusion on the interest rate channel of monetary policy, among which are Mbutor and Uba (2013) presented a simple model of the effects of financial inclusion on monetary policy in Nigeria between 1980 and 2012, using time series econometrics with VAR technique. The study used inflation as a measure of monetary policy in Nigeria and employed financial inclusion indicators such as the number of commercial bank branches, total loans, and advances of commercial banks as a percentage of GDP and aggregate loans and advances of rural banks. At the same time, money supply, interest rate, and exchange rate were the control variables. The result of the study supported the notion that growing financial inclusion would improve the effectiveness of monetary policy as the indicators of financial inclusion employed (except the number of commercial bank branches) yield the expected results. However, the coefficient of the number of bank branches has the wrong sign, and reason for this was justified from the motive for bank location, bank location whereby most time are for the objective of profit maximization with little or no consideration for financial inclusion. The coefficients of control variables, commercial banks' lending rate and exchange rate, have the right signs. The study concluded that financial inclusion is a veritable strategy for improving the effectiveness of monetary policy in Nigeria and recommend that the Central Bank of Nigeria increase its vigor for pursuing financial inclusion as it helps with economic growth as espoused in literature also improves monetary policy in Nigeria. While, theoretically, the growth rate of the money supply causes inflation, the study used broad money supply as a control variable.

Lenka and Bariwa (2016) researched the impact of financial inclusion on the monetary policy of South Asian Association for Regional Cooperation (SAARC) countries from 2004–2013. The study uses principal component analysis (PCA) to construct a Financial Inclusion Index that considers geographical, demographic, and banking penetration. Inflation was used as the monetary policy objective, while exchange rate and interest rate were the control variables. The study estimated three models: fixed effect, random effect, and panel-corrected standard error model (panel-corrected standard error is used to correct for heteroscedasticity and autocorrelation). The generalized least square (GLS) estimation shows that financial inclusion, exchange rate, and interest rate are negatively associated with inflation used as a proxy for monetary policy in SAARC countries. The study, therefore, concluded that financial inclusion helps in price stabilization and control of inflation, which is the monetary policy objective of these countries. The study recommended a hastened effort in promoting financial inclusion in these countries as this will improve the lives of the poor and improve the reach of monetary policy. While acknowledging the robust nature of the study, especially with the computation of index of financial inclusion, the index allows the survey to

examine as a whole and comprehensively the different indicators of financial inclusion, such index, however, prevent us from assessing the individual impact of each of the financial inclusion indicators on monetary policy, therefore, prevent financial inclusion policymaker from knowing which of the indicators is doing well and which ones need urgent review.

Examining the impact of financial inclusion on monetary policy effectiveness in Africa, Evans (2016) employed a Panel Vector Error Correction Model (Panel VECM) approach using annual data spanning between 2005 and 2014 for (15) African countries. The study showed that financial inclusion and monetary policy effectiveness share a long-run relationship. Also, while the survey showed that policy reaction to the positive financial inclusion shock is not significant, policy reaction to the positive money supply shock, on the other hand, is statistically significant and positive in the short run. In contrast, responses are not significantly different from zero in the long run. The interest rate has a positive and statistically significant impact on the level of monetary policy. The study shows that to some degree, financial inclusion, money supply, and interest rate shocks have some role in explaining variations in monetary policy effectiveness. Still, in the long run, more than 45 per cent of variations in policy effectiveness are explained by interest rate shocks. The study establishes and concludes that financial inclusion is not a significant driver of monetary policy effectiveness in Africa. Instead, monetary policy effectiveness is the driver of financial inclusion in Africa. The study, therefore, recommended that financial inclusion in Africa can be enhanced through effective monetary policy.

In a study of the relationship between financial inclusion and monetary policy in Vietnam, Hung (2016) employed the ECM method for data sampled between 2004 and 2015. The study computed a financial inclusion index that captures financial access and usage information. The study results indicate that increasing the financial inclusion index would lower inflation, used as a proxy for monetary policy. In addition, the lending rate of banks was found to be negatively related to inflation in Vietnam. This study also found that the Exchange Rate and Inflation are positively correlated. To analyze the response of inflation to the exogenous variables, the study conducted an impulse response function of inflation to a 1% of Financial Inclusion Index, Exchange Rate, and Interest Rate. The responses of inflation to the Financial Inclusion Index, Exchange Rate, and Interest rate are consistent with theory suggestions, reacting positively to exchange rate and negatively to financial inclusion index and lending interest rate. The empirical analysis of this study finds that the impact of financial inclusion on monetary policy is significant. It indicates that if financial inclusion increases, it may reduce Vietnam's inflation. However, while employing a time series approach, the study used data for 17 years. This data is too tiny for serious-time series econometric analysis.

Brownbridge et al. (2017) examined the impact of financial inclusion on the interest rate channel of the monetary policy transmission mechanism. The study uses a panel vector error correction (PVEC) methodology for data collection between 2001Q1 and 2016Q4 to test the hypothesis that economies with lower levels of financial inclusion have weaker monetary policy transmission mechanisms than economies with higher levels of financial inclusion. The idea was tested using four African countries (Ghana, Mauritius, South Africa, and Uganda) that have adopted inflation-targeting monetary policy frameworks. They were divided into two groups differentiated by their level of financial inclusion, with panel vector auto-regressions (PVARs) on each group estimated to assess the strength of the impulse response of inflation to the monetary policy variable. The results suggest that economies with higher levels of financial inclusion exhibit more robust impulse responses. However, this does not necessarily imply that higher levels of financial inclusion cause more robust monetary transmission mechanisms. The degree of financial inclusion may be correlated with other aspects of development that also affect the monetary transmission mechanism.

El Bourainy, Salah and El Sherif (2021) empirically assess the impact of financial inclusion on the inflation rate in 37 developing countries for a period of 10 years from 2009 to 2018 using a multidimensional Financial Inclusion Index (FII) computed by PCA for three dimensions of financial inclusion; access, usage, and quality of financial services. Generalized Method of Moments (GMM) was

used to assess the impact of financial inclusion on the inflation rate. The study established that an increased level of financial inclusion decreases the inflation rate in developing countries. It was also found that interest rate and official reserves significantly positively impact inflation. Therefore, their study concludes that financial inclusion has a significant impact on the inflation rate in developing countries.

Akanbi et al. (2020) investigated the impact of financial inclusion on the effectiveness of monetary policy in West Africa from 2005 to 2018. The study employed the Granger panel non-causality test developed by Dumitrescu and Hurlin (2012) to determine the direction of causality between inflation (a proxy for monetary policy) and financial inclusion indicators. The system GMM was also employed to investigate the impact of each indicator of financial inclusion on monetary policy. The results show that financial inclusion is a significant determinant of monetary policy. The study concludes that financial inclusion should be broadened to include many economic agents in the rural and informal sectors because a large volume of financial transactions occurs.

3. Methodology

3.1 Theoretical framework

The theoretical framework for this study is the inflation-targeting framework. According to this framework, inflation is the ultimate target of monetary policy, and interest rate is a channel of monetary policy transmission stabilizing inflation. Inflation is the primary variable which monetary authorities aimed at changing and stabilizing. On the other hand, the interest rate is one of the channels of transmission monetary policy into the real sector of an economy (others are the exchange rate and monetary growth). Therefore, it is an intermediate variable between the monetary policy instrument and the ultimate target (which, in the current study, is the inflation rate). Thus, the interest rate in this study is not a proxy for inflation.

3.2 Variables of the model

- **Inflation rate (INF):** Inflation rate refers to changes in the general price level. Inflation is the ultimate target of monetary policy. As such, it is the dependent variable in this study. The inflation rate is measured by the change in the consumer price index, and data on inflation is sourced from the World Bank's world development indicators database.

- **Growth of money supply ($\frac{dM2}{M2}$):** Growth of Money supply is expected to have a positive impact on inflation from the quantity theory of money, according to which an increase in monetary growth, without an approximate rise in output growth, will cause inflation to rise and vice versa. Data on money growth is sourced from the World Bank's world development indicators database.

- **Interest rate (INTR):** The interest rate is expected to harm inflation. Credit expansion increases with its attendant rise in aggregate demand and, hence, inflation when interest is lowered. On the other hand, an increase in an interest rate should have an opposite effect through this same channel. Studies like Evans (2016) and Mbutor and Uba (2013) used interest rates as the transmission channel of monetary policy in their studies. They found that interest rate significantly impacts monetary policy proxied by inflation. In this study, the interest rate is the channel of monetary policy transmission on whose financial inclusion is to be tested. Data on interest rate is from World Bank's world development indicators database.

- **Rate of exchange rate depreciation ($\frac{dEXCR}{EXCR}$):** Exchange rate depreciation should have a positive impact on inflation. An exchange rate appreciation means that the international value of a country's currency has increased, which means import prices will fall, leading to domestic prices. On the other hand, depreciate import prices to increase activity with the tendencies to cause domestic prices to rise. All

empirical studies reviewed in chapter two uses exchange rate while this study intends to test the impact of the rate of exchange rate depreciation. The indicators of interest in this study are Automated Teller Machine (ATM) per 100,000 adults, number of bank branches per 100,000 adults, and the number of bank depositors per 10,000 adults.

- **Automated teller machine (ATM) per 100,000:** As a financial service availability indicator, the number of automated teller machines (ATM) Per 10002 km is expected to hurt inflation used here as a proxy for monetary policy target. As more (ATMs) become available, there should be ease of financial transaction, leading to more people entering the financial system and thus coming under the monetary policy rate of the central bank, which in turn should strengthen the effect of monetary policy variables on inflation. Studies like Mbutor and Uba (2013), and Evans (2016) used ATM in their studies and found a significant impact of ATM on inflation; however, their approaches differ from the approach of this study.

- **Commercial banks branches per 10,000 Adults (CBB):** World Bank, World Development Indicators. (2021) defined Commercial bank branches are retail locations of resident commercial banks and other resident banks that function as commercial banks that provide financial services to customers and are physically separated from the main office but not organised as legally separated subsidiaries. It is expected to improve the effectiveness of interest rate channel monetary. Data on CBB is sourced from World Bank's world development indicators database.

- **Number of bank depositor per 10,000 Adults (NBD):** World Bank identified this variable as a measure of financial access, which is expected to impact inflation neg. With more adults depositing with commercial banks, the interest sensitivity of aggregate demand should be strengthened, which should improve the interest rate channel of monetary policy conduct. Data on NBD is sourced from World Bank's world development indicators database.

3.3 The Model

This paper derives the following equations:

$$INF = F (CONT, CONT*FII) \tag{1}$$

Where INF is inflation, which is the ultimate target of monetary policy, FII is the vector of financial inclusion indicators (financial accessibility, financial availability, and financial usage). CONT represents a list of the control variables that theoretically affect inflation, such as interest rate, nominal exchange rate depreciation and money supply growth rate. Assuming only one financial inclusion indicator and one monetary policy intermediate target variable in Equation (1), this will become, after linearizing it:

$$INF = \alpha_0 + \alpha_1 CONT + \alpha_2 (CONT*FII) \tag{2}$$

where α_0 is the intercept and α_1 and α_2 are slope parameters.

The effectiveness of interest rate as a channel of inflation rate control can be determined by taking the partial derivative of Equation (2) concerning the monetary policy intermediate target variable, here, interest rate. Thus:

Assuming Equation (2) is restated as

$$INF = \alpha_0 + \alpha_1 INTR + \alpha_2 (INTR*FII) \tag{3}$$

The partial derivative of Equation (3) concerning INTR is given below,

$$\frac{\partial INF}{\partial CONT} = \alpha_1 + \alpha_2 FII \qquad (4)$$

This shows that the effects of the inflation rate increase with FII. If α_2 is negatives in a situation where α_1 is both expected to be (and is also actually) negative (as in the case of interest rate), then the predicted effect interest rate is being reinforced and, hence, is made more effective by the FII. Also, if α_2 is negative and statistically significant when α_1 that is expected to be negative turns out to be statistically insignificant (whether positive or not), the interpretation would mean that the nil effect of interest rate on inflation rate is converted to the expected negative impact through the reinforcement of the FII. However, if the sign of α_1 is significant and against expectation and that of α_1 too follow suit (whether α_1 is statistically significant), the overall result would be implausible. FII would be interpreted as not strengthening the effectiveness of CONT on the inflation rate. The same conclusion of implausibility will be reached if both α_1 and α_2 is statistically significant but opposite in sign.

It is this econometric approach of interacting FII with the interest rate that makes this study differs from the studies of Mbutor and Uba (2013), Evans (2016), and Hung (2016). Using this approach, we now take each FII in turn below, starting with NBD.

Incorporating these variables into Equation (2) and interacting the financial inclusion indicators with interest rate and adding other monetary policy intermediate variables yields:

$$INF_{it} = \beta_0 + \beta_1 INTR_{it} + \beta_2 \left(\frac{dEXCR}{EXCR}\right)_{it} + \beta_3 \left(\frac{dM2}{M2}\right)_{it} + \beta_4 INTR_{it}*NBD_{it} + \beta_5\, INTR_{it}*ATM_{it} + \beta_6 INTR_{it}*CCB_{it} + U_{it} \qquad (5)$$

Since this study aimed to determine the influence of financial inclusion on the effectiveness of interest rate as a channel of monetary policy transmission, each financial inclusion variable interacts with the interest rate in the equation to know their impact on the effectiveness of interest rate in controlling inflation.

The influence or role of NBD, ATM, and CBB on the effectiveness of monetary policy variable (INTR) is indicated by the sign of the estimated parameters β_4, β_5, and β_6 in Equation 5. If β_4, β_5, or β_6 is negative and statistically significant (in a situation where β_1 is also negative and statistically significant or it is not statistically substantial, whether positive or not) it follows that the financial inclusion variable NBD, ATM, and CBB strengthens the effectiveness of interest rate as an intermediate target on the ultimate objective of INF. In any other case, the NBD, ATM, and CBB would be regarded as not strengthening the effectiveness of interest rate as an intermediate target variable if β_4, β_5, and β_6 are statistically insignificant. Based on the discussion above, it is expected that β_4, β_5, and β_6 or, at least, one of them would be negative and statistically significant (with none being positive and statistically significant) to support the postulated impact of NBD, ATM and CBB on the effectiveness of monetary policy intermediate targets (interest rate) on the inflation rate.

3.4 Estimation technique and diagnostic tests

This study carried out estimation using two approaches – descriptive and inferential approaches. The descriptive approach entails the summary statistics of the variables and a pairwise correlation matrix. In contrast, the second approach is inferential analysis, which involves statistical tools of regression, particularly the dynamic two-step system Generalized Method of Moment (GMM). This approach is used because it can be efficient in case of endogeneity problems and missing values.

This study conducted diagnostic tests to validate the result of regression. Here, the test conducted includes Arellano and Bond (1991) autocorrelation approach for the panel model to test if the successive error terms in the series are correlated. Arellano and Bond autocorrelation approach can detect AR (1) and AR (2) forms. It also remains valid in the presence of lagged endogenous variables among the regressors. The Generalized Method of Moment (GMM) approach to dynamic panel regression uses all available lags as an instrument; this often results in too many mechanisms leading to model overidentification. This may result in incorrect variance and standard error of the regression. The typical approach is to restrict the number of instruments to certain lags of instrumenting variables such that the instrument count is reduced (Windmeijer, 2005). The Sargan Test was equally conducted to test for the possibility of model over-identification. The Sagan test determines the validity of the instruments used in estimation. Under the Null hypothesis that there is no overidentification, a p-value for the Sargan test less than 0.1 means that the overidentification placed on the model is invalid. Therefore, the model is overidentified. If found, this study intends to increase the number of observations to correct for overidentification.

The normality test was also conducted using the Jarque–Bera test to confirm whether the regression estimate's residuals are usually distributed. If the error terms are not normally distributed, any inference made may be incorrect and may also violate the Central Lim Theorem. If the distribution has a probability value that exceeds 0.05, it implies that the error terms from the regression model are normally distributed.

4.   Discussion of findings

This section presents an analysis and discusses the results of the data. The presentation and discussion are carried out in correlation analysis and dynamic two-step Generalized Method of moments regression. Table 1 below presents the pairwise correlation matrix to show t relationships among the variables used in the models.

Table 1. Pairwise Correlation Analysis

Variable	INF	$\dfrac{dM2}{M2}$	INTR	$\dfrac{dEXCR}{EXCR}$	NBD	ATM	CBB
INF	1						
$\dfrac{dM2}{M2}$	0.39 (0.000)	1					
INTR	0.64 (0.000)	0.24 (0.009)	1				
$\dfrac{dEXCR}{EXCR}$	0.065 (0.37)	-0.008 (0.914)	-0.0111 (0.88)	1			
NBD	-0.05n (0.57)	-0.191 (0.02)	0.185 (0.02)	0.057 (0.49)	1		
ATM	-0.14 (0.088)	-0.237 (0.005)	0.119 (0.16)	0.029 (0.74)	0.658 (0.000)	1	
CBB	0.002 (0.98)	-0.173 (0.019)	0.416 (0.000)	0.022 (0.763)	0.646 (0.000)	0.697 (0.000)	1

Explanatory note and author's computation, 2021: INF is inflation rate which is the dependent variable, INTR, $\frac{dEXCR}{EXCR}$, and $\frac{dM2}{M2}$ are interest rate, exchange rate depreciation, and growth rate of money supply respectively, which are the control variables while CBB, NBD, and ATM are commercial bank's branches, number of depositors, and Number of Automated Teller Machine respectively which are the financial inclusion indicators of interest.

The second column of Table 1 shows that inflation (INF) has a correlation coefficient that is positive and statistically significant with each of INTR and $\frac{dM2}{M2}$; a correlation coefficient that is negative and statistically significant with ATM and statistically insignificant correlation coefficient with $\frac{dEXCR}{EXCR}$ NBD, and CBB. This means that INF is positively correlated with INTR and $\frac{dM2}{M2}$; negatively correlated with ATM and uncorrelated with $\frac{dEXCR}{EXCR}$ NBD, and CBB in the study. Therefore, the positive or direct correlation relationship between inflation (INF) and each of interest rate (INTR) and growth rate of money ($\frac{dM2}{M2}$) means that these variables move in the same direction such that an increase or decrease i illation is associated with an increase or decrease in each of interest rate (INTR), and growth rate of money ($\frac{dM2}{M2}$). In the third column, variables statistic varies correlation with INTR; a statistically significant negative correlation with ATM, NBD, and CBB, and a statistically insignificant correlation with $\frac{dEXCR}{EXCR}$. This means that $\frac{dM2}{M2}$ is positively correlated with INTR, negatively correlated with ATM, NBD, and CBB, and uncorrelated with $\frac{dEXCR}{EXCR}$. The positive or direct correlation relationship between $\frac{dM2}{M2}$ and interest rate (INTR) indicates that these variables are related in a way that an increase or decrease in $\frac{dM2}{M2}$ is associated with an increase or decrease in each interest rate (INTR). The negative correlation between $\frac{dM2}{M2}$ and each of ATM, NBD, and CBB is implicative of the fact than $\frac{dM2}{M2}$ is associated with a decrease in each of ATM, NBD, and CBB. The result of the correlation of INTR with other variables of the study is shown in the fourth column. In this column, INTR has a statistically significant positive correlation with NBD and CBB and a statistically insignificant correlation with $\frac{dEXCR}{EXCR}$ and ATM. Therefore, INTR is positively correlated with NBD and CBB, and uncorrelated with $\frac{dEXCR}{EXCR}$ and ATM in the study. Therefore, an increase in INTR is associated with an increase in NBD and CBB. The fourth column shows the results of the correlation of $\frac{dEXCR}{EXCR}$ with other variables of the study. In the third column, it is shown that $\frac{dEXCR}{EXCR}$ has a statistically insignificant correlation with ATM, NBD, and CBB in the study. This means that $\frac{dEXCR}{EXCR}$ is uncorrelated with ATM, NBD. Moving rightward to the fifth column NBD is seen to have a statistically significant positive correlation with ATM and CBB. Therefore, $\frac{dM2}{M2}$ is positively correlated with ATM and CBB in the study. The correlation relationship of ATM is examined in the sixth column of Table 1. The result shows that ATM has a significantly positive with CBB. Therefore, ATM is positively correlated with CBB in the study.

Based on the result of pairwise correlation, none of the coefficients of correlation is up to 0.70, as such, we can conclude that there is no strong interdependence among variables that can lead to multicollinearity in the model.

4.1 Dynamic GMM regression result

This sub-section presents the regression results and interpretation from the estimation of dynamic system GMM regression to examine the effect of financial inclusion on monetary policy effects on the ultimate inflation rate in West Africa. In the model, inflation is the dependent variable. In contrast, goal interest rate, rate of exchange rate depreciation, growth of money supply, and the interactions of financial inclusion indicators with these three policy variables are the regressors. The result is presented in Table 2 below.

Table 2. System Dynamic GMM Results.

Variable	Coefficient	Std Error	Z - Statistic	P-Value
INTR	-0.551	0.091	-6.03	0.000
$\frac{dM2}{M2}$	0.214	0.102	2.53	0.007
$\frac{dEXCR}{EXCR}$	-0.001	0.001	-0.91	0.363
INTR*ATM	-0.004	0.002	-1.73	0.083
INTR*NBD	-6.92	0.002	-0.03	0.975
INTR*CBB	-0.015	0.007	-2.03	0.042
No of Observations	128			

Explanatory note and author's computation, 2021: INF is inflation rate, which is the dependent variable, INTR, $\frac{dEXCR}{EXCR}$ and $\frac{dM2}{M2}$ are interest rate, exchange rate depreciation and growth rate of money supply, respectively, are the control variables. CBB, Depositors and ATM are commercial bank's branches, number of depositors and Number of Automated Teller Machine respectively, which are the financial inclusion indicators of interest.

Based on the result presented in Table 2, the following are the performance of the individual explanatory variables; Interest rate (INTR)has a negative and significant impact on inflation. In Table 2, INTR has a coefficient value of -0.551 and a p-value of 0.000 less than 0.1 significance level. This means that a percentage point increase in interest rate will cause inflation to reduce by 0.551 percentage points and vice versa. This negative impact of interest rate on inflation is explained by the fact that when interest rate falls, households tend to hold more money rather than invest in an interest-bearing asset, this increases the demand for money given a fixed money supply, for equality in the money market, prices increase thereby reducing the value of money. Thus, the money market necessitated price increase and, thus, inflation. This result is consistent with theory, meets the a priori expectation of this study and is supported by the finding of studies such as Lenka and Bairwa, (2016), Mbutor and Uba (2013), Hung (2016), and Akanbi et al. (2020).

In Table 2 above, the coefficient of Money Growth ($\frac{dM2}{M2}$) is 0.214 with a p-value of 0.007. This means that the growth of money. A positive and significant impact on the inflation rate and, a point increase in ($\frac{dM2}{M2}$) will cause inflation to increase by 0.214 percentage points. This result is consistent with the theory and a priority expectation. The positive impact of monetary growth on inflation emanates from the fact that when money out supply growth, the money income of households increases, which raises aggregate demand relative to supply, thereby causing inflation and vice versa. This finding is supported by Mbutor and Uba (2013), and Akanbi et al. (2020), each of whom also found money growth to be a determinant of inflation in their studies.

In Table 2, the coefficient of the interaction of Automated Teller Machine (ATM) with INTR is negative and significant. With the coefficient value of -0.004 and p-value of 0.083 being less than 0.1 significance level, it, therefore, means that a unit increase in the ATM will improve the effectiveness of interest rate INTR in controlling inflation by 0.004 percentage points and vice versa. This is so because, with the increase in ATM availability, monetary policy implemented through the intermediate target of interest rate tends to reach more economic agents who structure the consumption and investment decisions in line with dictates the policy being implemented. This result is in line with the a priori expectation of this study and is supported by Akanbi et al. (2020).

The result of the GMM, as presented in Table 2, shows that the number of Bank's Depositors (NBD) has an insignificant influence on the effectiveness of the interest rate channel of monetary transmission. The coefficient of NBD is -6.92 with a p-value of 0.975, with the p-value being more significant than 0.1 significance level; NBD does not have a substant influence on the effectiveness of the interest rate channel

of monetary policy transmission. Commercial Bank's Branches (CBB) is shown in Table 2 to significant the effectiveness of the interest rate channel of monetary policy transmission. With a coefficient of -0.148 and a p-value of 0.042, a unit increase in the number of bank branches per 10,000 adults will improve the effectiveness of the interest rate channel of monetary policy transmission in controlling inflation by 0.042 percentage points and vice versa. This result is in line with the a priori expectation of this study and is supported by findings of studies such as Mbutor and Uba (2013), Evans (2016), and Akanbi et al. (2020).

4.2 Diagnostic tests

Concerning the overall performance of the regression model, the tests carried out in this study include the Wald Chi-squared test of overall model significance, Arellano and Bond autocorrelation AR(1) and AR(2) tests, and Sargan test of over-identifying restrictions The result of these three tests as presented in Table 3 below.

Table 3. Diagnostic Tests

Test	Z - statistic	P-value
Wald χ^2	795.48	0.000
Ho: Overall model not Statistically significant		
Sargan Test:		
Ho: Overidentifying Restrictions are valid	10.514	0.971
Arellano and bond:		
Ho: No autocorrelation	-2.275	0.023
AR(1)	-0.525	0.409
AR (2)		

Wald Chi-squared value for the model is 795.48, with p-values of 0.000. Since the p-value is less than 0.1, this study rejects the null hypothesis that the overall model is not statistically significant. This simply implies that the model is statistically significant and correct. The result presented in Table 3 also shows that it fits the data's first-order serial correlation in the model with a p-value of AR (1) being less than 0.1 significance level. However, as shown in the table, this serial correlation dissipates in the second order. Therefore, since there is no second-order serial correlation in the models. The null hypothesis of no autocorrelation is not rejected; this is evident from the p-value of the AR (2) test which is greater than 0.1 significance level. This implies that there is no autocorrelation among the residuals of the models. The Sargan test results presented for the models in Table 2 show a chi-squared value of 10.57 with p-values of 0.971. This indicates a non-rejection of the null hypothesis that over-identifying restrictions are valid. This implies that the restrictions on the model instrument in order not to be over-identified are reasonable.

5.   **Conclusion**

Flowing from the result of the Generalized Method of Moments, interest rate and money growth both have a significant impact on inflation used as a proxy of monetary policy in West Africa, this implies that interest rate and money growth exact considerable influence on inflation in the region, it is therefore recommended that monetary authorities in the region should undertake careful management of the rate at which money grows and the rate of interest rate volatilities in a bid to achieve price stability in the region. Similarly, Number Automated Teller Machine and Number of Bank Branches were shown to improve the effectiveness of the interest rate channel of monetary policy transmission. At the same time, the Number of Depositors does not affect the effectiveness of interest rate at stabilizing inflation in West Africa. What this means is that, while ATM and NBB improve the effectiveness of the interest rate as a channel of conducting

monetary policy and are, therefore, variables to consider when conducting monetary policy using interest rate channel, NDB on the other hand do not influence the interest rate channel of monetary policy.

The finding of this study shows that financial inclusion is at the center of monetary policy transmission therefore, it is recommended that monetary authorities should improve and hasten financial inclusion efforts in West Africa, as doing so will improve the effectiveness of monetary policy conducted using interest rate as the operating target variable in the West Africa sub-region. This can be done by implementing a policy that set a minimum benchmark of the number of automated teller machine by law, that a commercial bank is required to install and keep in full operation depending on the type of license used in its operation. The monetary authority can equally develop a scheme where informal financial service providers can be incorporated into the formal financial system as it has been shown that a huge volume of financial transactions is done in the informal sector in West Africa. In general, this study calls for a renewed commitment to financial inclusion plans and strategies that will incorporate informal financial service providers, microfinance, and mobile money in West Africa as doing this will improve financial inclusion and strengthen the effectiveness of monetary policy in West Africa.

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Conflicts of interest statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with anyone or any previous study.

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This research was singly authored by Dauda Ridwan Olamilekan. All sections of the work (from conceptualization to review and editing) can be attributed to him alone.