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Original Research

MACRO-DETERMINANTS OF FORMAL AGRICULTURAL CREDIT SUPPLY IN TANZANIA

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ABSTRACT
This study investigates the macroeconomic determinants of formal agricultural credit supply in Tanzania, a nation where agriculture is a critical pillar of the economy. Using monthly data from 2006 to 2018 from the Bank of Tanzania, National Bureau of Statistics, and the World Bank, the research applies a Markov Regime Switching (MS) model to analyze non-linear dynamics in credit supply across distinct economic regimes. The findings show that interest rates, exchange rates, government spending, and foreign direct investment positively influence agricultural credit supply, while the volume of credit supplied in the previous year and the government effectiveness index have negative effects. The analysis identifies two economic regimes-high-growth and low-growth periods-characterized by different levels of volatility, highlighting the cyclical and non-linear behavior of macroeconomic factors in shaping credit supply. The study recommends incentives like tax breaks, subsidies, and investment guarantees to promote agricultural investment. Policymakers are encouraged to design longer-term loans aligned with the sector's production cycles and to reduce bureaucratic inefficiencies hindering credit disbursement. Financial institutions, guided by the Bank of Tanzania, should develop tailored loan products that address the specific needs of the agricultural sector.

Keywords: Agricultural credit, Markov Regime switching Model, Macro-determinants, Non-linear dynamics, Tanzania.

INTRODUCTION
Agriculture remains one of the most important sectors in the global economy, particularly in developing countries, where it plays a crucial role in promoting sustainable development and ensuring food security (Ndung'u & Signé 2020; Torero 2020). The industrial revolution has further amplified the importance of the agricultural sector, as the demand for agricultural products continues to grow in international markets (Ndung'u & Signé 2020). According to the World Bank (2021), agriculture plays a crucial role in developing countries by contributing significantly to economic growth, employment, and poverty reduction. Agricultural growth has been found to be more effective in reducing poverty in Sub-Saharan Africa (SSA) than growth in non-agricultural sectors (AGRA 2021).

Despite the growth experienced by the agricultural sector in recent years, it continues to underperform, with lower productivity compared to other global regions *(Bjornlund, H., Zuo, A., Wheeler, S. A., & Parry, K., 2022; Wineman, A., Jayne, T. S., & Isinika, A. C., 2020)*. This underperformance is due to various challenges, including limited access to formal agricultural credit, poor infrastructure, inadequate technology, and poor marketing and distribution systems (Jayne *et al.,* 2019).

Access to formal agricultural credit is a significant challenge for smallholder farmers in developing countries, particularly in SSA. Formal agricultural credit refers to credit provided by financial institutions and other formal sources, such as agricultural development banks and microfinance institutions. These institutions provide credit to farmers and other stakeholders in the agricultural value chain to finance agricultural activities, such as production, processing, and marketing (Chileshe 2019). However, smallholder farmers in developing countries often lack the necessary collateral, credit history, and other requirements to secure formal agricultural credit. This lack of access to formal credit limits their ability to invest in their farms, purchase inputs, and increase productivity, ultimately impeding the growth and development of the agricultural sector (Agbodji & Johnson, 2021).

Globally, Asia dominates with the largest share of agricultural credit globally at 49%, while Africa is trailing behind all the regions with least share of agricultural credit at 3% as depicted in the Fig. 3.1 below. This sharp disparity creates a multiplier effect on the growth of the sector in the SSA region. The low share of agricultural credit means that many farmers and agribusinesses struggle to access the finance they need to invest in their operations and improve productivity. This can result in low yields, limited access to markets, and reduced incomes for small-scale farmers. The lack of investment in the agricultural sector also means that there are limited employment opportunities, lower economic growth, and food insecurity in the region (FAO, 2020).

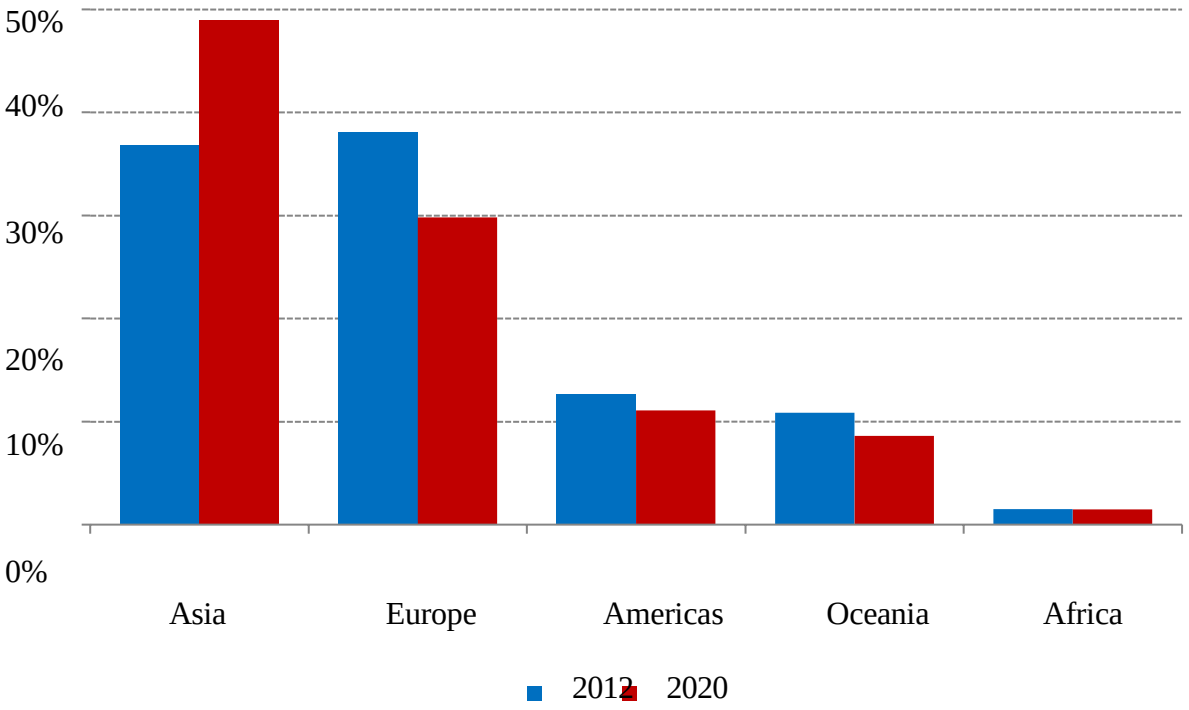

Figure 3.1: Regional Shares of Credit to Agriculture in Global Total
Source: FAOSTAT: Credit to agriculture.

Tanzania is one of the countries where supply and access to formal agricultural credit pose as a significant challenge. Agriculture is the backbone of Tanzania's economy, accounting for over a quarter of the GDP and employing more than half of the population (BOT, 2021a). However, smallholder farmers in the country face numerous challenges in accessing formal agricultural credit, including lack of collateral, high-interest rates, and stringent loan requirements (Chileshe, 2019). Additionally, the sector continues to suffer from underinvestment by both the public and private sectors, with limited allocations of bank credit and other forms of investment (BoT 2022b; FAO, 2022).

PROBLEM STATEMENT

Understanding the macro-economic determinants of formal agricultural credit supply in Tanzania is crucial for informing policy interventions that can address the challenges of accessing formal agricultural credit and promote the growth and development of the agricultural sector(C. Masenya *et al.,* 2018).

The macro-determinants of formal agricultural credit supply include macroeconomic policies such as interest rates, exchange rates, public spending, taxation, and foreign direct investment (FDI) (Abuka *et al.,* 2019; Kilindo 2021). Furthermore, addressing the challenges of accessing formal agricultural credit by smallholder farmers requires the provision of guarantees to financial institutions to reduce the risk associated with lending to them (Balana *et al.,* 2020). Additionally, identifying policy interventions that can stimulate the supply of formal agricultural credit can inform policies aimed at promoting agricultural credit to stimulate the growth of the sector.

Therefore, this study aims to examine the macro-determinants of formal agricultural credit supply in Tanzania, with a particular focus on the policies and other macroeconomic factors that influence credit supply. The study will contribute to the literature on agricultural finance in Tanzania, providing insights into the factors that affect the supply of credit and, ultimately, inform policy interventions to address the challenges of accessing formal agricultural credit.

The proposed study's significance is two-fold. First, the study's findings will contribute to the existing literature on agricultural finance in Tanzania. There is a limited body of literature on agricultural finance in Tanzania, particularly on the macro-determinants of formal agricultural credit supply. Therefore, this study will add to the body of knowledge on agricultural finance in Tanzania by providing insights into the factors that influence formal agricultural credit supply at the macro level.

Second, the study's significance lies in its potential to inform policy interventions aimed at addressing the challenges of accessing formal agricultural credit and promoting the growth and development of the agricultural sector. Access to formal agricultural credit is critical to smallholder farmers, who often lack the collateral required to access credit from formal financial institutions. Limited access to formal agricultural credit has been identified as a significant challenge to agricultural growth in developing countries, including Tanzania.

Therefore, the study's findings will inform policy interventions aimed at addressing the challenges of accessing formal agricultural credit and promoting the growth and development of the agricultural sector in Tanzania. By providing insights into the macro-determinants of formal agricultural credit supply, the study will inform policy interventions aimed at improving access to formal agricultural credit. The study's findings will inform policy interventions aimed at addressing the challenges of accessing formal agricultural credit by smallholder farmers, such as the provision of guarantees to financial institutions, reducing interest rates on agricultural loans, and improving collateral requirements. The study's findings will also inform policies aimed at promoting the growth and development of the agricultural sector in Tanzania, such as increasing public spending on the sector, improving market access for smallholder farmers, and promoting agricultural diversification.

The study's expected outcomes include a better understanding of the macro-determinants of formal agricultural credit supply in Tanzania and their impact on smallholder farmers' access to credit. The study's findings will also provide insights into the challenges facing smallholder farmers in accessing formal agricultural credit and recommend policy interventions aimed at addressing these challenges.

LITERATURE REVIEW

Agriculture is a key sector in many developing countries, providing employment opportunities for millions of people and playing a vital role in promoting economic growth and food security. However, the sector is often constrained by limited access to credit, which is essential for modernizing and improving productivity(Seven & Tumen, 2020). In recent years, there has been growing interest in understanding the macro-determinants of agricultural credit, with several

empirical studies examining the factors that affect credit supply in developing countries (Javed *et al.,* 2020).

One of the most widely studied macro-determinants of agricultural credit is interest rates. High interest rates have been found to discourage borrowing and reduce the supply of credit in many developing countries (Amha & Peck 2019; Kamau 2013; Maloba & Alhassan 2019; Mwonge & Naho 2021). Inflation is another important macroeconomic factor that affects agricultural credit supply, with high inflation rates reducing the purchasing power of borrowers and making it more difficult for lenders to assess creditworthiness (Adams, 2021; Memon *et al.,* 2022; Oluwaseyi & Oluwaseyi, 2023; Walde, 2022).

Exchange rates have also been found to affect agricultural credit supply in many developing countries. A study by Mwang'onda *et al.* (2018)found that fluctuations in exchange rates significantly influenced the availability of agricultural credit in Tanzania. Similarly, Adongo *et al.* (2020); Efanga *et al.* (2020) found that exchange rates were a significant determinant of formal agricultural credit supply in Kenya and Nigeria respectively. This suggests that exchange rate stability and currency management are important factors for ensuring a stable and reliable supply of agricultural credit. Lyimo and Hussein (2022) conducted a study in Tanzania to evaluate the impact of macroeconomic variables on the performance of banks. The research design applied was correlation analysis on time-series data collected from 2009 to 2022. The study found that there was an insignificant relationship between exchange rates and interest rates and the performance of commercial banks.

Government spending and policies are also important determinants of agricultural credit supply. In many developing countries, governments play a key role in promoting access to credit through targeted policies and programs. For example, the government of Tanzania established the Tanzania Agricultural Development Bank (TADB) in 2015 to provide affordable credit to smallholder farmers. In Ethiopia, the government has implemented various policies aimed at promoting agricultural credit supply (BoT, 2022a). However, the effectiveness of these policies depends on the political and economic contexts in which they are implemented, and further research is needed to determine the specific mechanisms through which government policies influence agricultural credit supply.

Other macro-determinants of agricultural credit supply that have been examined in empirical studies include the government spending and government effectiveness. For example, a study by Jambo (2017) found that government spending was a significant determinant of agricultural credit supply in Tanzania.

In conclusion, the empirical literature suggests that the macro-determinants of agricultural credit supply in developing countries are complex and multifaceted, involving a range of factors such as interest rates, inflation, exchange rates, government policies, financial development, and economic growth. Understanding these macro-determinants is essential for designing effective policies and programs that can promote agricultural credit access and contribute to the development of the sector. However, further research is needed to determine the specific mechanisms through which these macro-determinants influence agricultural credit supply and to

develop targeted interventions that can address the unique challenges faced by different countries and regions.

While several studies have assessed the macro-determinants of agricultural credit supply, very few have used advanced econometric models such as the Markov Switching Model (MSM). The MSM is a statistical model that allows for the identification of different regimes or states in a time series dataset, which can be used to analyze the relationship between macroeconomic variables and agricultural credit supply across different regimes.

One of the earliest studies to use the MSM to analyze the macro-determinants of agricultural credit supply was by Fofack and Fofack (2005), who examined the impact of macroeconomic volatility on credit supply to the agricultural sector in sub-Saharan Africa. The study found that macroeconomic volatility, particularly inflation, had a significant negative impact on credit supply to the agricultural sector, highlighting the importance of macroeconomic stability in promoting agricultural credit supply.

Fiaz *et al.* (2022) utilized monthly data spanning from 1981 to 2020 and applied the Markov Regime Switching (MS) model to analyze the data. Before proceeding with the analysis, the study conducted the BDS and CUSUM square tests to detect any non-linearity in the model. As the model was found to be non-linear, the Markov regime-switching model was utilized for further analysis. The study found that each regime's mean and variance were highly significant, showing a high-growth regime with high volatility and a low-growth regime with low volatility. Additionally, the results indicated that inflation, interest rate, and trade openness had a negative impact on development in both regimes, while real effective exchange rates had a positive effect. Moreover, the negative impact of interest rate, exchange rate, inflation, and trade openness were found to be more pronounced in low-growth regimes. Overall, the use of the MSM to analyze the macro-determinants of agricultural credit supply is still relatively new, with limited studies available in the literature. However, the studies reviewed above highlight the potential of the MSM to provide insights into the non-linear relationship between macroeconomic variables and agricultural credit supply across different regimes.

In conclusion, the empirical review of the macro-determinants of agricultural credit supply has revealed a limited number of studies on this area, indicating the need for further research. The varying macro-determinants of agricultural lending across different study areas suggest that available evidence cannot be inferred to other contexts. Therefore, it is essential to conduct further studies that are specific to our context. Additionally, the issue of abrupt policy changes and macroeconomic time series exhibiting regime shifts that make them behave differently during expansionary and contractionary periods is a methodological concern not adequately accounted for in most of the literature reviewed. This point highlights the potential biasness of the literature's findings and the need for more robust and comprehensive research methodologies in future studies.

Theoretical Review

The concept of lending under the agricultural sector can be underpinned by two key theories, The Real Business-Cycle Theory and Theory of Financial Intermediation.

Real Business-Cycle Theory (RBC)

Real Business-Cycle Theory (RBC) is rooted in assertion Schumpeter (1939) that economic evolution occurs in two separate phases: "prosperity" and "recession." Under one, the urge for entrepreneurship pulls away from one equilibrium position, whereas under the second, it pulls toward a different equilibrium position. The oscillations and cyclical processes in the economy are referred to as the business cycle by Schumpeter. Schumpeter's essential belief was that banks and the banking system were critical institutions to any nation's economic development and advancement, rather than simply being gateways for deposits and loans(Lakomski-Laguerre 2016; Messori 2002). Through a process known as credit creation via bank financing that promotes economic growth and development, Schumpeter demonstrates the financial sector's position as a middleman between those who save and invest (Lakomski-Laguerre, 2016; Ülgen, 2014) Both the lender and the borrower experience profit and loss because of this procedure.

The business cycle theory can be further ascribed by applying Keynesian explanation of the business cycle which maintains that the economy is inherently unstable (Cloete, 1990). The level of economic growth increases and decreases over time, creating a growth path. According to the Keynesian school of thought, business cycles are mainly endogenous and the cyclical fluctuations of macroeconomic variables in an economy are time-lag and multiplier accelerator-relationship generated as part of the economy (Day & Lin, 1991; Mankiw, 1995). Hence, the economy reacts to stimuli due to this presence, resulting in a cyclical fluctuation or shocks in the economy (Praščević, 2008). Keynes argued that the main feature of the business cycles is asymmetry, expansion, and contraction, where the former is long-term and the latter more vicious. This is further explained, when output increases toward a peak, the economy is said to be in a boom or expansion. In contrast, the economy is in recession when output falls to a low point, this period is distinguished by negative growth rates (Hamilton 1989; Rand & Tarp, 2002). Due to the transition period of the macroeconomic variables in the business cycle, it leads to nonlinear behavior that depicts the long-term growth of the economy.

Certain macroeconomic variables, according to Bikker and Hu (2001), typically exhibit a distinct pattern of boom and bust in a business cycle as explained by the asymmetry above. A crisis is said to occur at the peak of an expansion when real GDP growth and domestic demand slow, causing inflation to accelerate (Olaniran *et al.,* 2017). During periods of economic development, firm and sector profits rise, and asset prices rise. The aggregate sectoral demand for credit facilities grows, resulting in increased bank lending and interest income. Banks may underestimate their risk exposures by loosening credit standards and reducing provisions for future losses as the economy's debt grows. Individual, firm, and sector profitability deteriorates as the downturn takes place (Lakomski-Laguerre 2016). As banks' risk exposure grows, it necessitates larger loan provisions and higher levels of capital at a time when capital is more expensive or simply unavailable. Hence, this may cause banks to reduce lending, particularly if they have low capital buffers above the minimum capital requirement, thereby amplifying the effects of the economic downturn and raising lending rates (interest rates). In the context of agricultural credit, the RBC theory and Keynesian explanation of the business cycle have important implications for the macro-determinants of agricultural credit.

Financial Intermediation Theory

The financial intermediation theory explains the determinants of agricultural credit by emphasizing the role of financial intermediaries in reducing information and transaction costs between lenders and borrowers (Gorton & Winton, 2003; Pyle, 1971; Scholtens & Van Wensveen, 2003). Financial intermediaries facilitate the mobilization of funds from the surplus to the deficit side of the economy, enabling credit to flow from savers to borrowers. According to Diamond (1984), financial intermediaries monitor and control the usage of funds by borrowers to ensure appropriate usage through diversification. Furthermore, Stiglitz and Weiss (1981); Fisman and Love (2007); Rajan and Zingales (1996) argue that financial intermediaries reduce information and transaction costs, enabling allocation of funds to the most profitable investment projects and promoting economic growth. In the context of agricultural credit, macroeconomic factors such as interest rates, inflation, and exchange rates affect the amount of credit channeled through financial intermediaries, which has significant implications for the performance of the agricultural sector.

METHODOLOGY

Conceptual Framework

Conceptually, the idea of this study emanates from the understanding that agricultural lending is not exogenous by itself rather it is determined through range of macro-economic policy variables. Interest rates, exchange rates, Foreign Domestic Investment in Agriculture, government spending and governance are viewed as important macroeconomic variables which, apart from the external influence, are also affected by the national policy. The macroeconomic policies moderate the transmission mechanisms which manifest themselves into the level of the agricultural lending. In this paper we focus on the results of the transmission mechanism.

For example, interest rate as one macro-determinants of agricultural lending, represent the cost of capital to the borrower and the expected earning with respect to the lender. In less developed agricultural sectors like Tanzania's, interest rates provided to the sector are high due to the perceived higher levels of risk and uncertainty associated with the sector and limited mitigation strategies. Consequently, lenders in the agricultural sector tend to ration the credit stringently according to commercial criteria. This leads to lending institutions seeking customers offering greater security in the form of collateral and less risk. Low interest rates do not allow institutions sufficient operating margin to accommodate the higher expense associated with lending to small and new borrowers. To overcome this, additional fees are added which raise borrowing costs and restrict the supply of agricultural credit.

Exchange rate is another theoretically hypothesized determinant key determinant of agricultural lending as it determines the relative prices of imports and exports, as well as foreign investment in agriculture. Therefore, exchange rate regimes remain important issues of discourse in agricultural finance and investment especially in developing nations, where majority of the population derive their livelihood from the sector.

The focus of this analysis are the variables that are bolded (interest rate, exchange rate, government effectiveness, FDI in agriculture, public expenditure). Given this theoretical basis with

regards to agricultural lending, the model adopted explores an indeterminate sign and magnitude of the association between agricultural lending and macroeconomic policy variables. The whole idea of the association between agricultural lending and macroeconomic policy variables is clearly illustrated in Fig. 3.2.

CONCEPTUAL FRAMEWORK

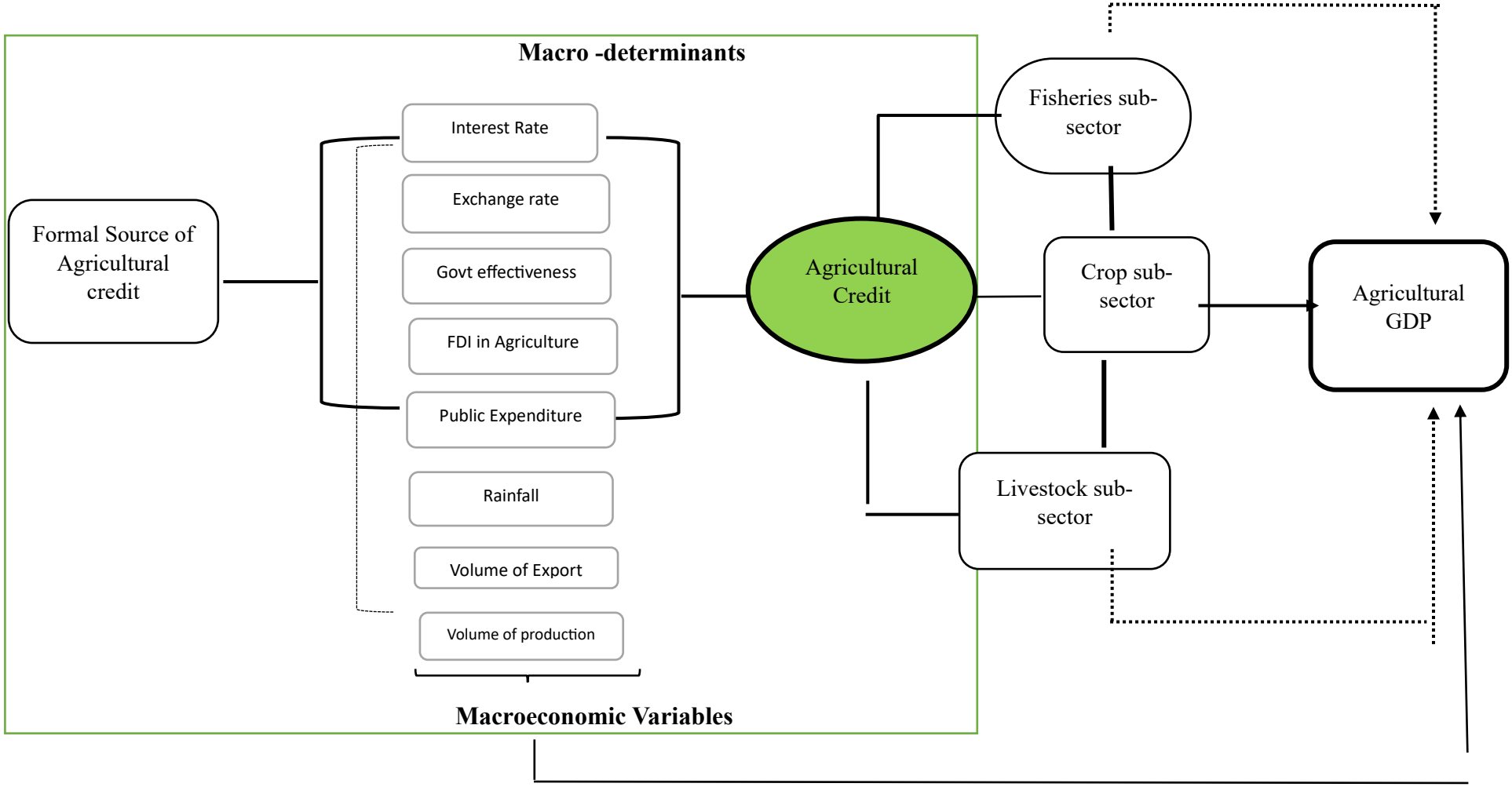

Figure 3.2: Conceptual Framework
Source: Author's Compilation

Study Design

The study used quantitative secondary data from Bank of Tanzania. This study was designed to assess the determinants which affect the supply of agricultural lending.

Empirical Model

To capture the observed asymmetry and non-linearity in the business cycle Regime Switching models are applied. In this study we employ the Markov switching model which is especially appropriate to examine the behaviour of macroeconomic series with non-linearities, asymmetries and regime shifts.

Various time-series models have been employed to investigate the behaviour of agricultural credit and the macro-determinants. Linear models such as Auto Regression model (AR), and OLS models as the common models were employed. Investigating the effect of macro-determinants on agricultural credit in Tanzania, firstly we adopt the following a regression model adopted by to provide some baseline results [1]:

$$VAgrCr_t = \mu_0 + \beta_1 Int - rate_t + \beta_2 inflation - rate_t + \beta_3 Ex.rate_t + \beta_4 FDI - Agric_t + \beta_5 Pub - spending_t + \beta_6 Govt\ Effect + \varepsilon_t \quad (1)$$

Where $VAgrCr_t$ is the volume of agricultural credit supplied at time t, $Int - rate_t$ is the interest rate, $inflation - rate_t$ is the inflation rate, $Ex.rate_t$ is the exchange rate, $FDI - Agric_t$ is the Foreign direct investment towards the agricultural sector, and $Pub - spending_t$ is the public spending on the agricultural sector. While μ_0 and ε_t are the constant and the error term at a time.

Although these linear models in many cases are good fitting, they are not adequate to analyse the non-linear dynamic behaviour of variables due to their ability to detect asymmetry. According to a significant weakness of the linear regression model (1) is that it is based on constant specification where the model parameters are assumed to be constant over time. It ignores the possible structural breaks and regime changes which may impact our results. Agricultural financing, economic growth and other macroeconomic indicators are characterised by unusual jumps or structural changes in their levels or volatility. The presence of important various economic or non-economic events causes significant non-linearity in the stochastic process. When regime shifts are stochastic rather than deterministic, linear model approaches may lead to biased or at least inefficient results.

Markov Switching Model for Agricultural Credit-macro-determinants Relationship

To capture the possible asymmetric responses of agricultural GDP to agricultural credit, we attempt to employ Markov-Switching (MS) model, which is extended by (Bauwens *et al.,* 2006; Hamilton 1989; Hamilton 1990), among many others, and have seen some success in capturing the nonlinearity and regime shifts of the underlying time series, and shown some superiority in analysis. We assume that two regimes (low and high volatility regime) are sufficiently describing

the dynamic interactions between agricultural financing/credit and the macro-economic determinants.

Furthermore, when data are modelled with the Markov switching time series framework, the parameters of the model depend on a stochastic and unobservable state variable that represents the different phases of the economy. These regimes are driven by an unobservable stochastic state variable where some or all the model parameters may take different values concerning the regime prevailing at a given point in time. Our model is extended to test whether the supply of agricultural credit is affected by the macro-economic variables in Tanzania. Several studies have successfully applied the MS models to investigate financial and economic behaviour of the macroeconomic variables (Epaphra & Kazungu 2021; Ihle *et al.,* 2009; Marcelletti & Emmanuel 2015). Following these empirical studies, we consider the MS model, which, with its rich structure, can accommodate the dynamic impacts of macroeconomic variables on agricultural credit supply.

Our estimation follows the original model constructed by where only the intercept switches between regimes. We extend this model by allowing the intercept term, slope coefficient and variance of the error term to be regime dependent as applied by (Awotide *et al.,* 2015). The extension of Eq. (1) is shown as:

$$VAgrCr_t = \mu_{0,S_t} + \beta_{1,S_t} Int - rate_t + \beta_{2,S_t} inflation - rate_t + \beta_{3,S_t} Inter_{t_3} + \beta_{4,S_t 4} Ex.rate_t + \beta_{5,S_t} FDI - Agric_t + \beta_{6,S_t} Pub - spending_t + \beta_{7,S_t} Govt\ Effec + \varepsilon_{t,S_t} \quad (2)$$

With $\varepsilon_t \sim ND(0, \sigma_{S_t}^2)$

While

$$\mu_{S_t} = \mu_0 S_{0t} + \cdots + \mu_k S_{kt} \quad (3)$$

$$\sigma_0^2 S_{0t} + \cdots + \sigma_k^2 S_{kt} \quad (4)$$

Where $S_t = 0,1 \ldots, k$ denotes the unobserved state indicator following a first-order Markov-process, which implies that the current regime depends only on the regime prevailing one period ago. Interpretation of the model depends on the value of k.

Terms μ_{S_t} and $\sigma_{S_t}^2$ are, respectively, the state dependent mean or intercept and variance in agricultural credit. Therefore, our MS model distinguishes between different market states by allowing for different levels of economic condition or situation.

The description of Markov trend dynamics becomes complete after defining a probability rule for the transition between different states. As per the literature, we assume that the unobserved state variable, more precisely S_t, follows two states Markov-process with transition probability matrix given by:

$$P = \begin{bmatrix} P_{00} & P_{01} & P_{k0} \\ P_{10} & P_{11} & P_{k1} \\ \ldots & \ldots & \ldots \\ P_{0k} & P_{1k} & P_{kk} \end{bmatrix} \quad (5)$$

Where $P[S_t = j/S_{t-1} = i] = p_{ij}; i, j = 0,1 \ldots . k$ denotes the probability that the process is in state j at time t given that it had been in state i the previous period, and by the rule of probability; $\sum_{j=1}^{k} p_{ij} = 0$ where $i = 0,1 \ldots, k$ and $0 \leq p_{ij} \leq 1$. The transition probabilities are supposed to be constant over time as in the original Hamilton model.

Besides, the most relevant question when dealing with Markov Switching model is how long, on average, the regime will last. Markov switching model answers this question by considering the expected duration for each regime state under the study. Let D_j denote the duration of state j whereby D_j follows a geometric distribution. The expected duration for regime j is given by:

$$E(D_j) = \frac{1}{1-p_{jj}} \quad (6)$$

Overall, the MS model specified in Equations (2) allows us to gain insight into the determinant of macroeconomic variables on agricultural credit on in Tanzania. The model not only accounts for direct effects of uncertainty of the macroeconomic variables but also provides insight into the transitions between different economic regimes.

Source of Data

The data was sourced from the research department of the Bank of Tanzania which is also responsible for collection of this data and development of quarterly and annual economic reviews. The datasets contain information on different macro-economic indicators of economic performance, general lending and lending by sector, contribution of each sector to the GDP. Some of the data of the variables are collected on monthly basis while some on a quarterly basis. The Central Bank of Tanzania collects data from different formal financial Institutions such as commercial banks, stock markets and development banks. Some of the data (Government Index) was collected from the World Bank.

Data Analysis

To empirically analyze the link between macroeconomic variables and agricultural credit supply, annual data was converted into quarterly to provide enough data for analysis. In the second part data was then converted into natural log and tested for autocorrelation.

Testing for Non-linearity and a Model Selection Strategy

Two critical issues arise from the recent empirical literature regarding the macroeconomic variables and agricultural credit relationship. Firstly, is the relationship between Agricultural credit and macroeconomic variables linear or nonlinear? Second, how does one decide which test should be used? The starting point is to test for the presence of non-linearity in the data.

As stated by Naifar and Al Dohaiman (2013) we should note that the selection of the regime switching process is difficult because the identification of the nonlinearity in MS models cannot be recognised by the regular likelihood ratio, Wald test or Lagrange multiplier tests as since their asymptotic distributions are non-standard. To answer the above two questions, we have used the likelihood ratio test (LR) suggested by which is approximately X_q^2 distributed with q restrictions

plus the nuisance parameters that are not identified under the null hypothesis. Thus, we test the null hypothesis of no regime switching in agricultural credit represented by Equation (1) against an alternative specification Equation (2) which involves regime switching in the agricultural credit. The LR test statistics is defined as $LR = 2\{MS_{Eq.(2)} - Linear\ Reg._{Eq.(1)}\}$ and the critical value is based on the p-values of (Davies 1987).

The next step in the analysis involves determining the required number of regimes and evaluating the quality of the fitted Markov Switching (M.S) model. However, selecting the number of regimes cannot be done using direct and straightforward statistical criteria. Instead, our approach follows the recommendations of several scholars, Baele (2005a); Balcilar *et al.,* (2013); Garcia and Perron (1995) who propose using the likelihood ratio test and Regime Classification Measure (RCM) to identify the appropriate number of regimes. A well-fitting M.S model is one that displays a distinct classification of regimes and has smoothed probabilities. To evaluate the accuracy of the M.S model, we use the regime classification measure (RCM) introduced by (Ang & Bekaert 2002):

The RCM is given for $K > 0$ states by the following:

$$RCM(K) = 100 * \left(1 - \frac{K}{K-1}\frac{1}{T}\sum_{t=1}^{T}\sum_{h=1}^{K}\left\{p_{i,t} - \frac{1}{K}\right\}^2\right) \quad (7)$$

Where $p_{i,t} = Pr[S_t = i \,/\, I_T]$ is the probability of being in regime i at time t. The RCM measure range between 0 (perfect regime classification) and 100 (failure to detect any regime classification).

Once the MS model with a correct specific regimes number is obtained, the last important aspects to consider are the below mentioned criteria: model fit based on the residual diagnostic test, value of the log-likelihood function, values of the estimated coefficients in different regimes and the relationship between the macroeconomic factors and the probability of the regime-switching behaviour. Thus, we make a comparison of the selected models based on these criteria.

RESULTS AND DISCUSSIONS

Testing for Non-linear Relations

Since our study aims to investigate the relationships between macro-economic variables and formal agricultural credit supply in Tanzania in regime-switching conditions, the first step in our empirical analysis is verifying whether agricultural credit of Tanzania display regime-switching properties. For this purpose, we test the null hypothesis of no regime switching against the alternative of a regime-switching MS model.

Table 3.1 below presents the results of the likelihood ratio (LR) test statistics proposed by Garcia and Perron (1996) for testing non-linearity. The results support the alternative hypothesis of Markov Switching model against the null hypothesis of a linear regression model. These findings reject the null hypothesis of no regime shifts for the Tanzania agricultural credit, which means that the nonlinear MS model better explains the behaviour of this sector.

Table 3.1: Likelihood ratio test: Linear versus MS specifications

Country	$Linear\ Reg._{Eq.(1)}$	$MS_{Eq.(2)}$	LR
Tanzania	111.89	165.52	107.26*** (0.000)

The LR test is nonstandard test since there are unidentified parameters under the null. The p-values of Davies (1987) test are given in square brackets. The asterisks ***, ** and * represent significance at the 1%, 5%, and 10% levels, respectively.

Previous studies like Su Dinh and Nguyen (2019) and Rahman *et al.,* (2020b), among others, find similar results for developing countries like Tanzania. From a theoretical point of view, this behaviour is likely to be observed in Tanzania. Structural economic reforms (e.g. trade liberalisation) and political events specifically during election period, changing of presidential regimes and global scale (e.g. 2007-2008 financial crises) may lead to regime shifts in Tanzania. Therefore, a MS model seems to be suitable for analyzing the macroeconomic determinants of agricultural credit supply credit under the effects of regime shifts.

Determining the Number of Regimes

The empirical mechanism for constructing a suitable MS model starts with establishing a possible set of models to consider. We conduct tests for Tanzania to investigate whether a two or a three-state best captures the macro-determinants of agricultural credit. Since nuisance parameters are unidentified under the null hypothesis, the standard asymptotic distribution theory cannot be applied as explained above in our methodology. Hence, we used the likelihood ratio test (LR) proposed by Garcia and Perron (1996) and regime classification measures proposed by Baele (2005b) to choose the number of regimes for each country.

Initially, a three-regime model was employed to assess the effects of macroeconomic determinants on agricultural credit supply in Tanzania. However, the results demonstrated that this specification was not suitable. A two-regime specification was found to capture the dynamic impact of macroeconomic determinants on agricultural credit supply better than the three-regime specification. The two regimes were identified as a low-volatility regime and a high-volatility regime. To account for significant variation in volatilities, regime-dependent variance models were considered for both the macroeconomic variables and agricultural credit series. The estimated results are presented in the tables below.

Volatility Behaviour and Persistence on Tanzania's Agricultural Credit

The standard deviation of each regime, which indicates the magnitude of its volatility, is represented by Sigma. The study reveals two regimes in Tanzania, with regime 0 characterized by a low volatility value and regime 1 characterized by a high volatility value. The former is typically considered a non-crisis period, while the latter is a volatile or crisis period. The results presented in Table 3.2 show that the standard deviations for Tanzania are statistically significant and positive, indicating the existence of these two different regimes. Moreover, regime 1 is almost six times as volatile as regime 0, with an 8.4% volatility estimate for regime 1 compared to a 1.3% volatility

estimate for regime 0. The estimated regime durations in Table 3.2 further show that regime 0 (low volatility) is more persistent, with an average regime duration of 36.97 quarters, compared to regime 1 (high volatility) with an average regime duration of 10.86 quarters.

Table 3.2: **Estimated coefficients of Markov regime-switching time-series model**

Country	State	Sigma	Transition Probabilities		Duration	RCM	LR
Tanzania	S_0	0.013***	0.972	0.027	36.97	7.765	107.26
			0.092	0.907			[0.000]
	S_1	0.084***			10.86		

Notes: LR statistics is test calculated as $2\{MS_{Eq(1)} - Linear_{Eq(2)}\}$
LR test represents the null hypothesis of no regime shift. The p-values of Davies (1987) test are given in parenthesis. The asterisks ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively.

In addition, the magnitude of the probabilities (p_{00} and p_{11}) indicates that regime 0 is more persistent than regime 1 in Tanzania. The probability of being in regime 0 is higher than the probability of being in regime 1, which means that the effects macro-economic determinants on Tanzania's agricultural credit tend to stay longer in regime 0 than regime 1. The results show that spikes in probabilities of regime 1 are highly related to the political events and financial crisis periods. The probability of being in regime 0 is 0.972, while the probability of being in regime 1 is 0.907.

Lastly, the Markov-switching model with two states has the regime classification measures (RCM) of 7.765. The RCM values are in agreement with plots of the smoothed probabilities of being in a low-volatility regime and a high volatility regime indicated in Figure 3.3 which identify the accuracy of each regime for Tanzania.

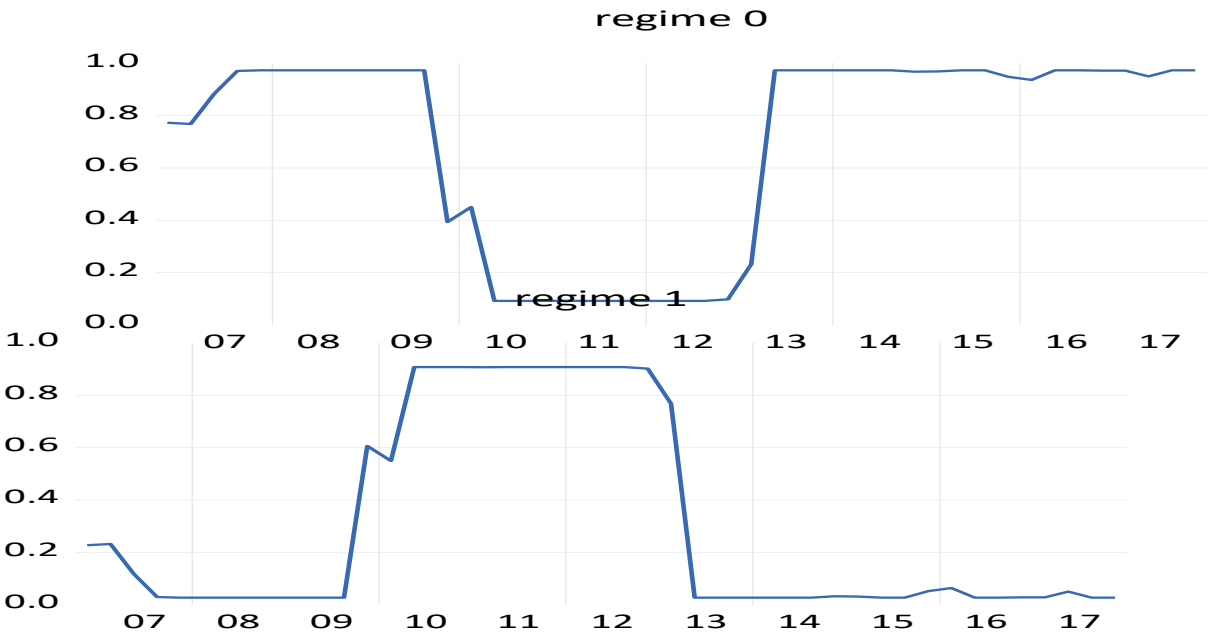

Figure 3.3: The smoothed probability of being in regime 0 and regime 1

Effects of macroeconomic variables on Agricultural Credit Supply

In this section, the effects of macro-determinants of Tanzanian agricultural credit are assessed. Firstly, the linear regression model is estimated, and the results in Table 3.3 can be analyzed as the baseline results capturing the dynamic effect of the macroeconomic determinants factors to the supply of Tanzanian formal agricultural credit in the absence of any regime switching impacts.

Table 3.3: Estimated coefficients of the linear regression time-series model

Variables	Coefficient
$\mu_{i,t}$	-0.014**
	(0.004)
$FDI_{i,t}$	0.098**
	(0.046)
$GINDEX_{i,t}$	-0.013
	(0.012)
$INT_{i,t}$	-0.003
	(0.012)
$SPEN_{i,t}$	-0.055
	(0.044)
$TZS_{i,t}$	0.574**
	(0.310)
$AgrCredit_{i,t-1}$	-0.029**
	(0.125)

The standard errors are reported in parentheses. ***, ** and * denotes coefficients significant at the 1%, 5%, and 10% levels, respectively.

Table 3.4 above captures the dynamic effect of the macroeconomic determinants' factors to the supply of Tanzanian formal agricultural credit in presence of Markov Regime Switching Model.

On the determinants of agricultural credit, the coefficients of the Markov regime time-series model results show the following:

- **FDI:** In the regime "0" it shows to have significant impact on agricultural credit this can be attributed to Government's initiatives in boosting the economy through improving FDI into the country. During the regime "1" the effect of FDI isn't significant as during this regime the economy is doing well so no need of additional efforts to boost it. The government in turn does raise interest to control production and attract deposits.
- **Government Index:** Is measured as the corruption index in the study. During regime "1" effect of corruption index is negative and significant on agricultural credit supply. This leads to reduction of credit supply during high growth because mitigating corruption requires a lot of government resources.
- **Exchange rate:** In both regimes, exchange rate shows a positive and significant impact on agricultural credit supply. An increase in exchange rate as an endogenous growth variable causes an increase in demand of the currency which in turn enhances volume of net exports thus increasing export earnings. The higher the export earning the higher the economic growth. This in line with studies by Fiaz *et al.* (2021); Lyimo and Kimaro (2022); Zoramawa *et al.,* (2020) who found that exchange rate had positive impact on economic growth by affecting the agricultural production through export-led growth. Hence, this positive correlation can lead to a budgetary allocation to towards the agricultural credit increasing the volume of agricultural credit supplied.
- **Corruption Index in Terms of Government Effectiveness:** Corruption index has a negative significant effect on agricultural credit supply because it takes a lot of government resources to allocate the already limited resources to mitigate corruption.
- **Interest Rate:** The positive coefficient of interest rate on agricultural credit lending during economic down-turn (0) suggests that Government can take on initiatives such as Credit Guarantee Schemes to boost the performance of the sector as done in 2009. The establishment of the Credit Guarantee Scheme can be used to explain the positive effect of interest rate on lending as many farmers (borrowers) are unlikely to be less sensitive to the increased interest rate. As a result, the Credit Guarantee Scheme will absorb many of the farmers due to less risk and it will shield the expected negative effect of the interest rate. Simultaneously, in implementing the Credit guarantee Scheme the government also increases the interest rate to balance the effect of the Credit Guarantee Scheme. Alternative explanation, sometimes interest rate decision lies with the Financial Institutions rather than the borrowers despite the conventional view that the supply of credit is a derived demand as consistent with (Maloba & Alhassan 2019). During growth rate regime (1) interest rate has a negative effect on volume of agricultural credit supplied. The higher the interest rate the higher the cost of lending which creates risk of inability for repayment. Formal Institutions

transfer the cost of lending in the form of interest rate to farmers making the loans expensive. This result is consistent with (Deng *et al.,* 2021; Emenuga 2019).

- **Agricultural Credit**: The volume of agricultural lending is negative and significant in the regime (0) which is the poor growth period. The demand for agricultural lending is normally for the long-term use particularly infrastructure development as a result a longer gestation period is required to recoup the funds. This is turn affects the performance of the credit as majority of the financial institutions do not offer longer repayment periods for agricultural loans. Hence, the contribution from repayment doesn't suffice to create a substantial portfolio that decreases the volume of agricultural credit supplied. This in turn also affects the availability of agricultural credit for the upcoming financial year. This negative relationship is similar to various studies (Okezie & Erendu 2016)**.**

CONCLUSION AND RECOMMENDATIONS

Agriculture has been a consistent contributor to Tanzania's GDP over the past two decades, and it is also the largest employer in the country. However, formal financial institutions, such as commercial and development banks, are significantly underinvesting in the agricultural sector in terms of credit disbursal. Despite the government's recent efforts to improve the supply of agricultural credit, macroeconomic variables, including interest rates and exchange rates, also play a crucial role in the availability of formal agricultural credit. The aim of this study was to determine the macro-determinants of agricultural credit supply from formal and development banks using secondary time-series data from 2006-2018. A Markov-Switching Model was used to estimate the time-series data model. The findings revealed that interest rates, foreign direct investment in agriculture, government spending, exchange rates, and government effectiveness index were significant factors in determining credit supply to the agricultural sector. Additionally, interest rates, foreign direct investment in agriculture, and exchange rates had a positive and significant effect on the volume of agricultural credit supplied, while the volume of credit supplied in the previous year had a negative and significant impact on the current year's supply. Based on the findings of this study, the following recommendations are made to improve the supply of formal bank's agricultural credit in Tanzania.

First, the government should enforce a minimum loan allocation requirement to the agricultural sector, and these loans should be more long-term to match the production cycle and needs of the farmers. This will make the loans more attractive to the farmers and increase the derived demand for agricultural credit. Alternatively, the Ministry of Agriculture could collaborate with formal financial institutions by increasing allocation in tailored funded programs targeting agricultural infrastructure projects for farmers operating in the sector.

Second, the positive effect of agricultural FDIs suggests the need for government efforts to incentivize potential investors in the agricultural sector. This will increase the availability of funds for agricultural credit supply, especially during high volatility periods, thus promoting the development of the sector.

Third, banks through the Bank of Tanzania should consider having differ revising the credit supply conditions to reflect the nature and needs of the agricultural sector. Currently, most loan products are characterized by similar conditions (such as interests and repayment plans) between the agriculture and non-agricultural sectors thus affecting the availability of credit to the sector. By introducing tailored loan conditions for the sector, banks can improve the supply of agricultural credit.

Finally, future research can be conducted to re-examine the relationship between macro-determinants and agricultural credit supply, with the inclusion of Microfinance Institutions which form an important component of the agricultural credit supply side. This will provide a clearer picture of the factors affecting the supply of agricultural credit in Tanzania and allow for more effective policy interventions.

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