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Monetary policy transmission channels and the performance of the real sectors in selected sub-Saharan African countries: a system-GMM approach

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Abstract

This study investigated the impact of monetary policy channels on the real sector performance in selected sub-Saharan African countries. This study covers the period 1990 to 2020. The broad objective of the study was to examine the impact of monetary policy transmission channels on the real sectors of selected sub-Saharan African countries within the period, 1990–2020. Using the system generalized method of moments (sys-GMMs) amidst other pre-estimation and post-estimation tests, it was discovered that credit and exchange rate channels positively drove agricultural productivity, while interest rate channel exerted a negatively significant influence. Conversely, credit and exchange rate channels were found to negatively affect manufacturing, while interest rate channels had no significant impact on the manufacturing sector. Given the overwhelming impact of monetary policy channels on both the agricultural and manufacturing sectors of the SSA economies, it is recommended that effective monetary policy framework be put in place to continually create positive transmission effect on the real and productive sectors of the economy.

Keywords Monetary policy, Interest rate channels, Credit channels, Exchange rate channels, Sub-Saharan Africa and system GMM

Introduction

There is considerable controversy about the impact of monetary policy transmission channels on the real sector of the SSA economy. The monetary transmission mechanism by which monetary policy is chaneled into the real sector has been broadly discussed by economists and central bankers in recent years. There is a consensus that monetary policy affects the real sector in the short term. Moreover, there is consensus that monetary policy decisions are passed on to the real sector through various complex mechanisms that may differ, for example, between developed and developing economies. However, the question of whether or not such a relationship has been clarified in the literature has become a matter of controversy. Ganley and Salmon [1] point out that "the transmission mechanism of monetary policy is one of the most important, yet least well-understood, aspects of economic behavior." Additionally, Bernanke and Gertler [2] suggest that the determination of different channels through which monetary policy transmission affects aggregate demand, and prices remains *a black box* due to continuous monetary innovations and financial market integrations. Much of this is based on the experiences of industrialized economies.

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There has also been much interest in whether the transmission of monetary policy has an impact on the real sector in the non-advanced economies. Prior studies of developing economies by Asaleye, Adama and Ogunjobi (2017), Ugwuoke, Ume and Ihedioha (2018), as well as Orji et al. [3] used traditional methods such as (OLS) and correlation techniques, which yielded mixed results. More recently, several academics and institutions have expressed the opinion that monetary policy has a meaningful impact on the real sector. See, for example, [4],Central Bank of Nigeria, 2014,Ezeaku, Ibe, Ugwuanyi, Modebe & Agbaeze, 2018; [3, 5–10],World Bank, 2007; Hendami&Namakalu, 2016; and [11].

In contrast, research by Imoughele & Ismaila [12], Davoodi et al. [13], Mengesha & Holmes [14],Rowbotham, Saville & Mbululu (2014), Kilian (2014), [15],Holburn [16] suggested the impact was significant. This evidence is by no means exhaustive and conclusive.

Because of the importance of monetary policy transmission to real sector as the cornerstone of the general development framework of developing countries by itself and as reference in policy decisions, revisiting such a relationship has continued to attract the attention of many researchers. However, in countries in sub-Saharan Africa, the impact is controversial among researchers. The monetary policy transmittal mechanism (MOM) for the countries in our sample depends on the functioning of the various financial markets. In general, the real sector is likely to be affected by changes in interest rates, asset prices, and exchange rates. Another challenging issue for SSA countries is that institutional and structural features in various economies are different and have been known to change over time. In recent decades, some SSA countries have continued to internationalize financial markets as well as liberalize national financial market liberalization policies. The stock market is becoming better in these economies. The economic success in countries in the SSA region has been remarkable, after lessons learned from the global financial crisis of 2007 through 2009, which led to the collapse of intermediation in most advanced nations. In addition to the financial crisis, the effectiveness of the mechanism for transmitting monetary policy has been challenged for countries with a fixed link between the CFA and the euro. These countries have been severely hit by the global recession following the limited impact of the financial crisis.

Economists and policymakers alike agree on the vital importance of examining the impact of monetary policy and its transmission channels in SSA countries: first, monetary policy has critical distributional effects, which have been mainly overlooked in studies in SSA countries and focus, have overly been placed on the demand side [17], [18]. It is essential for the SSA economies because of its real sectoral implications[1], especially in the agricultural and manufacturing sectors. These sectors, which are the productive sectors of the economy over the years, have had checkered movements and growth (See Fig. 1 and 2)

Second, contractionary monetary policy has a significant impact on the open economy, which has employment implications. High interest rates, weak domestic credit, and a resilient national currency weaken export attractiveness and aggravate the current account [19]. These potential side effects of supply and demand on the channels of monetary policy must be carefully examined.

This main objective of this study is to provide new evidence on the effects of monetary policy channels on the real sector in 39 low-income and developing countries. The evidence presented will add another dimension to this literature and provide a basis for comparison of the results of future studies. Knowledge of the transmission mechanism to the real sector on the part of monetary authorities is a prerequisite for implementing an effective monetary policy aiming at promoting real economic growth and mitigating the inflationary pressures. Without this knowledge, the authorities are unlikely to meet all their goals. For example, Holmes and Mengesha (2013) examined the monetary policy transmission channels in the country of Eritrea and concluded that interest rate and exchange rate channels may be ineffectual or inoperative in the case of a low-income country. Moreover, the expected impact of a trade liberalization policy can be condemned by a non-reactive exchange rate and could precipitate a balance of payment crisis.

There are several value added of this study. The first is the number of countries studied, and sample periods

[1] Within the 2000s Sub-Saharan Africa had sustained rapid economic growth, and this period was a very promising period for Africa's growth. This growth focused on the activities of the real sectors predominated by the informal sector. The global financial crisis in 2008 and a crash in commodity prices changed the outlook within the said period. Evidently, sub-Saharan Africa has the world's lowest total gross domestic product (GDP), and average GDP per capita is just under four thousand dollars, which is one-fifth of the world average. In 2018, eight of the twenty fastest growing economies in the world were found in the region. Despite big GDP gains in countries such as Ethiopia and Ghana, sub-Saharan wealth remains heavily concentrated. Nigeria and South Africa, the region's wealthiest countries, generate almost half of the region's GDP. Nigeria and South Africa, by far the region's richest countries, have very different types of economies. Nigeria's economy has been volatile in recent years due to its dependence on oil, a commodity susceptible to unpredictable prices. Thirty percent of the earth's mineral resource reserves are in sub-Saharan Africa. Many of the region's economies are based on commodity exports, making them beholden to the ups-and-downs of global commodity prices. Sub-Saharan Africa is home to a thriving informal sector, which refers to economic activities that are not monitored or regulated by the government. These include small plot farming, small-scale mining operations, craft making, and other services like housekeeping, giving rides, or fixing cars. Informal economic activity is typically not accounted for in a country's GDP or official employment rate.

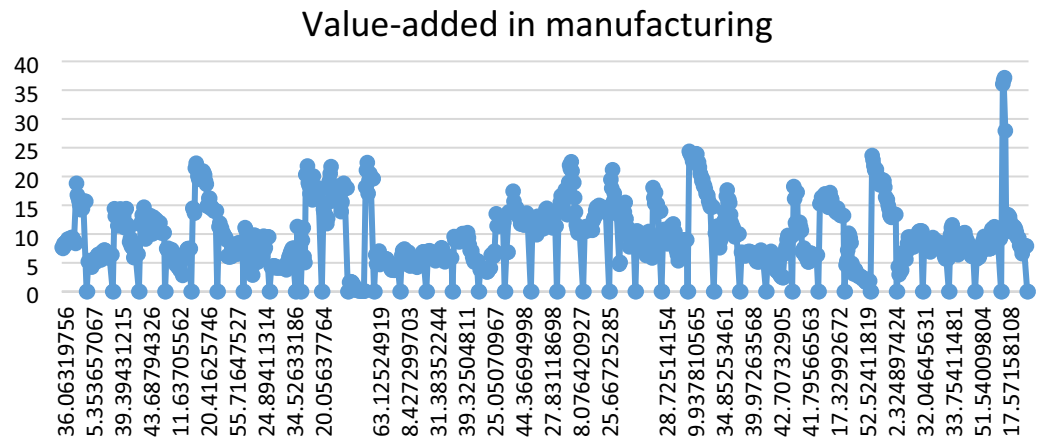

Fig. 1 Manufacturing value added in SSA 2000–2020

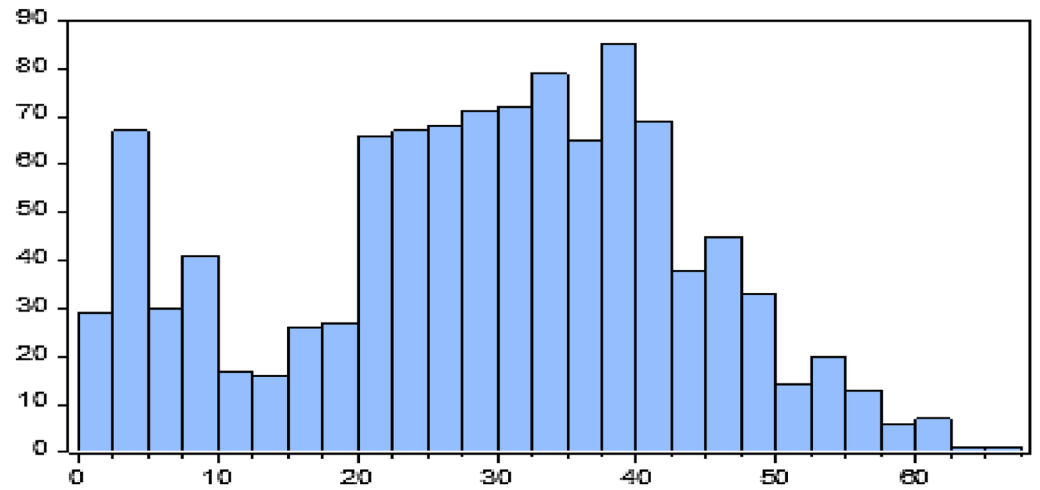

Fig. 2 Agriculture value added 2000–2020

are particularly extensive. Other studies generally only take into consideration a small number of SSA countries. Our sample includes some countries that were never included in earlier studies due to data availability. We study data covering a longer period from 1990–2020 and include the recent period of global economic uncertainty, 2007–2009.

The second is that most of the SSA countries have been undergoing significant financial liberalization during the sample period, and it allows us to see to what degree these have influenced the evidence from our 39 low-income and SSA countries. Monetary policy in the SSA economies has moved toward a more market-oriented and future-oriented setup. Furthermore, monetary policy has been actively used to contain inflation and promote economic growth during the sample period. Therefore, the knowledge of the relative importance of monetary policies could prove useful to policymakers as they continue to struggle with the problems of aggregate demand management. Moreover, experiences during these financial liberalization and lessons acquired will be useful for policymakers to understand the effectiveness of policy measures, hence minimize costly policy mistakes.

The third is that we examine the time series properties of the variables, and we rely on system-GMM, which provide the means through which our estimated models can be evaluated for misspecifications like nonspherical errors. This study uses a long panel of 1990–2020 to maximize estimation efficiency. It adds to the scanty empirical studies for these 39 low-income and SSA countries by employing system-GMM, which addresses the estimation problems of endogeneity, second-order serial correlation, and weak instruments. Most but not all studies ignore these issues, which may result in biased results.

Finally, this study relates to some of the Sustainable Development Goals, particularly SDG 8, which aims to achieve sustainable, inclusive economic growth, full and productive employment for all, as well as SDG 9, which aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation, as well as SDG 3 that aims to ensure a healthy and happy life for all.

The rest of the study is divided as thus: section two contains the literature review, methodology is in section three, the penultimate section presents data and results, while section five concludes.

Literature review

The chief reason for this investigation is a severe disagreement among economists about monetary policy's real impact and size on economic activities and their transmission. On one side of the argument, monetary policy is viewed as futile in inducing the real economy, such as real output and employment [20]. On the other hand, other researchers said that monetary policy could impact real economic activities in the short run [13, 14]. Also, those in the middle of these two proponents consider that the output causes the money supply [21]. Hinged on these arguments, growing the real sector in the SSA has been one of the aims of most of the countries in the region [22]. Still, the sectorial identification of the appropriate monetary policy transmission channels has not been largely explored.

The debate concerning the impact of monetary policy on the real output started with the exposition of the role of money in influencing macroeconomic objectives like economic growth, price stability, equilibrium in the balance of payments, and a host of other objectives [23]. One aspect that has received considerable attention globally is the sectoral effects of monetary policy shocks. Bernanke and Gertler [2] highlighted the sectoral impacts of monetary policy with increased identification of monetary policy transmission channels. The rationale is that if sectors respond differently to the same monetary policy, they must also be differences in the operations of the channels relative to them [1, 24, 25]. Consequently, the traditional methodology employed in such empiric is to identify shocks from monetary policy, measure their effect on different sectors, and characterize the variances to structural features upsetting the transmission channels [26], [27], [22], Blinder (1987,).

Because of the above inconclusive evidence, this paper aims to revisit the issue using alternative estimation procedures. Second, unlike previous studies, this study markedly emphasizes the effects of monetary policy transmission channels on the real sectors following the interest rate or cost of capital, exchange rate or external shocks, and credit channel to explore the real-side effect of monetary policy. It is well-known that shortage of credit, interest rate, or exchange rate instability constitutes a constraint on capacity utilization, investment, and employment in the real sector, therefore, puts it that "credit restriction, which reduce the supply of credit for either investment or working capital are a major channel through which financial policies have real effects." Nevertheless, if this credit supply effect is quantitatively vital, the trade-off between output growth and price stability may not occur. Therefore, this study argues that monetary policy could affect productivity through the cost of borrowing and by influencing the pool of loanable funds in the banking system. There might be two lines of argument to describe the roles of the transmission mechanism of monetary policy. The first is where changes in interest rate have a direct effect on the exchange rate and investment, while the second line is that transmission of monetary policy impulses passes through the banking intermediaries to output and prices [2, 28, 29]. Adrian and Shin [30], and Sukmana and Kassim [31] contended that researchers should pay specific attention to the vital role played by the banking sector as an intermediary in the monetary policy transmission mechanism. This particular attention should be paramount in countries with financial systems centered primarily on banks, which is the focal character of developing countries such as most of the sub-Saharan African financial systems [32]. Therefore, understanding the credit channel of monetary policy transmission to the real sector is imperative. The channel is relevant in sub-Saharan African countries with a bank-dominated financial system [33] [34].

In sub-Saharan African countries, policies that strive for domestic credit restriction to hold up inflation have most times eventually worsened the adverse effects of the persistent bank's credit rationing [34]. The banking system in Africa, and the lack of competition, keep the costs of loans high (Ng'etich & Wanjau, 2011). Furthermore, they provide loans to sectors thought to be safe, particularly the big trading companies. Banks in the region have lower incentives to increase their customer base as they can minimize exposure risk and sustain high profit. As a result of all these factors, credit is eventually supply determined, suggesting that monetary policy regimes that obviously increase the cost of credit will have and worthy of note, adverse effects on the real sector. Likewise, the sub-Saharan African monetary landscape has transformed severely during the past three decades, from fiscal deficit money-financing of the 80s to stabilize [33]. The stabilization is a de jure money-targeting regime, comprehensive reform programs in the 1990s, and, more lately, efforts to streamline policy frameworks.

The 1990s saw several severe changes in the monetary policy scheme and conduct [35, 36]. Additionally, in the past two decades, monetary policy regimes have gradually converged in Africa **to** inflation control as the dominant economic policy objective (Honohan& O'Connell, 2008, [34, 37],Kasekende & Brownbridge, 2011). In effect, some SSA countries have at present properly progressed to complete inflation targeting (Ghana and South Africa), whereas two others (Uganda and Mauritius) have approved informal inflation targeting or inflation "lite" [38], [19].

Moreover, as the world tends toward a global community, there is a more critical requirement for closer economic performance convergence among trading partners. Therefore, many developing countries have implemented more flexible exchange rate regimes, creating greater monetary policy possibilities. Prominent sub-Saharan African countries adopting more flexible regimes than fixed exchange rate regimes include South Africa, Ghana, and Mauritius [33]. Although the exchange rate regimes in sub-Saharan African countries vary greatly, this situation has evolved. Research on exchange rate regimes proposes no single appropriate rule for a nation, and it depends on the macroeconomic problems facing the country and its specific conditions (Ghosh, Ostry & Tsangarides, 2010). In turn, the exchange rate regime has an impact on the economy. However, it is in combination with other macroeconomic policy actions, likewise the depth and strength of institutions. These changes have triggered a considerable debate on how monetary policy transmission can affect the real economy.

Likewise, most empirical research has not gotten hold of an unambiguous conclusion on how monetary policy, in extension, monetary policy transmission channels affect the economy, particularly in less developed (LDC) and low-income countries. While there are many channels of monetary policy transmissions, the credit channel appears to command approval in developed countries [39–41]. Nevertheless, for low-income and developing countries, the empirical results are mixed and with inconsistencies [14, 42–44],Abradu-otoo et al., 2013, [13], [45], [46].

Finally, examining the impact of monetary policy and its transmission channels in SSA countries is vital for several reasons: first, monetary policy has critical distributional effects, which have been mainly overlooked in studies in SSA countries and focus has overly been placed on the demand side [17, 18]. Secondly, contractionary monetary policy has a significant open economy impact, which has consequences for employment. High interest rates, low domestic credit, and a resilient national currency weaken export attractiveness and worsen the current account [19]. It is essential for the SSA economies because of its real sector implications, especially in the agricultural and manufacturing sectors. These potential supply and demand side effects on monetary policy channels require careful examination.

The study covers **39 selected sub-Saharan African countries from** 1990 to 2020. Our sample period is when most countries in the region saw significant changes in the design and conduct of monetary policy. The choice of countries hinges on the relative central bank's independence (Agobaa, arbor, Osei, & SA-Aadu, 2017) and data availability in those countries. The chosen countries are Angola, Benin, Botswana, Burundi, Burkina Faso, Cape Verde, Cameroon, Central African Republic, Chad, Comoros, Congo DR, Cote d'Ivoire, Democratic Republic of Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, and Zambia. The variables of interest in this study are the agricultural sector's contribution to the gross domestic product, the manufacturing sector's contribution to the gross domestic product, the credit to the private sector, the nominal interest rate, and the nominal exchange rate.

In addition, prior studies in this area have mainly focused on developing countries while neglecting developing countries like SSA. Therefore, this study is essential in ensuring that economic forces and factors in developing countries are making conclusions about monetary policy channels and real sector linkage. The contribution of this paper is that it seeks to acquaint the governments of the SSA countries with the need to understand the sectorial implications of monetary policy instability and how monetary policy transmission channels could enhance macroeconomic performance. It will help the government understand the different costs of monetary policy channels such as the exchange rate, interest rate, and Credit, and processes in acting as incentives for growth in SSA countries. Monetary policy is a key driver of government intentions and directions as they relate to any economy. Having an understanding of the interactive effect of monetary policy with the real sectors is of great policy significance.

This study contributes to the literature and may serve as reference material for future researchers at different levels in the area of monetary policy transmission channels and real sector performance in developing nations, particularly, sub-Saharan Africa. Interestingly, this study adds depth to the ongoing debate on the effectiveness of monetary policy transmission channels. The results are connotative of an expansion in documented empirical evidence on monetary policy transmission for use by different economic agents.

Table 1 Summary of key underpinning theories. *Source* Authors' Compilation

Variable of interest	Role	Underpinning theories
Interest Channel of Monetary Policy Transmission	Explanatory variable	Keynes Quantity Theory of Money, Liquidity Preference theory of Interest Rate, and Friedman's Modern Quantity Theory of Money
Credit Channel of Monetary Policy Transmission	Explanatory variable	Loanable Funds theory and Theory of Financial Intermediation.
Exchange Rate Channel of Monetary Policy Transmission	Explanatory variable	Mint Theory of Exchange Rate and Purchasing Power Parity Theory.
Agricultural Sector Productivity	Outcome variable	Kuznet Economic Structure and Growth Theories
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Monetary policy effectiveness appears to have a beneficial impact on society. It is important to note that with effective monetary policy, comes an improvement in the citizens' price level, living standard, and wellness through improved economic indicators. This study will enlighten the citizens of SSA countries and guide them in advocating for the enhancement of the monetary policy framework of their respective countries for the imperatives of better economic and social well-being. In addition, it will improve their appreciation of not just the economic governance of their countries but also the tools and techniques that are deployed along this line and how effective or otherwise these tools can be.

There have been some key studies and documented findings on the interaction between monetary policy channels and the growth of the real sectors in different climes and at different times. A summary of some key empirical findings is shown in Table 1:

Numerous theoretical arguments have been established and empirical analyses carried out, yet there still appears to be no complete explanation to the questions of the role of credit, interest rate, and exchange rate in this regard. However, theory leaves out the magnitude of the change—quantitative measures such as elasticities of demand and supply. Empirically, these things have been examined, but it appears that there is little or no agreement on the best way to quantify credit, interest rate, and exchange rate influence on the real sectors—agriculture and manufacturing. One of the major problems is not whether or not monetary policy transmission channel plays a role in output growth, but just how significant are these roles. Most of the literatures that treated monetary policy transmission channel and sectoral performance were country-specific studies, while others that are cross country were outside sub-Saharan Africa. The most common methodology used by the literatures reviewed were OLS, VAR, ARDL and VECM. In contrast, this study used the system generalized method of moment (SYS-GMM).

Based on some characteristics inherent in SYS-GMM, such as its ability to take care of endogeneity problems through lagged explanatory variables as instruments, allowing the use of both the level equations and lagged values, it minimizes information loss related to cross-sectional regression and could produce an efficient estimate of the parameters with short time period and larger cross sections (observations). It is seen as the most appropriate panel regression estimation technique when compared to the traditional fixed-random effect and the differences GMM [47]. The estimation method has proved to be more efficient in relations to traditional GMM methods [48, 49]. It also controls cross-sectional dependence, and the two-step approach could take care of heteroscedasticity [50]. The use of OLS, VAR, ARDL, and VECM is not enough to adequately expose the empirical relationship between monetary policy transmission channels and agricultural and manufacturing output growth.

Also, through the review of both the theoretical and empirical literatures on the monetary policy transmission channels, it is clear that, it has been studied extensively in both developed and developing countries. Although there is no general agreement on the operation of the different channels, no clear picture appeared on the channel that is most effective in low-income countries like those of sub-Saharan Africa. While there are many channels of monetary policy transmission mechanism, the credit channel appears to command approval in most developed countries of the world [39–41]. Nevertheless, for the low-income and developing countries, the empirical results are mixed and inconclusive (Disyatat & Vongsinsirikul , 2003, [14, 42, 44],Abradu-otoo et al., 2013; [13], [45], [46]. Considering the presence of relative central banks' independence in some sub-Saharan African countries (Agobaa, arbor, Osei, & SA-Aadu, 2017), it is important to understand the channel that is most relevant to the agricultural and manufacturing output. Therefore, another gap that this study fills is the identification of the most appropriate channel(s) of monetary policy in SSA countries.

Table 3 Summary of model variables description

Variable	Description	Measure	Designation	Source
ACGDP	Agricultural Sector Contribution to GDP	Annual%	Dependent Variable	African Development Bank, African Highway Information, 2019
MCGDP	Manufacturing Sector Contribution to GDP	Annual%	Dependent Variable	African Development Bank, African Highway Information, 2019
CPS	Credit to the Private Sector percentage of GDP	Annual%	Independent Variable	World Bank, World Development Indicators, 2019
INTR	Nominal Interest Rate	Annual %	Independent Variable	World Bank, World Development Indicators, 2019
TOPN	Trade openness measured by Export + Import as a percentage of GDP	Annual %	Control Variable	World Bank, World Development Indicators, 2019
INV	Total investment as a percentage of GDP	Annual %	Control Variable	International Monetary Fund, World Economic Outlook, 2019
INF	The inflation rate as measured by the Consumer Price Index	Annual %	Control Variable	World Bank, World Development Indicators, 2019

Authors' Compilation

Methodology

Theoretical framework

This study is theoretically underlined by a blend of theories on monetary policy transmission and theories of economic growth and productivity. While the dependent variables (real sector productivity) are underpinned by growth theories, the independent variables are underpinned by theories on monetary policy transmission. The table below clearly aligns the variables under study to the relevant underlying theories.

Summarily, the theoretical framework for this study is webbed around the growth theories on one hand and the theories around the monetary policy transmission channels. While the growth theories show the outcome of monetary policy transmission, the transmission channel theories accentuate the routes through which these outcomes are enhanced through various monetary policy actions and postulations.

Data

The dataset for this study were extracted from the World Bank, *world development indicators*, International Monetary Fund *World Economic Outlook,* and African development bank *African information highway* for each country. This covers 39 SSA countries over the period 1990 to 2020. Table 3 presents the description of key variables and sources of data. The data were analyzed using generalized method of moments (GMMs) considering the possible presence of endogeneity.

Model specification

The estimation framework for this study follows two models as specified below:

$$\begin{aligned} lnACGDP_{i,t} = {} & \beta_0 + \beta_1 lnACGDP_{i,t-1} \\ & + \beta_2 lnCPS_{i,t} + \beta_3 lnINV_{i,t} \\ & + \beta_4 lnINF_{i,t} + \beta_5 lnINTR_{i,t} \\ & + \beta_6 lnEXR + e\pi_i + \rho_t + \mu_{it} \end{aligned} \quad (1)$$

$$\begin{aligned} lnMCGDP_{i,t} = {} & \partial_0 + \partial_1 lnMCGDP_{i,t-1} \\ & + \partial_2 lnCPS_{i,t} + \partial_3 lnEXR_{i,t} \\ & + \partial_4 lnINV_{i,t} + \partial_5 lnINF_{i,t} \\ & + \partial_6 lnINTR_{i,t} + \pi_i + \rho_t + \varepsilon_{it} \end{aligned} \quad (2)$$

where $ACGDP$ = agricultural sector contribution to gross domestic product, $MCGDP$ = manufacturing sector contribution to GDP, CPS = credit to the private sector, INV = investment (% of GDP), INF = inflation rate, $INTR$ = Interest rate, EXR_t is the exchange rate, and ε = error term. π_i is unobserved country-specific effect, ρ_t is the time-specific effect and μ_{it}&ε_{it} is the idiosyncratic error term, while i represents the country dimension, and t is the time dimension. $B_1 - \beta_6$ and $\partial_1 - \partial_6$ are the coefficients, and β_0 and ∂_0 are the intercept.

This study adopted dynamic system GMM as a technique for the analysis. System generalized method of moment (SGMM) technique is attributed to Arellano and Bover [51], and Blundell and Bond [52] and aims to overcome the weak instrument problem of the difference generalized method of moment (DIFF-GMM) by applying differences and level equations. According to 53, 54, the efficiency of the estimated equation improves when the moment conditions of the differences and level form are combined.

The lagged differences were used as the instruments for the level equations' endogenous variables restricting the coefficients in the difference equations and level as equal. The instruments used in our model for the difference equation are the lagged levels of the variables, while the instrument for the level equation is the lagged

first differences of the variables. The additional momentary condition assumed that the predetermined variables and country-specific fixed effects might be correlated in the equation, and the country-specific fixed effects and the lagged differences are not correlated. Based on some characteristics inherent in SYS-GMM, such as its ability to take care of endogeneity problems through lagged explanatory variables as instruments, allowing the use of both the level equations and lagged values, minimizes information loss related to cross-sectional regression and could produce an efficient estimate of the parameters with short time period and larger cross sections (observation). It is seen as the most appropriate panel regression estimation technique when compared to the traditional fixed-random effect and the differences GMM [47]. 53, 54 improved Arellano and Bover [51] dynamic panel GMM estimation technique was adopted. This estimation method has proved to be more efficient relative to traditional GMM methods [48], [49]. It also controls for cross-sectional dependence, and the two-step approach could take care of heteroscedasticity (Sarafidis, Yamagata &Robertson, 2009).

Panel stationarity tests used in the study include I'm, Pesaran and Shin (IPS) test (2003), Levin-Lin-Chu test (2002), Breitung's Test (2000), Levin and Lin (LL) test (1992), and the Fisher test. This study employed the Fisher test that does not need a balanced panel for a robust result. It adopted the use of different lag lengths in the ADF regressions. Also. unit root test p-values for each cross-sectional unit obtained by Monte Carlo simulations were adopted and could be observed as a major disadvantage of the test (Maddala&Wu (1999), Choi, 2001, Hlouskova& Wagner, 2006). To see that the SYS-GMM gives a valid estimate, the study tested for the validity of the overidentified condition using the Hansen test for validity and overidentification restriction as it is considered more appropriate in SYS-GMM [55]. Relevant tests for heteroscedasticity and autocorrelation were also carried out.

Results and discussion

Table 4 presents the descriptive statistics of all the variables in logarithmic form. In the selected sub-Saharan African countries, the descriptive statistics indicate that the agricultural contribution to GDP (*lnACGDP*) within the period averaged about 1.349% and a coefficient of variation (CV) of about 3.666%, which could be seen as volatile. The average value of the manufacturing sector contribution to GDP is about 0.925% with a CV of 3.201%. The first measure of the channel of monetary policy transmissions—domestic credit to the private sector percentage of GDP (*lnCPS*) shows a mean of 1.066% and a CV of 2.719%. The second measure of the channel of monetary policy transmissions–nominal interest rate (*lnINTR*), has a mean of 1.108% and a CV of 3.463%. On average, the third measure of the channel of monetary policy transmissions—deposit money bank assets to GDP (*lnEXR*) reveals a mean of about 2.195% and a CV of 1.783%. The relative averages of the control variables were also reported.

Table 4 Descriptive statistics of the selected sub-Saharan African countries. *Source*: Author's Computation

Variables[2]	Mean	SD	CV	Min	Max
LnACGDP	1.349	0.368	3.666	0.040	1.788
LnMCGDP	0.925	0.289	3.201	−0.959	1.381
LnCPS	1.066	0.392	2.719	−0.180	2.181
LnINTR	1.108	0.320	3.463	0.653	2.314
LnEXR	2.195	1.231	1.783	−6.733	4.864
LnTOPN	1.795	0.188	9.548	1.025	2.468
LnINV	1.074	0.282	3.809	0.100	2.047
LnINF	0.807	0.591	1.365	−1.000	3.943

[2] lnACGDP = log of agricultural sector contribution to GDP, lnMCGDP = log of manufacturing sector contribution to GDP, lnCPS = log of domestic Credit to the private sector as a percentage of gross domestic product, lnINTR = log of nominal interest rate, lnEXR = log of exchange rate, lnTOPN = log of trade openness, lnINF = log of inflation rate, lnGOVGDP = log of government consumption as a percentage of GDP, lnPOP = log of total population, SD = standard deviation and CV = coefficient of Variation

Table 5 presents the correlation matrix for the selected variables. The correlation matrix shows a mixed relationship between the dependent and independent variables. There is a negative relationship between the log of agricultural sector contribution to gross domestic product (*lnACGDP*) with the log of domestic credit to the private sector percentage of gross domestic product (*lnCPS*), the log of interest rate (*lnINTR*), the log of trade openness (*lnTOPN*), the log of investment (*lnINV*), and the log of inflation (*lnINF*), while the log of agricultural sector contribution to gross domestic product (*lnACGDP*) has a positive relationship with the log of an exchange rate (*lnEXR*). On the other hand, there is a positive relationship between the log of manufacturing sector contribution to gross domestic product (*lnMCGDP*) with the log of domestic credit to the private sector percentage of gross domestic product (*lnCPS*).

However, the manufacturing sector contribution to gross domestic product (*lnMCGDP*) has a negative correlation with the log of interest rate (*lnINTR*), the log of an exchange rate (*lnEXR*), the log of trade openness (*lnTOPN*) and the log of inflation (*lnINF*). The correlation matrix in further shows that all variables are not strongly correlated given that they all have correlation coefficients of less than 90 percent. This erases every suspicion of multicollinearity.

Table 5 Correlation matrix for selected sub-Saharan countries. *Source*: Author's Computation

	LnACGDP	LnMCGDP	LnCPS	LnINTR	LnEXR	LnTOPN	LnINV	LnINF
LnACGDP	1							
LnMCGDP	0.035	1						
LnCPS	−0.463	0.345	1					
LnINTR	−0.014	−0.048	−0.197	1				
LnEXR	0.326	−0.056	−0.087	−0.344	1			
LnINV	−0.327	−0.237	0.217	−0.050	−0.122	0.490	1	
LnINF	−0.010	−0.067	−0.289	0.710	−0.452	−0.037	−0.101	1

Table 6 Fisher Type Panel Unit Root Test at 5% significance level. *Source*: Author's Computation

Variable	ADF Inverse Chi-Square Test Statistic			Decision	Order of integration at 5% level
	No Drift and Trend	Drift	Trend		
LnACGDP	75.784	164.602***	106.200***	RejectH_0	*I*(0)
LnMCGDP	109.161***	159.259***	138.294***	RejectH_0	*I*(0)
LnCPS	61.673	145.765***	194.959***	RejectH_0	*I*(0)
LnINTR	487.738***	289.461***	376.377***	RejectH_0	*I*(0)
LnEXR	434.320***	352.804***	271.406***	RejectH_0	*I*(0)
LnTOPN	49.280	149.075***	62.337	RejectH_0	*I*(0)
LnINV	124.667***	198.563***	127.036***	RejectH_0	*I*(0)
LnINF	159.457***	237.784***	240.202***	RejectH_0	*I*(0)

***, **, and * are 1%, 5%, and 10% significance level, respectively

Table 6 presents the unit root test. This study adopted the panel Fisher test under finite cross-sectional assumption. Unlike the other panel unit root tests, the Fisher ADF test makes use of unbalanced panel data for a robust result. The Fisher ADF test also implements different lag lengths for each panel in the ADF regressions. It adopts the Monte Carlo method to derive its p-values [56],Choi, 2001).

The panel ADF result in Table 6 reveals that the variables for our study are stationary at levels at the 5 percent level of significance. The stationarity results support the use of the panel system generalized method of moments (SGMMs) for estimation of models.

Next, we present Table 7 showing the impact of the credit channel (Credit to the private sector), interest rate channel and exchange rate channel on agricultural sector contribution to gross domestic product in sub–Saharan Africa. The table shows SGMM result.

Table 7 reveals that the coefficient of the constant term *C* is 32.44, and it is significant at the 0.05 level of significance. It shows that all things being equal, when there is nothing else influencing the agricultural sector contribution to GDP, it increases with time. This means that when all the influencing variables are held at zero, the regress and still rises with time at a significant rate of 32.44%. The coefficient of the lagged value of the agricultural sector contribution to GDP (*L1.ACGDP*) is 0.9433 and significant at the 5% level of significance. It means that the past agricultural output influences the contemporaneous output. The natural log of credit to the private sector, a measure of the credit channel of the monetary policy transmission (*lnCPS*) is 0.219 with a probability value (P-value) of 0.018, meaning that a percentage increase in Credit to the private sector through monetary policy, increases agricultural value added by 0.219 percent in sub-Saharan Africa. This conforms to the *'a priori'* expectation implying that Credit is a veritable tool for the monetary policy transmission in sub-Saharan Africa.

Also, the natural log of interest rate, a measure of the interest rate channel of the monetary policy transmission (*lnINTR*) is -0.1230 with a probability value (P-value) of 0.000, which implies that a percentage increase in interest rate through monetary policy, decreases agricultural value added by 0.123 percent in sub-Saharan Africa. This conforms to the *"a priori"* expectation, implying that high interest rate due to monetary policy changes discourages agricultural output in sub-Saharan Africa.

Table 7 SGMM regression result for model one

Dependent variable: *lnACGDP*				
Method: System generalized method of moment				
Variable	**Coefficient**	**Std. Error**	**t-statistcs**	**Prob.**
C	32.4365	14.2948	2.27	0.030
L1.lnACGDP	0.9433	0.0463	20.35	0.000
LnCPS	0.2194	0.0881	2.49	0.018
LnTOPN	−0.0708	0.1769	−0.40	0.692
LnEXR	0.0141	0.0033	4.21	0.000
LnINTR	−0.1230	0.0157	7.82	0.000
LnINV	−0.0973	0.0776	−1.25	0.219
LnINF	−0.0368	0.0243	−1.52	0.139
	F-stat (8,32) = 68.84		Prob (F-stat)=0.000	
	Hansen J-Statistic=20.14		Prob (J-Statistic)=0.325	
	Arellano-Bond AR(1) = -2.32		Prob (AB)= 0.021	
	Arellano-Bond AR(2) = 0.60		Prob (AB)= 0.547	
	No. Obs = 286		No of instruments/groups =27/33	

More so, the natural log of an exchange rate (*lnEXR*) is 0.0141 with a probability value (P-value) of 0.000 indicates that a percentage increase in exchange rate through the monetary policy, increases agricultural value added by 0.0141 percent in sub-Saharan Africa. This conforms to the *"a priori"* expectation implying that exchange rate devaluation encourages agricultural productivity in sub-Saharan Africa.

A look at the moderating variables shows that the estimated coefficient of the log of trade openness (*lnTOPN*) is -0.071 although not significant at 5%. The estimated coefficient of the log of investment (lnINV) is negative (-0.097) and nonsignificant at the 5% level of significance. Also, the estimatied coefficient of the log of inflation rate (lnINF) is -0.037 and non-significant at the 5% level of significance.

The F-stat value of 68.84 and the probability value of 0.000 proves the significance of the overall regression. The Hansen J-statistics proves that the instruments are valid, which means that the error term is uncorrelated, and the instruments excluded are rightly excluded. It is important to understand that the *rule of thumb* is that the number of instruments should not exceed the number of groups, and it was satisfied with our model. (No of instruments/groups =27/33.) Also, the Arellano–Bond AR test reveals that there is no second-order autocorrelation due to the nonsignificant probability value, AR (2) p-value of 0.547.

Further, we present Table 8 shows the impact of the credit channel (Credit to the private sector), interest rate channel and exchange rate channel on manufacturing sector contribution to gross domestic product in sub-Saharan Africa.

Table 8 reveals that the coefficient of the constant term *C* is -27.49, and it is significant with p-value less than 0.05 level of significance. It shows that all things being equal, when there is nothing else influencing the manufacturing sector contribution to gross domestic product, it decreases with time in SSA countries. The coefficient of the lagged value of the manufacturing sector contribution to gross domestic product (*L1.MCGDP*) is 0.7976 and significant at 5% conventional level of significance. It means that the lagged manufacturing output influences the contemporaneous output.

The natural log of Credit to the private sector, a measure of credit channel of the monetary policy transmission (*lnCPS*) is -0.095 with a probability value (P-value) of 0.001 meaning that a percentage increase in Credit to the private sector as a result of the monetary policy, decreases manufacturing value added by 0.095 percent in sub-Saharan Africa. This did not conform to the *"a priori"* expectation due to the negative sign, which implies that the manufacturing sector does not benefit from expansion of Credit through the monetary policy in sub-Saharan Africa.

Also, the natural log of interest rate (*lnINTR*) is -0.0984 with a probability value (P-value) of 0.008, which is less than 0.05 levels means that a percentage increase in interest rate through monetary policy, decreased manufacturing value added by 0.0984 percent in sub-Saharan Africa. This conforms to the *"a priori"* expectation due to the significance and negative sign

Table 8 SGMM Regression Result for Model Two

Dependent variable: lnMCGDP				
Method: system generalized method of moment				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**Prob.**
C	−27.4851	6.5200	−4.22	0.000
L1.lnMCGDP	0.7976	0.0370	21.54	0.000
LnCPS	−0.0953	0.0260	−3.66	0.001
LnINTR	−0.0984	0.0346	−2.84	0.008
LnEXR	−0.0198	0.0048	4.15	0.000
LnTOPN	−0.3253	0.0656	−4.96	0.000
LnINV	−0.0765	0.0449	−1.70	0.098
LnINF	0.0137	0.0083	1.64	0.112
	F-stat (8,32) = 29.36		Prob (F-stat)=0.000	
	Hansen J-Statistic=19.18		Prob (J-Statistic)=0.634	
	Arellano-Bond AR(1) = −1.13		Prob (AB)= 0.258	
	Arellano-Bond AR(2) = 0.41		Prob (AB)= 0.682	
	No. Obs = 258		No of instruments/groups =31/33	

implying that it is a veritable tool for the monetary policy transmission in sub-Saharan Africa.

The natural log of an exchange rate (*lnEXR*) is -0.0198 with a probability value (P-value) of 0.000 means that a percentage increase in exchange rate through the monetary policy, caused a decrease of 0.0198 percent in manufacturing value added in sub-Saharan Africa. This implies that exchange rate devaluation discourages manufacturing sector productivity in sub-Saharan Africa.

The coefficients of the control variables are also reported with the estimated coefficient of the log of trade openness (*lnTOPN*) as -0.325 and significant at 5%. The estimated coefficient of the log of investment (lnINV) is negative (-0.0765) and nonsignificant at the 5% level of significance, while the estimated coefficient of the log of inflation rate (lnINF) is -0.037 and nonsignificant at the 5% level of significance.

The F-stat value of 29.36 and the probability value of 0.000 show the model to be statistically significant and good enough for inference. The calculated Hansen J-statistic of 19.18 with a p-value of 0.634 is greater than 0.05 significant levels, meaning that the instruments are valid, and that the error terms are uncorrelated, and the instruments are rightly set. It is also important to note by *rule of thumb* that the number of instruments should not exceed the number of groups, and it was satisfied with our model. (No of instruments/groups =31/33.) Also, the Arellano-Bond AR test reveals that there is no second-order autocorrelation due to the nonsignificant probability value of AR (2), which is 0.682.

Conclusion

This study examined the impacts of monetary policy transmission channel on the real sector of sub-Saharan African countries from 1990 to 2020. The study found that credit channel has a positive and significant impact on the agricultural sector contribution to gross domestic product while it exhibits a negative and statistically significant impact on the manufacturing sector contribution to gross domestic product. Also, the interest rate channel has a negative and significant impact on the agricultural and manufacturing sector. The exchange rate channel has significant positive impact on agricultural output and a negative impact on manufacturing output.

Specifically, the finding that credit adversely affect manufacturing value added did not agree with economic views held by McKinnon [57] that increased provision of financial services encourages more productivity (See also SSA focused studies like [58–64] and Muchingami, Monamets and Paradza 2017. However, the finding agrees with Mbah and Okoli [65], Ezeaku et al [66], Mesagan, Olunkwa and Yusuf [67] and Bada [59]. The negative impact of the credit channel on manufacturing in SSA can be blamed on credit diversion to unproductive sectors of the economy. It could also be attributable to the harsh economic climates in SSA countries that stifle productivity even in the face of increased credit chaneling.

Another finding of interest is the fact that increase in interest rate through monetary policy, reduces both agricultural and manufacturing value added in sub–Saharan Africa. This conforms to the *"a priori"* expectation, implying that high interest rate due to monetary policy changes discourages agricultural output in sub-Saharan

Africa. Theoretically, this finding supports the loanable funds theory. The theory attempts to point out the estimated causes of long-term interest rate variations by examining the demand for and supply of credit. The rate of interest could be seen as the opportunity cost. The lower the interest rate, the smaller the opportunity cost of present consumption, the lower the rate of saving. The real investment is a negative function of the rate of interest as it demonstrates the cost of finance. The lower the interest rate, the more investable projects are considered profitable, and investors will be willing to borrow from the market to finance production. The study supports the empirical findings of Iliyasu [68], Wagan et al [69], Ugwuoke, Ume and Ihedioha (2018) and Ernest (2010) that discovered that interest rate increase dampens agricultural output. Also, Opusunju, Akyuz and Santeli (2019), Ezeaku et al [66], Ighoroje and Egberi [70], Adebiyi and Obasa (2004), Arnold et al. [71], Udoh and Ogbuagu [72] and Udensi et al [73] with evidence of the manufacturing output reduction as interest rate rises. This can further be explained by the slow performance of the manufacturing sector in sub-Saharan Africa with continuous increase in interest rate, reducing the capacity utilization and output of the manufacturing sector. The behavior of interest rates, to a large extent, determines investment activities and growth in the manufacturing sector of any economy.

The exchange rate transmission channel of monetary policy is found to positively affect the agricultural value added and adversely affect the manufacturing sector value added. The impact on agricultural value added supports the Dornbusch overshooting model of exchange rate. A fundamental assumption of the model is that if the real exchange rate is overvalued initially, the demand for domestic goods will increase and vice versa after a downward change. Also, the positive impact of nominal exchange rate on agricultural output is in consonance with exchange rates positive impact on livestock and forestry. The result suggests that a decline in the strength of sub-Saharan African currency may encourage demand for agricultural products, which increases income for the farmers, and then accentuating agricultural sector and output. Conversely, for the manufacturing sector, though this did not conform to the *"a priori"* expectation (as it implies that exchange rate devaluation discourages manufacturing sector productivity in sub-Saharan Africa), empirically, it is in consonance with the findings Mlambo [74], Egbulonu and Ukwuoma [75], Falaye et al. [6], Ezeaku et al [66], Nwokoro [76] and Tkalec and Vizwk (2009). However, our result disagrees with the empirical findings of Shobande, Ezenekwe and Uzonwanne [77], Oriji et al. (2019), Hunegnaw [7], Ume et al [64] that discovered that increased exchange rate encouraged manufacturing productivity. Providing explanation to the negative impact of the exchange rate channel on the manufacturing sector, it can be adduced that possible dependence on foreign inputs by local manufactures could make exchange rate devaluation or reduction injurious to manufacturing value added. Therefore, when depreciation makes manufactured goods cheaper for foreigners, the reverse impact will be the expensiveness of imported factor inputs for the manufacturing sector in SSA countries. This is worsened by the overdependence on factor input by domestic producers in SSA countries.

On a general note, the findings arising from this study support that monetary policy controls the availability, value and cost of money, and credit in order to achieve the preferred level of prices, employment, output, and other economic objectives (Arnold, Kool, &Raabe, 2006, Bernanke &Gertler, 1995). And that monetary policy affects the real sector through its transmission mechanism. It is also noteworthy that the actions of the monetary authority in managing the aggregate money supply and interest rates, passes through the various channels to different sectors of the economy (Arnold, Kool, &Raabe, 2006). This provides tacit support to the endogenous growth theory. The endogenous growth theory implied that technology, unlike the Solow growth model, is not exogenous but determined by factors like innovation. The endogenous growth model regards the provision of financial services as a factor that promotes innovation and then economic growth. This stresses that output can be raised by increasing inputs and its factor productivity (See Ibrahim & Alagidede, 2018).

Conclusively, given the observed impact of these channels of monetary policy transmission on the performance of the real sector in the studied SSA countries, it is imperative to advocate for improved policy on the part of the managers of the monetary system. This is with the aim of building safety nets against the adverse effects of monetary policy initiatives while aiming to heighten the benefits that may arise from monetary policy transmission to the real sectors of the SSA countries.

Abbreviations

ACGSF	Agricultural Credit Guarantee Scheme Fund
AGDP	Agricultural gross domestic product
ARDL	Autoregressive distributed lag
Bops	Balance of payments
BVAR	Bayesian VAR
CBK	Central Bank of Kenya
CBN	Central Bank of Nigeria
CV	Coefficient of variation
DIFF-GMM	Difference generalized method of moment
DSGEM	Dynamic stochastic general equilibrium model
DSR	Debt service ratios
DWH	Durbin-Wu-Hausman test
EAC	East African community
ECM	Error correction mechanism

FAVAR	Factor augmented vector autoregressive
FDI	Foreign direct investment
FMOLS	Fully modified ordinary least squares
GDP	Gross domestic product
GMM	Generalized method of moment
GNP	Gross national product
IMF	International Monetary Fund
INF	Inflation rate
INTR	Nominal interest rate
INV	Investment
IPS	I'm, Pesaran and Shin
IS-LM	Investment-savings/liquidity preference/money supply
LTI	Loan to income
LTV	Loan to value
M2	Money supply
MG	Mean group
MPR	Monetary policy rate
MPTM	Monetary policy transmission mechanism
MSMEs	Micro, small and medium scale enterprises
NARD	Nonlinear autoregressive distributed lag
NBS	National Bureau of Statistics
O.M.O	Open market operations
OLS	Ordinary least square
PMG	Pooled mean group
PPP	Purchasing power parity
REER	Real exchange rate
SACU	South African Customs Union
SPSS	Statistical package for social sciences
SSA	Sub-Saharan Africa
SVAR	Structural vector autoregressive model
SYS-GMM	System generalized method of moment
TSLS	Two-stage least squares
VAR	Vector autoregression
VECM	Vector error correction model
WDI	World development indicator

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