Bank Efficiency and The Bank Lending Channel: New Evidence *

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Abstract

We test the bank lending channel of monetary policy in Africa and examine the role of bank cost efficiency in this relationship. We use the stochastic metafrontier approach to estimate cost efficiency scores of 447 commercial banks in Africa. The Fixed Effect (FE) estimator is used as the baseline estimation method. The 2SLS Instrumental Variables (IV) and two-step system GMM approaches are used as main estimation techniques to control for endogeneity. The results consistently show the existence of the bank lending channel in Africa: thus, bank credit responds to changes in monetary policy rate. Again, we find strong evidence to show that higher cost efficiency leads to higher loan growth. The results further show that cost efficient banks are less responsive to monetary policy shocks. The evidence suggests that bank cost efficiency weakens the bank lending channel. This implies that the effect of monetary policy on bank lending depends not only on bank size, capitalization, and liquidity as espoused in literature but also on bank efficiency. The results are robust in formal sample-splitting. Policy implications are discussed.

Keywords:Bank Efficiency; Monetary Policy; Bank Lending Channel; Stochastic Metafrontier; Africa

JEL Classification: B22; E50; E52; G21

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1 Introduction

The bank lending channel (BLC) of monetary policy transmission has been studied widely in advanced economies like the US (Kishan & Opiela, 2000; Kashyap & Stein, 2000), UK (Butt et al., 2014), and in advanced regions like Europe area (Altunbas et al. 2002; Fungácová, Solanko, & Weill 2014) with few studies in Africa (Lungu, 2007; Matousek & Solomon, 2018). However, Mishkin (2016) observes that many recent studies on advanced economies find the diminishing role of the bank lending channel. This is mostly because these developed countries have well-developed capital markets with deregulated banking markets that allow banks to raise funds from different sources other than their dependence on deposits. Mishkin (2016) observed that banks' traditional intermediating role in giving long-term loans and funding them with short-term deposits had reduced dramatically due to financial innovation in developed markets. However, as Mishra and Montiel (2012) indicated, studies on monetary policy transmission in developing countries are limited and are at its infancy stage. While the bank lending channel's dwindling effect is well documented in advanced countries, the impact of monetary policy in Africa may differ due to African countries' institutional characteristics.

The BLC is critical for Africa for two key reasons. First, because the stock markets in Africa are undeveloped, the banking sector remains the most crucial financial sector, making firms more dependent on the sector for funds (Mishra et al., 2012). Indeed, there is little access to private international capital markets by firms in SSA, making them dependent on banks: making the BLC very significant for the effective implementation of monetary policy. Second, according to the International Finance Corporation (IFC), Africa is characterized by many small and medium enterprises (SMEs), which represent over 90% of private businesses in most countries. Since it is difficult for small firms to access the capital market, firms in Africa are more dependent on the banking sector for credit. These characteristics in Africa make the BLC important since monetary policy is likely to have a more significant impact considering the banking sector's dominance in the financial system. The underdeveloped bond and stock markets further limit even larger firms' ability to raise funds on these alternative sources. This makes the intermediation role of banks in allocating loanable funds very key in ensuring the effectiveness of monetary policy in Africa.

Meanwhile, the bank lending channel's effectiveness or otherwise has largely been attributable to some heterogeneous bank characteristics mainly bank size, bank liquidity, and bank capitalization (Boughrara & Ghazouani, 2010; Matousek & Solomon, 2018). The argument has been that the bank lending channel's effectiveness depends on whether the bank is big or small, highly capitalized (less risky), and whether it is liquid. Interestingly, one important characteristic of banks, which is at the core of banks' lending ability, cost efficiency, has received little attention in the literature. To effectively play their intermediation role, banks need to be efficient in the allocation of their resources. This is because efficiency in allocating these resources is key to banks' survival (Mester, 1993). Efficiency involves the ability to achieve results with minimum resources. Therefore, cost-efficient banks can use minimum inputs to achieve the desired output (loans). Cost efficient banks are more likely to better handle any negative shock than inefficient ones. For instance, a cost-efficient bank-a bank that can use less cost than other banks to produce the same unit of loans-will most likely respond less strongly to monetary policy change than an inefficient bank. The study conjectures that banks that are cost efficient would have lower "prices"-lower loan rates-which would translate into low cost of credit; hence more loans can be given. Therefore, these banks are likely to be less responsive to monetary policy shocks, given that they are efficient.

To achieve this, the study uses 447 commercial banks in Africa for the period 2000 to 2015. In estimating the cost efficiency scores, the study uses the new stochastic metafrontier approach proposed by Huang, Huang & Liu (2014). The efficiency scores are then used in the bank lending channel model. First, the study uses the FE estimator to give the baseline results. The study then addresses any possible causality issues between loan growth and monetary policy using the 2SLS IV approach. The moderating role of bank efficiency in the BLC is further tested using the two-step sys-GMM approach. The results show that the bank lending channel is strongly present in Africa. Again, we find strong evidence to support our conjecture that bank efficiency improves credit growth. The interaction between monetary policy variable and bank efficiency shows that cost efficient banks are less responsive to monetary policy shocks and that cost efficient banks weaken the BLC..

In the remaining sections on the paper, section 2 provides a review of the empirical literature on the BLC, section 3 describes the data used and shows the methods adopted to estimate the data to achieve the study's objectives, section 4 presents and discusses the results of the study, and finally, section 5 concludes and provides policy implications of the results of the study.

2 Literature Review

Several studies have tested the bank lending monetary transmission channel in different countries and regions by examining the role of bank-specific and industry-specific variables in this relationship. Some of these studies are reviewed in this study.

On bank market power and competition, In Europe, Fungácová, et al. (2014) examine how bank competition affects the bank lending channel in a panel of banks from 12 Euro area countries from 2002 to 2010. The study found that the effect of monetary policy on bank lending depends on bank competition showing that bank lending monetary transmission channel is ineffective through banks with high market power. In a similar study, Leroy (2014) confirms these results for some selected Eurozone countries from 1999 to 2011 and found that banks with higher market power are less responsive to monetary policy shocks.

For Southeast Asian countries, Khan, Ahmad and Gee (2016) in a study of five ASEAN countries also used the GMM method and examined the role of bank competition in the bank lending monetary transmission channel from 1999 to 2014. The results show that the impact of monetary policy on bank lending reduces as the competition levels reduce confirming the findings of Fungácová et al. (2014) and Leroy (2014).

On the more extensive research on the role of bank size, capitalization and liquidity, Boughrara and Ghazouani (2010) test whether the bank lending channel exists in some Middle East and North African countries (MENA). The study used bank-level data for four countries (Egypt, Jordan, Morocco and Tunisia) from 1989 to 2007. It tested how monetary policy affects bank lending behaviour conditioned on bank characteristics like capital, size and liquidity. They found that the bank lending channel exists in all the countries even though the role of these bank characteristics in the bank lending behaviour is heterogeneous depending on the country.

Matousek and Solomon (2018) also examined the bank lending channel in Nigeria, testing the bank size and capitalization effects. Using data from 2002 to 2008 for 23 banks in Nigeria, the authors analysed this relationship using the two-step GMM approach. Their results showed the bank lending channel's presence in Nigeria, mostly influenced by the bank size and capitalization. More recently, Abuka et al. (2019) studied the bank lending channel in developing countries using Uganda as a case study. The study tests whether the banks' level of leverage and sovereign debt exposure play a role in this relationship using micro data the applications for loans, loan volumes, and rates. The study found evidence of the bank lending channel in Uganda where a contractionary monetary policy reduces bank credit supply, especially for banks that are more levered and have more exposure to sovereign debt.

Simpasa, Nandwa, and Nabassaga (2015) examined the bank lending channel in Zambia by testing the dependency on bank size. The study used quarterly data from 1998-2011 for all banks in Zambia and estimated the relationship using the difference GMM technique. The results showed that monetary policy's bank lending channel is mainly effective through large banks and moderately effective for medium-banks but ineffective when small banks are considered.

A review of the literature found no study addressing the role of bank efficiency in the bank lending channel in Africa. The closest study was that of Jonas and King (2008) who studied this relationship for the banking market in the U.S. The study estimated the cost-efficiency of U.S. banks using the SFA and examined how bank efficiency affects the bank lending channel. The results showed that cost-efficient banks are more responsive to monetary policy changes. Mishkin (2016) even observed that the bank lending channel is losing its relevance in the U.S. mainly due to regulatory changes and highly developed capital markets. Given the peculiar characteristics of the financial markets in Africa-the dominance of the banking sector in the financial market- and that no study has examined the role of bank efficiency in the bank lending channel, this study is key to address this issue to inform decisions on effective implementation of monetary in the continent.

3 Methodology

Here, the study presents the data used in the study and the methods adopted to estimate the data.

3.1 Data

Data on bank specific variables are taken from Bankscope. The data set covers a total of 447 commercial banks in Africa. This panel data set consists of a total of 38 countries for the period 2000 to 2015. This provides an unbalanced panel because not all banks provide data for every year. The study follows some rules in selecting the sample for the analysis. Data on other financial institutions like mortgage banks, central banks, securities houses, and medium & long-term credit banks were all removed. These types of banks tend to be less dependent on the traditional intermediation objective and may have financing structures that are different from the selected banks. All holding companies were also dropped.

3.2 The Stochastic Metafrontier Approach

The study makes use of the stochastic meta-frontier (SMF) cost function following the approach by Huang et al. (2014). Huang et al. (2014) applied this approach to a production function hence estimating technical efficiencies. This study however uses a cost function to estimate cost efficiencies. This approach helps to make use of the cost function of different countries so that they can be comparable. In the first step of the SMF approach, the group-specific frontiers are estimated and the scholastic frontier (SF) approach is also used in the second step to estimate the meta-frontier cost function. Here, suppose that group j, in this case say country j, its SF of the ith decision making unit (DMU) in this case bank, in the tth period is modelled as:

$$C_{jit} = f_t^j\left(\mathbf{X}_{jit}\right) e^{V_{jit}+U_{jit}}, \quad j \;=\; 1,2,\; \ldots,\; J:\; i \;=\; 1,2,\; \ldots,\; N_j\;; t = 1,2,\; \ldots,\; T \tag{1}$$

Where C_{jit} is the scalar cost and $\mathbf{X}_{jit}$ is the vector of output Y and input prices of the ith bank in group j, for the period t. The subscript t and superscript j of the function, $f_t^j(.)$ of the cost frontier indicates that the technologies for the various individual groups may differ for different times. The standard SF approach denotes V_{jit} as the statistical noise while U_{jit} is the term for the cost inefficiency. V_{jit}s are assumed to be $N(0, \sigma_v^{j2})$ and are independent of the $U_{jit}s$ which follow a truncated-normal distribution as $N\left(\mu^j\left(Z_{jit}\right),\; \sigma_u^{j2}\left(Z_{jit}\right)\right)$.Here the truncation is done at zero and with a mode of $\mu^j\left(Z_{jit}\right)$ where the $Z_{jit}s$ are identified exogeneous variables. Here, the cost efficiency (CE) of the bank for the group frontier in this function will be:

$$CE_{it}^j = \frac{f_t^j\left(\mathbf{X}_{jit}\right) e^{V_{jit}}}{C_{jit}} = \; e^{-U_{jit}} \tag{2}$$

It is important to note the environmental variables Z_{jit} are exogenous to the firms even though related to the CE of the firms in their specific groups.

Here, the meta-frontier cost function that is common to all the groups in period t is defined as $f_t^M\left(\mathbf{X}_{jit}\right)$. This function is the same for all groups j = 1, 2, . . . , J. The meta-frontier envelopes the individual group-specific frontiers and can be represented as:

$$f_t^j\left(\mathbf{X}_{jit}\right) = f_t^M\left(\mathbf{X}_{jit}\right) e^{U_{jit}^M},\; \forall j, i, t \tag{3}$$

Where $U_{jit}^M \geq 0$. This implies that $f_t^j(.) \geq\; f_t^M(.)$ and thus the ratio of the meta cost frontier to the jth group's cost frontier is defined as the technological gap ratio (TGR) which is represented as:

$$TGR_{It}^j = \frac{f_t^M\left(\mathbf{X}_{jit}\right)}{f_t^j\left(\mathbf{X}_{jit}\right)} = \; e^{-U_{jit}^M} \;\leq 1. \tag{4}$$

The fact that each group or country is exposed to certain unique environmental characteristics-both economic and non-economic- accounts for the technological gap. This makes the technological gap component, U_{jit}^{M}, group, bank and time specific. Given the observed outputs and inputs, this ratio measures the ratio of the potential minimum cost available at the metafrontier level to the cost function at the group level. The meta-frontier of bank i in group j at time t, $f_t^M(\mathbf{X}_{jit})$ can therefore be decomposed into three components:

Component 1 (The technology gap ratio) : $TGR_{It}^{j} = \frac{f_t^M(\mathbf{X}_{jit})}{f_t^j(\mathbf{X}_{jit})}$,

Component 2 (The bank's cost efficiency) : $CE_{it}^{j} = \frac{C_{jit}\ e^{-U_{jit}}}{C_{jit}} = e^{-U_{jit}}$

Component 3 (The random noise) $e^{V_{jit}} = \frac{C_{jit}\ e^{-U_{jit}}}{f_t^j(\mathbf{X}_{jit})}$

i.e.

$$\frac{f_t^M(\mathbf{X}_{jit})}{C_{jit}} = \ TGR_{It}^{j}\ x\ \ CE_{it}^{j}\ x\ \ e^{-V_{jit}}. \tag{5}$$

Equation 5 can be expressed alternatively as:

$$MCE_{jit}\ \equiv \frac{f_t^M(\mathbf{X}_{jit})\, e^{V_{jit}}}{C_{jit}} = \ TGR_{it}^{j}\ x\ \ CE_{it}^{j} \tag{6}$$

Where MCE_{jit} is therefore the cost efficiency of the bank with respect to the meta cost frontier, $f_t^M(.)$, as opposed to the bank's cost efficiency, CE_{it}^{j}, with respect to the group-j (country) production technology $f_t^j(.)$.

To estimate empirically, suppose that in a panel framework:

$$lnC_{jit} = \ lnf_t^j(\mathbf{X}_{jit}) + V_{jit} + U_{jit} \quad i = 1,\ 2,\ \ldots,\ N_j;$$

$$t = 1,\ 2,\ \ldots,\ T \tag{7}$$

With the composite error $\varepsilon_{jit} = V_{jit} + U_{jit}$ and the distribution assumptions that $V_{jit}\ \ N(0,\ \sigma_v^{j2})$ and $U_{jit}\ \ N\left(\mu^j(Z_{jit}),\ \sigma_u^{j2}(Z_{jit})\right)$. Let $\hat{f}_t^j(\mathbf{X}_{jit})$ be a maximum likelihood estimate of the group-j's specific frontier and the group jth cost efficiency is estimated as the conditional expectation. The first stage cost efficiency is given as:

$$\hat{CE}_{it}^{j} = \hat{E}\left(\hat{\varepsilon}_{jit}\right) \tag{8}$$

Where $\hat{\varepsilon}_{jit} = lnC_{jit} - ln\hat{f}_t^j\left(\mathbf{X}_{jit}\right)$ are the estimates composite residuals.

In the second stage, SFA estimates of the various group-specific frontiers $\hat{f}_t^j\left(\mathbf{X}_{jit}\right)$ for each country obtained following Equation 7, the estimation error of the group-specific frontier is given by:

$$ln\hat{f}_t^j\left(\mathbf{X}_{jit}\right) - lnf_t^j\left(\mathbf{X}_{jit}\right) = \ \varepsilon_{jit} - \ \hat{\varepsilon}_{jit} \tag{9}$$

If we define the estimated error as $V_{jit}^M = \ \varepsilon_{jit} - \ \hat{\varepsilon}_{jit}$, then Equation 9 which represents the metafrontier relations can be rewritten by substituting $f_t^j\left(\mathbf{X}_{jit}\right)$ on the left-hand side with the estimates for $\hat{f}_t^j\left(\mathbf{X}_{jit}\right)$. Hence, we would have:

$$ln\hat{f}_t^j\left(\mathbf{X}_{jit}\right) = \ lnf_t^M\left(\mathbf{X}_{jit}\right) + U_{jit}^M + V_{jit}^M,$$

$$\forall, i, t, \ j = 1, \ 2, \ \ldots, \ J,$$

$$U_{jit}^M \ \geq 0, \ U_{jit}^M \ N^+\left(\mu^M\left(Z_{jit}\right), \ \sigma_u^{M2}\left(Z_{jit}\right)\right),$$

$$U_{jit}^M \ \perp\!\!\!\perp V_{jit}^M. \tag{10}$$

The presence of V_{jit}^M is important in the formulation of Equation 10 as a stochastic rather than a deterministic one. This stochastic setting may thus result in a potential problem in the second stage. Since $ln\hat{f}_t^j\left(X_{jit}\right)$ was estimated using a maximum likelihood estimator of the group-specific frontier in Equation 7, it can be assumed that the estimation error, $V_{jit}^M = \ \varepsilon_{jit} - \ \hat{\varepsilon}_{jit}$, is to be asymptotically normally distributed with zero mean but not i.i.d. since it contains the residuals from estimating the group frontiers, that is where, $\hat{\varepsilon}_{jit} = lnC_{jit} - ln\hat{f}_t^j\left(X_{jit}\right)$. Hence, the SF likelihood function of Equation 10 assuming $i.i.d$ in V_{jit}^M is referred to as the quasi-likelihood function. This derived quasi-maximum likelihood (QML) function is still consistent and asymptotically normal, even though Huang et al. (2014) indicates potential problem of heteroskedasticity in the standard errors which can be corrected by using White (1982) approach to compute a sand-which of the covariance matrix of the estimators to obtain the correct standard errors.

Equation 10 is therefore the SMF regression. Here, the technology gap ratio is estimated as:

$$T\hat{G}R_{it}^{j} = \hat{E}\left(e^{-M_{jit}}|\hat{\varepsilon}_{jit}^{M}\right) \leq 1 \tag{11}$$

Where $\hat{\varepsilon}_{jit}^{M} = \; ln\hat{f}_{t}^{j}\left(X_{jit}\right) - \; ln\hat{f}_{t}^{M}\left(X_{jit}\right)$ are the estimated composite residuals of Equation 10. The estimated technology gap ratio is a function of the production environments Z_{jit} via the mode $\mu(Z_{jit})$ and the heteroskedasticity variance $\sigma_{u}^{M2}\left(Z_{jit}\right)$.

Since $ln\hat{f}_{t}^{j}\left(X_{jit}\right)$ is the estimates for the group-specific frontier from equation 7, regression of Equation 7 is done J times, one for each group. The estimates for all the J groups are now pooled to estimate Equation 10. The estimated meta cost efficiency is therefore the product of Equations 8 and 11:

$$M\hat{C}E_{jit} \equiv T\hat{G}R_{It}^{j} \; x \;\; C\hat{E}_{it}{}^{j} \tag{12}$$

Where MCE is the meta cost efficiency of bank i in group j at time t.

3.3 Model Specification of the SMF

The study follows a two-stage approach. First, the SMF technique is employed to measure bank efficiency. This is used to generate the efficiency scores. In the second stage, the study uses the two-step sys-GMM approach to estimate the impact of changes in monetary policy on banks credit growth and examine the moderating role of bank efficiency.

The first stage of the analysis estimates cost efficiency scores using the SMF approach. The study follows a translog cost function given as:

$$ln\left(\frac{TC_{it}}{w_{1_{it}}}\right) = \alpha_0 + \sum_{k=1}^{3}\alpha_k ln\mathbf{X}_{kit} + \sum_{k=1}^{3}\sum_{l=1}^{3}\alpha_{kl}(\ln\mathbf{X}_{kit})(\ln\mathbf{X}_{lit}) + \frac{1}{2}\sum_{k=1}^{3}\alpha_{kk}(\ln\mathbf{X}_{kit})^2 + \nu_{it} + \mu_{it}$$

$$for\ k\ \neq l \tag{13}$$

Where ln is the natural log, TC is the total operating cost, X_{kit} is a vector of k variables made of one output total loans, Loans, and three input prices of the ith bank at time t. The input prices are the price of labour (w_1), the price of physical capital (w_2) which is also scaled by w_1 to get $\frac{w_2}{w_1}$ and the price of deposits (w_3) which is scaled by w_1 to get $\frac{w_3}{w_1}$. The study normalizes the costs and prices by w_1 to impose linear homogeneity in accordance with literature (Shamshur & Weill, 2019). ν_{it} is the random error term with is assumed to be $i.i.d$ with $\nu_{it} \sim N(0, \sigma_\nu^2)$ and it is independent of the explanatory variables (Aigner et al.,1977; Coelli et al., 1998). u_{it} is the inefficiency term and $u_{it} \sim N\left(\mu\left(Z_{it}\right), \sigma_u^2\left(Z_{it}\right)\right)$. Also u_{it} is independent of ν_{it}. Where Equation 13 is estimated for each country j. The study includes some bank specific environmental variables that may account for technological differences between the banks. In the metafrontier analysis where cross-country comparison is made, Berger & Mester (1997), Lozano-Vivas et al. (2002) and Sathye (2005) indicate the importance of adding these environmental variables in cross-country efficiency analysis. The bank-specific environmental variables that the study included are age of the bank, age squared, dummy variable taking the value of 1 for a listed bank and 0 otherwise, and the equity ratio. The industry or country-specific environmental variables include bank concentration, GDP per capita and a dummy variable taking a value of 1 if the country is in SSA and 0 if in North Africa.

In estimating Equation 13, the study follows Huang et al. (2014). Battese et al. (2004) and O'Donnell et al. (2008) builds on the works of Hayami and Ruttan (1971) and Battese & Rao (2002) to develop the stochastic meta-frontier approach. Battese and Rao (2002) approach considered the two data generating approaches. First was to estimate the stochastic production function using the data for the jth group and then second estimating the metafrontier production function using data for the entire sample. Battese et al. (2004) later on modified the model so did O'Donnell et al. (2008). The authors used a two-step approach in estimating the meta-frontier production where in the first stage, stochastic frontier regression is used to estimate the group-specific stochastic production functions. By using a linear or quadratic programming algebraic calculation, the authors combine the stochastic frontier regressions used in the first stage to estimate the meta-frontier. Huang et al. (2014) on the other hand criticizes this two-step mixed approach as the meta-frontier estimates would have no statistical properties due to its deterministic nature. Huang et al. (2014) also observe that this two-step mixed approach does not allow for incorporation of potentially different production environments that the firms may face and that it makes it incapable to isolate the idiosyncratic shocks.

Hence, this study follows the approach of Huang et al. (2014) which corrects these anomalies to estimate the cost efficiency scores using a new two-step stochastic frontier approach. This new approach allows for the estimation of group-specific frontiers and then the metafrontier. This further allows a decomposition of the efficiency scores of the various groups into cost efficiency (CE) and technology gap ratios (TGRs). Huang et al. (2014) achieves this by still using a stochastic framework in the second stage instead of the mathematical programming technique used by Battese et al. (2004) and O'Donnell et al. (2008). This approach is called the Stochastic Metafrontier (SMF) approach.

The SMF approach uses the usual maximum likelihood approach to estimate the parameters while still carrying out the usual statistical inferences without relying on bootstrapping or simulations as used by Battese et al. (2004) and O'Donnell et al. (2008). This allows the SMF approach to decompose the error term to estimate the technology gap ratios unlike the mathematical approach that may be contaminated with random shocks. Other empirical studies have used the SMF approach after identifying that the technology gap ratios estimated by the mixed-approach was underestimated with greater variance (Chang, Huang, & Kuo., 2014; Huang et al., 2014; Zhang et al., 2017).

The study follows the approach of Battese and Coelli (1995. This approach allows for the inclusion of environmental variables such that the truncation of the distribution of the inefficiency term is of the form $N\left(\mu_{it},\, \sigma^2\right)$ where $\mu_{it} = z_{it}\delta$, with the z_{it} representing the environmental variables and the vector of unobserved scalar parameters are represented by δ. The predict bc option of the sfpanel is used to generate the efficiency scores. This option estimates the cost efficiency scores following Battese and Coelli (1988) via $E\ \{exp\,(\varepsilon)\}$.

3.4 Model Specification of the BLC

In the second stage analysis, after generating the efficiency scores of the banks *(CostEff)* as given by the MTE, these scores are used in the next estimation to test the role of bank efficiency in the bank lending channel. The bank lending channel model is estimated following the basic econometric model below:

$$\Delta \ln(Loans_{i,j,t}) = \alpha_i + \alpha_1 \Delta MP_{j,t} + \alpha_2 \operatorname{Cos} tEff_{i,j,t} + \gamma \mathbf{X}_{i,j,t} + \mu_j + \varepsilon_{i,j,t} \tag{14}$$

Where *i,j,t* represents bank i in country j at time t. δ is the one period change. $Loans_{i,j,t}$ therefore, denotes total loans by bank i in country j at time t, MP denotes the monetary policy indicator (monetary policy rate). *CostEff* is the efficiency scores from the SMF which is the meta cost efficiency scores. **X** is a vector of specific control variables identified in literature (bank size, capitalization, liquidity, GDP p.c. growth and inflation). α_i is the fixed effect and α_1 and α_3 are the coefficients of MP and *CostEff* respectively. γ is a vector of parameters for each control variable. $\varepsilon_{i,j,t}$ is the idiosyncratic error term. As a benchmark exercise we first use the fixed effect model to estimate Equation 14.

To identify causality issue between bank credit growth and monetary policy, the study uses the two-stage least squares (2SLS) instrumental variables (IV) approach as the main model. We adopt an instrumental variables approach with the first-stage regression given in Equation 17:

$$\Delta MP_{j,t} = \beta_0 + \beta_1 CBI_{i,j,t} + \beta_2 \operatorname{Cos} tEff_{i,j,t} + \eta \mathbf{X}_{i,j,t} + \mu_j + \delta_t + \xi_{i,j,t} \tag{15}$$

Where all other variables are as defined earlier. The central bank independence (CBI) is the percentage change in the de jure central independence index by Garriga (2016). We use the index from Garriga (2016) because the dataset is broad and covers about 182 countries unlike previous studies that focused on developed countries and few samples from developing countries. It is by far the most extensive dataset that computes the Cukierman, Webb and Neyapty (CWN) index computed yearly from 1970 to 2012. The index aggregates 16 legal indicators into four main categories. First is the tenure of the bank's governor, second is related to policy formulation, third is with the objectives and fourth is the limitation on lending to the government. The index ranges from 0 to 1 with higher values suggesting more independence. In the estimation, the overall index as well as the subcomponents were tested on the full sample and sub-sample. The ones that had an impact on monetary policy and are properly identified in the model were used. The overall CBI index was used for the full sample while the index on tenure of the governor was used for all the sub-samples.

CBI is a plausible exogeneous source of variation as an instrument for monetary policy to identify any causal effect of monetary policy on credit growth. CBI is the central bank's capability of controlling monetary instruments (Bernhard 2002:21) or, inversely, CBI is the set of restrictions to the government's influence on the central bank management of monetary policy (Garriga, 2016). We use the central bank independence as an instrument for monetary policy because it is theoretically rooted and highly correlated with monetary policy and plausibly satisfies the exclusion restriction. We find this plausible because the level of independence of the central bank will influence the monetary policy decision which then translates to affect bank credit. We argue that the impact of central bank independence on bank credit can only be through the monetary policy decisions and not directly. Hence, CBI is uncorrelated with $\xi_{i,j,t}$ satisfying the exclusion restriction. The second-stage regression follows from Equation 14.

As further robustness checks, the study follows previous research that have tested the BLC model using the GMM approach. This is because loan growth may persist hence the need to include the lag of loan growth in the estimation. The GMM allows for the dynamic nature of such a model. Equation 14 is also estimated by including a one-period lag of loan growth. In order to check the moderating role of bank efficiency in the BLC, the study follows Equation 16.

$$\Delta \ln(Loans_{i,j,t}) = \varphi_1 \Delta \ln(Loans_{i,j,t-1}) + \varphi_2 \Delta MP_{j,t} + \varphi_3 \, \text{CostEff}_{i,j,t} + \varphi_4 (\Delta MP_{j,t} * CostEff_{i,j,t}) + \lambda \mathbf{X}_{i,j,t} + \mu_j + \delta_t + \zeta_{i,j,t} \tag{16}$$

Where all variables are as defined. The variable of interest is $(\Delta MP_{j,t} * CostEff_{i,j,t})$ which represents the interaction term between monetary policy and bank cost efficiency. The coefficient of interest is φ_4 which is expected to be positive. A positive sign indicates that cost efficient banks are less responsive to monetary policy shocks and that the BLC is weakened in highly efficient banking markets. Following from this, the study calculates the marginal effect of monetary policy changes on credit growth in the presence of cost efficiency by differentiating Equation 16 with respect to monetary policy as below:

$$\frac{\partial \Delta \ln(Loans_{i,j,t})}{\partial \Delta MP_{j,t}} = \varphi_2 + \varphi_4 \cos tEff_{i,j,t} \tag{17}$$

The marginal effect is estimated using the sample mean, minimum and maximum values of cost efficiency *(CostEff)*. Equation 16 is estimated using the system generalized method of moments (sys-GMM).

The sys-GMM approach was developed by Blundell and Bond (1998) to address potential endogeneity as well. First, inclusion of the lag of loan growth gives rise to autocorrelations. The sys-GMM approach is normally chosen over the difference GMM approach in order to reduce any potential biases or imprecision with the difference GMM estimator. The sys-GMM is used to combine both regressions in levels and in differences in a system. This helps to address possible endogeneity in with the various independent variables. For instance, previous loan growth is likely to improve the performance of banks in the current year as they expand credit and become profitable hence the introduction of lagged growth in loans. Again, Roodman (2009) presented these conditions that necessitate the use of GMM estimations: (a) some of the independent variables may be determined endogenously; (b) the model specified is dynamic showing that credit growth persists; (c) the idiosyncratic disturbances are uncorrelated across individual; and finally, (d) when there is small time period in the panel compared with the total number of observations. As indicated by Wintoki, Linck, and Netter (2012), the GMM helps to address these sources of endogeneity which are basically unobserved heterogeneity, dynamic, and endogeneity". The GMM approach uses the lag of the independent variables as instruments and internal transformations to help address the endogeneity issues raised above.

Following from Roodman (2009), the lags of the independent variables are used as instruments. The study employs the collapsing method proposed by Holtz-Eakin, Newey and Rosen (1988) to limit the reduction in data points resulting from the use of the instruments. Again, in order to limit the number of instruments., the study uses the forward orthogonalization method of Arellano and Bover (1995). The study reports the P-value of the Hansen test to test for over-identifying restrictions with valid over-identifying restrictions as the null hypothesis. This test is chosen over the Sargan test because it is consistent even when there are autocorrelations and heteroskedasticity (Roodman, 2009). The second order serial correlations test, AR (2), by Arellano and Bond (1991) is used to check whether the deeper lags of the instruments are correlated with deeper lags of the disturbances. This is appropriate for sys-GMM estimations.

3.5 Variable Description and Data Sources

The variables used are describe in Table 1. In the frontier equation we expect total loans to have a positive impact on total cost indicating that more loans that are processed comes with its associated costs. Price of physical capital and deposits are also expected to be positive. In the inefficiency equation, we expect either a positive or negative sign for bank concentration. A positive sign shows that more cost-efficient banks are prevented from gaining market share resulting from the monopolistic nature of the market. In these markets there is less competition hence bank managers are not pushed to be more efficient. A negative sign on the other hand would mean that concentration itself is as a result of efficient production processes by the most dominant banks (Wezel, 2010). Thus, more efficient banks are the ones that have higher profits and thus gain more market share.

Table 1: Variables description and Data sources

Name	Variable	Description	Source
Total Cost	TC	This is interest and non-interest expenses in USD.	Bankscope
Total Loans	Loans	Total loans as defined in bankscope	Bankscope
Price of Labour	w1	Personnel expenses as a ratio of total assets	Bankscope
Price of Physical capital	w2/w1	other non-interest operating expenses as a ratio of fixed assets scaled by the price of labour	Bankscope
Price of deposits	w3/w1	ratio of interest expense as a ratio of total deposits and short-term funding scaled by price of labour	Bankscope
Bank concentration	CR3	the assets of the three largest banks as a share of total assets of the industry	Global Finance Development Database
GDP per capita	GDPp.c PPP	GDP per capita, PPP	World Development Indicators
Monetary Policy	Policy	monetary policy rate	IFS, Central bank websites
Capitalization	CAR	Ratio of total capital to total assets	Bankscope
Equity ratio	EQUITY	Ratio of total equity to total assets	Bankscope
Liquidity ratio	LIQ	The ratio of liquid assets to total assets	Bankscope
Bank size	SIZE	Natural log of Total Assets	Bankscope
GDP per capita growth	GDPp.c.g	GDP Per capita, growth	World Development Indicators
Inflation	CPI	Inflation, consumer price	World Development Indicators

4 Descriptive Statistics and Correlations

4.1 Descriptive Statistics

Table 2 shows the descriptive statistics of the data used in the study. From the table, the mean total cost of the continent is around US$152 million. The Southern African region has the highest mean total cost of around US$314 million with the Central African region having the least mean total cost of around US$ 30 million. The varying degrees of bank cost allows the study to better appreciate the difference in the management of bank costs by different banks with different cost structures. This ensures that the cost efficiency scores are not biased for either banks with higher costs or those with lower costs.

The results also show that the mean loans for the continent is around US$ 1.2 billion again with the Southern African region recording the highest mean total loans of around US$2.8 billion followed by North Africa with a mean total laons of around US$1.5 billion. Again, the Central African region recorded a mean total cost of US$215 million. These suggest that the southern African region has the largest market followed by North Africa with Central Africa being the smallest market for loans. Again, this shows the varying degrees in size of the banks in terms of giving out credit. This helps the study to test the bank lending channel through different means; both banks with small credit and large credit portfolios.

The table also shows similar mean price of labour for the continent and the sub-samples. The continent recorded a mean labour price of 0.02 with the minimum of 0.01 recorded in north Africa. The continent however recorded a mean price of capital of 197.75 with Southern Africa recording the highest price of capital of 434.45 while East Africa recorded the least of 81.73. Also, the continent recorded a mean deposit price of 3.18 with the highest deposit price of 4.36 recorded in Southern Africa and the least recorded in Central Africa.

From the table also, the mean age of banks in Africa is around 30 years. Indeed, the sub-regions seem to have relatively experienced banking markets with the oldest banks being in North Africa with a mean age of 32 years, while the youngest banks are found in Central Africa with a mean age of 21 years. The varying experience levels in the sample further strengthens the argument of accounting for this in the efficiency estimation as the study conjectures that banks learn by doing and thus more experienced banks are more likely to be cost efficient than less experienced banks.

The mean equity ratio for the continent is around 13% ranging from a low of 9% in Central Africa to a high of 14% in both North and East Africa. This presents a fairly well-represented data combining both riskier banks (low equity ratio) and less risk banks. The continent recorded a mean capital ratio (CAR) of 21% with the North and East Africa also recording the same mean ratio. The highest capitalization is seen in Central Africa with a mean capital ratio of around 32%. Southern Africa has a mean CAR of 20% a little shy away from the continent's average. Hence, while banks in the various regions have similar levels of capitalization, the Central African region is relatively highly capitalized suggesting low risk.

The mean total assets for the continent is around US$ 2.3billion. The largest banking sector is that of Southern Africa with mean total assets of around US$ 4.4billion while the Central Africa has the smallest banking sector with a mean of US$ 433 million. The varying degrees of bank size in terms of assets could show how both small and big banks absorb monetary policy shocks. This presents a good blend for the sample. Bank concentration shows that the three-largest banks control a mean of 64% of total industry assets on the continent. Southern Africa has the highest concentrated market with a mean of 72% above the continent's average with North Africa having 59

Concerning the monetary policy variable, on average the monetary policy rate for the continent is 9% with the Central African region recording the highest mean rate of 12%. Southern and East Africa regions also recorded double digit monetary policy rate of 10.6% and 11.4% respectively. The lowest mean monetary policy rate is in North Africa with a rate of 5.9%. The mean central bank independence index for the continent is 0.51 with West and central Africa having higher central independence index of 0.58 above the continent's average. The least independent central banks are in Southern Africa with a mean of 0.48.

The average Inflation (CPI) of the continent is 7.9% with the higest rate of 25.9% recorded in

Central Africa. The lowest mean inflation rate is 5.3% recoded in North Africa. The variation in consumer prices in different countries and regions presents the need to account for loan demand factors. The average GDP per capita (PPP) for the continent is around US$5,200 with North Africa recording the highest mean per capita GDP of US$10,000. The least mean per capita GDP is around US$2,100 recorded in East Africa. This shows different income levels or development status of the countries included in the study. Also, the continent recorded a mean GDP per capita growth of 2.79% with the highest growth recorded in East Africa and the least growth recorded in Central Africa.

4.2 Correlation Matrix

Here, the study test for multicollinearity in the independent variables using the correlation matrix. Kennedy (2008) indicates a threshold correlation coefficient of 0.70 below which the variables are free of multicollinearity. First the results in Table 3a shows the correlation between the variables used in estimating the group specific and metafrontier efficiency scores. The table shows that all correlation coefficients are below the 0.70 mark with the least being 0.013 between the price of deposits (lnw3/w1) and AGE and the highest being 0.469 between Loans and GDPp.c.PPP. Table 3b similarly shows correlation coefficients below 0.700 with a least coefficient of 0.011 between GDPp.c.g and CAR and between GDPp.c.g and SIZE. The highest correlation coefficient is 0.570 which is recorded between EQUITY and CAR. Even though these are below the 0.70 threshold EQUITY and CAR are used in separate estimations as measures of firm risk.

Table 2: Descriptive Statistics

Variable	Africa	SSA	North	Southern	East	West	Central
Total cost (TC) (US$ Thousand)	151,615.30	145,118.30	170,631.60	314,105.90	44,145.44	95,753.97	29,883.14
	(657731.4)	(697334.1)	(394723.8)	(1186731)	(85436.51)	(224916.5)	(26012.67)
Total Loans (Loans) (US$ Thousand)	1,244,724	1,162,996	1,532,338	2,770,434	306,138.1	543,931.2	215,094.6
	(5880582)	(6342422)	(2479512)	(10900000)	(694644.8)	(1279847)	(265877.1)
Labour price (w1)	0.02	0.03	0.01	0.03	0.03	0.02	0.02
	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Physical capital price (w2/w1)	197.75	197.54	189.82	434.45	81.73	83.69	98.72
	(1679.72)	(1756.87)	(1183.76)	(3066.29)	(121.26)	(236.58)	(157.83)
Deposit price (w3/w1)	3.18	2.91	4.36	4.79	2.45	1.79	1.22
	(10.67)	(10.81)	(9.55)	(18.39)	(4.01)	(1.64)	(1.29)
Age	30.09	29.44	32.17	31.08	29.37	30.31	21.6
	(29.43)	(30.14)	(24.98)	(33.58)	(26.53)	(32.15)	18.05)
Equity ratio % (Equity)	13.1	12.98	14.16	13.9	14.83	10.78	9.18
	(9.80)	(9.18)	(12.29)	(10.26)	(9.67)	(6.66)	(7.65)
Capitalization % (CAR)	21.39	21.44	21.22	20.43	21.71	22.46	31.7
	(17.23)	(17.64)	(13.99)	(11.30)	(13.09)	(29.70)	(24.98)
Liquidity % (LIQ)	41.43	40.68	44.95	47.01	42.61	28.97	52.05
	(43.58)	(44.65)	(36.77)	953.16)	(50.47)	(28.34)	(22.55)
Total Assets (US$ Thousand)	2,345,716	1,990,308	3,810,417	4,379,891	645,492.1	1,188,149	432,627.9
	(9214595)	(9547748)	(6902871)	(16200000)	(1539049)	(2861795)	(439335.7)
Bank Concentration% (CR3)	64.25	65.58	59.02	72.20	60.32	63.22	64.33
	(17.63)	(17.82)	(15.44)	(15.02)	(18.83)	(18.77)	(12.15)
Monetary policy% (MP)	8.87	9.61	5.91	10.6	11.43	7.24	12.74
	(7.56)	(8.22)	(2.05)	(7.33)	(3.63)	(6.05)	(17.16)
Central Bank Independence (CBI)	0.51	0.52	0.49	0.47	0.48	0.58	0.58
	(0.15)	(0.15)	(0.11)	(0.12)	(0.15)	(0.18)	(0.03)
Inflation, consumer price% (CPI)	7.9	8.44	5.27	7.75	10.49	5.44	15.94
	(19.14)	(20.88)	(3.57)	(12.53)	(7.40)	(5.35)	(68.16)
GDP per capita, PPP (GDPp.c.PPP) (US$)	5,208.73	4,106.28	10,163.45	7,341.75	2,094.38	2,815.72	3,034.3
	(4742.29)	(4031.55)	(4405.99)	(5262.25)	(729.54)	(1476.41)	(4278.36)
GDP per capita Growth% (GDPp.c.g)	2.79	2.84	2.43	3.17	3.56	2.11	2.00
	(7.31)	(3.40)	(15.58)	(3.74)	(3.02)	(3.33)	(2.30)

NB: Standard deviation in parenthesis. Cost is total interest and non-interest expense; Loans is total loans; w1 is the ratio of personnel expenses to total assets; w2 is the ratio of other operating expenses to fixed assets; w3 is the ratio of interest expense to deposits and short term funding; EQUITY is the ratio of equity to total assets; CAR is the ratio of total capital to total assets; GDP p.c PPP is the GDP per capita (PPP); Age is the number of prior years of experience of the bank; LIQ is the ratio of liquid assets to deposits and short term funding; Assets is total assets; Policy is the monetary policy rate; CR3 is the ratio of the total assets of the 3-Largest banks to total assets of all banks; CPI is the inflation, consumer prices; GDP p.c. PPP is the GDP per capita in purchasing power parity terms; GDP p.c.g is the GDP per capita growth.

Table 3a: Correlation matrix (Variables for first-stage SFA and SMF analysis)

	lnLoans	lnw2/w1	lnw3/w1	EQUITY	LIQ	AGE	CR3	GDPp.c. PPP
Loans	1	0.351***	0.405***	-0.244***	-0.126***	0.314***	-0.141***	0.469***
lnw2/w1		1	0.314***	-0.173***	0.021	-0.027*	-0.017	0.294***
lnw3/w1			1	0.028*	0.050***	-0.013	-0.104***	0.210***
EQUITY				1	0.413***	-0.117***	-0.060***	0.032**
LIQ					1	-0.149***	0.144***	0.071***
AGE						1	-0.107***	0.099***
CR3							1	-0.043***
GDPp.c.PPP								1
NB: * Significance at 10%, ** Significance at 5%, *** Significance at 1%								

Table 3b: Correlation matrix (Variables for second-stage GMM analysis)

	ΔMP	CostEff	EQUITY	CAR	LIQ	SIZE	GDP p.c.g	CPI
ΔMP	1							
CostEff	0.026	1						
EQUITY	0.013	0.026	1					
CAR	-0.025	-0.056**	0.570***	1				
LIQ	-0.072***	-0.215***	0.413***	0.324***	1			
SIZE	0.034*	-0.310***	-0.208***	-0.182***	-0.116***	1		
GDP p.c.g	-0.016	-0.049***	0.019	0.011	0.023	-0.011	1	
CPI	-0.021	-0.032**	0.036**	0.033	0.059***	-0.068***	-0.039**	1
NB: * Significance at 10%, ** Significance at 5%, *** Significance at 1%								

5 Empirical results

5.1 Estimation of Efficiency Scores

The study estimates the cost efficiency scores for each of the 38 countries. This is done following Equation 7 and estimating the country-specific efficiency scores (CE) as given by Equation 8. These CEs are used in Equation 10 in the estimation of the metafrontier cost efficiency (MCE) scores. The technological gap ratio (TGR) is estimated following Equation 11 and finally the MCEs are estimated following Equation 12. The study presents the results of the metafrontier model in Table 4a. According to Huang et al. (2014), the significance of the variance ratio shows that the SMF approach which uses the predicted value of the group specific frontiers, $ln\hat{f}_t^j\left(\mathbf{X}_{jit}\right)$, as shown in Equation 10 justifies the use of this approach over the linear programming approach of Battese et al. (2004) and O'Donnell et al. (2008). If the group-specific frontiers, $lnf_t^j\left(\mathbf{X}_{jit}\right)$, are equal to the estimated values, $ln\hat{f}_t^j\left(\mathbf{X}_{jit}\right)$, then V_{jit}^M as seen in Equation 10 should be equal to zero, or equivalently $\sigma_v^M = 0$. From Table 4a, $\sigma_v^M = 0.580$ and it is statistically different from zero at 1% significance level. This indicates that the choice of the stochastic frontier approach of Huang et al. (2014) in the metafrontier estimation is justified showing the bias in the linear programming approach of Battese et al. (2004) and O'Donnell et al. (2008).

The study uses the Log Likelihood ratio test (LRT) of Kumbhakar, Wang and Homcastle (2015) to test the presence of technical inefficiency (in this case cost inefficiency) in the errors. Kumbhakar et al. (2015) indicate that in models that have truncated-normal or parameterization of the inefficiency by no constant variables, the gamma parameter $\gamma = \sigma_v^2/(\sigma_u^2 + \sigma_v^2)$ which tests a hypothesis of $\gamma = 0$ for the existence of one-sided error is not useful. Hence, the use of the LRT is preferred.

The LR test statistic is given by $-2[L\left(H_0\right) - L\left(H_1\right)]$. Where $L\left(H_0\right)$ is the log likelihood of the restricted model and $L\left(H_1\right)$ is the log likelihood from the SMF estimation. The log likelihood value estimated for $L\left(H_0\right)$ using the generalized linear model (GLM) is -3663.674082 and that of $L\left(H_1\right)$ as shown below Table 4a is given as -3615.5339. The LR test statistic is therefore 96.28 ($-2[-3663.674082 - (-3615.5339)]$). This has a mix distribution with 2 degrees of freedom since two parameters are restricted (i.e., $\sigma_u^2 = 0, \mu = 0$). The test statistic 96.28 is read against the critical values provided by Kodde and Palm (1986). The critical value at 1% significance level provided by Kodde and Palm (1986) is 8.273. Given that the test statistic is 96.28 higher than the critical value, the results from Table 4.3a strongly rejects the null hypothesis of no cost inefficiency. Hence the use of SMF is justified.

From Table 4a, all coefficients in the frontier model are statistically significant at 1%. The output variable (lnLoans) has a positive and significant coefficient at 1% with ln(w2/w1) also showing a positive sign. $ln(w3/w1)$ shows a negative and significant coefficient satisfying the homogeneity constraint; given that the study scaled the prices and dependent variable by the price of labour ($w1$). Concerning the environmental variables, CR3 has a significant negative impact on cost inefficiency at 5% level. This supports the efficient-structure hypothesis which argues that both concentration and efficiency are endogenous. This means that cost efficient banks are the ones that increase their market share as they enjoy greater profit and thus increase their superiority (more market concentration) in the banking system (Demsetz, 1973). This supports the findings of Kasman and Carvallo (2013) who also found concentration to increase efficiency.

The results also showed that GDPp.c.PPP has a significant positive impact on cost inefficiency. This may be the case that as countries develop the banking system is likely to be more competitive. This results in banks offering products at higher costs hence leading to a reduction in their profit margins. This supports the argument of Dietsch and Lozano-Vivas (2000). The SSA dummy showed a significant negative impact on cost inefficiency at 1% level. This shows that the SSA region is more cost efficient than their North African counterparts. This supports the findings of Kablan (2010) who also show that SSA countries are generally cost efficient. Given that the NA region is mostly characterised with high oil revenues, these countries are more developed than their SSA counterparts and are thus more likely to face stiffer competition hence reducing their cost efficiency.

Table 4a: Estimates of the Stochastic Metafrontier Model - Africa

Variable	Coef.	Std. Err.
Frontier		
ln(Loans)	0.340***	0.063
ln(w2/w1)	0.666***	0.075
ln(w3/w1)	-0.544***	0.082
ln(Loans)*ln(w2/w1)	-0.051***	0.007
ln(Loans)*ln(w3/w1)	0.043***	0.007
ln(w2/w1)*ln(w3/w1)	0.039***	0.007
0.5*ln(loans)*ln(loans)	0.053***	0.005
0.5*ln(w2/w1)*ln(w2/w1)	0.027***	0.009
0.5*ln(w3/w1)*ln(w3/w1)	0.018**	0.008
constant	5.156***	0.449
Second-step Environmental variabes equation		
CR3	-0.010*	0.005
GDP.p.c. PPP	0.000**	0.000
SSA dummy	-2.545***	0.709
Log Likelihood = -3615.5339		
σ_u^M	0.604***	0.077
σ_v^M	0.580***	0.008
λ(lamda)	1.042***	0.079
Wald χ^2[P-Value]	21300 [0.000]	
No. Obs.	3909	
Number of banks	447	

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%.

Following from the estimation of the metafrontier cost function, the MCE are estimated following Equation 12. The study presents the descriptive statistics for the whole sample and sub-samples of the country-specific cost efficiency score (CE), the technology or cost gap ratio (TGR) and the meta-cost efficiency (MCE) in Table 4b. Africa is the full sample hence the MCE for Africa is where Africa is used as the metafrontier. As robustness checks, the study also uses the various regions in Africa as the metafrontier and estimate their corresponding MCEs. Here, North Africa means the North African region is used as the metafrontier and Sub-Saharan Africa means the Sub-Saharan African region is used as the metafrontier so on for the other regions.

The Table shows that the mean MCE scores of the continent is 0.622 indicating that the average bank in Africa operates at 62.2% efficiency level. This varies from a minimum of 0.003

to a maximum of 0.925 for the continent. The mean country specific CE however is higher with 0.724 cost efficiency score. This is because banks in Africa are on average operating at 86.1% of cost efficiency level given the best technology in the continent. The results for SSA are very close to that for Africa. The mean CE and MCE for SSA is 0.735 and 0.611 respectively with a TGR of 0.840. This shows that the best technology used in the whole continent (mean MCE) is only about 1.1% slightly higher than the SSA region.

As indicated earlier, the various regions (North, East, West, Southern, Central) in the continent are also used as the metafrontier while the individual countries are still considered as the group with the same technology. On average, the countries in West Africa have the highest CE of 0.847 followed by the countries in Central Africa with a CE of 0.787. The region with the least mean score of CE is North Africa. It is not surprising as the initial estimation of the metafrontier for Africa showed that the SSA countries are more cost effective than the NA counterparts. Looking at the TGR, West Africa still leads with a ratio of 0.823 indicating that on average the best cost-efficient technology in the is being used in the region. The region however recorded MCE score of 0.696. The North African region has the lowest meta cost efficiency score (MCE) of 0.161 with TGR of 0.268 and CE score of 0.688.

The trend analysis of the various MCEs for Africa along with that of the regional frontiers are presented in Figure 1. The trend shows that West Africa leads with the highest MCE even though if follows a downward trend in cost efficiency. This is followed by Central African region which has seen a generally upward trend over the years. Generally, it can be seen that meta-cost efficiency in Africa has remained stable over the years. The MCE for Africa averages between the MCE of West, Central and East Africa. The figure further shows that the Southern and East African regions have seen an increasing trend in cost efficiency over the period. The north African region has the least MCE also showing a downward trend.

Table 4b: Efficiency scores and Technology Gap Ratios (TGRs)

Variable	Mean	SD	Min.	Max.	Obs.	No. of banks
Africa						
CE	0.724	0.217	0.003	1.000	3909	447
TGR	0.861	0.098	0.150	0.936	3909	
MCE	0.622	0.198	0.003	0.925	3909	
Sub-Saharan Africa (SSA)						
CE	0.735	0.200	0.011	1.000	3252	363
TGR	0.840	0.115	0.194	0.980	3252	
MCE	0.611	0.174	0.011	0.977	3252	
North Africa						
CE	0.688	0.275	0.003	0.995	710	90
TGR	0.268	0.160	0.024	0.949	710	
MCE	0.161	0.107	0.001	0.889	710	
West Africa						
CE	0.847	0.133	0.111	0.999	970	117
TGR	0.823	0.099	0.206	0.972	970	
MCE	0.696	0.132	0.098	0.945	970	
East Africa						
CE	0.665	0.196	0.186	1.000	933	106
TGR	0.759	0.185	0.057	0.974	933	
MCE	0.481	0.134	0.047	0.926	933	
Southern Africa						
CE	0.674	0.214	0.011	0.999	1051	110
TGR	0.684	0.179	0.110	0.939	1051	
MCE	0.453	0.178	0.010	0.938	1051	
Central Africa						
CE	0.787	0.166	0.027	0.999	245	24
TGR	0.798	0.110	0.571	0.995	245	
MCE	0.626	0.153	0.017	0.967	245	

Source: Authors' calculations

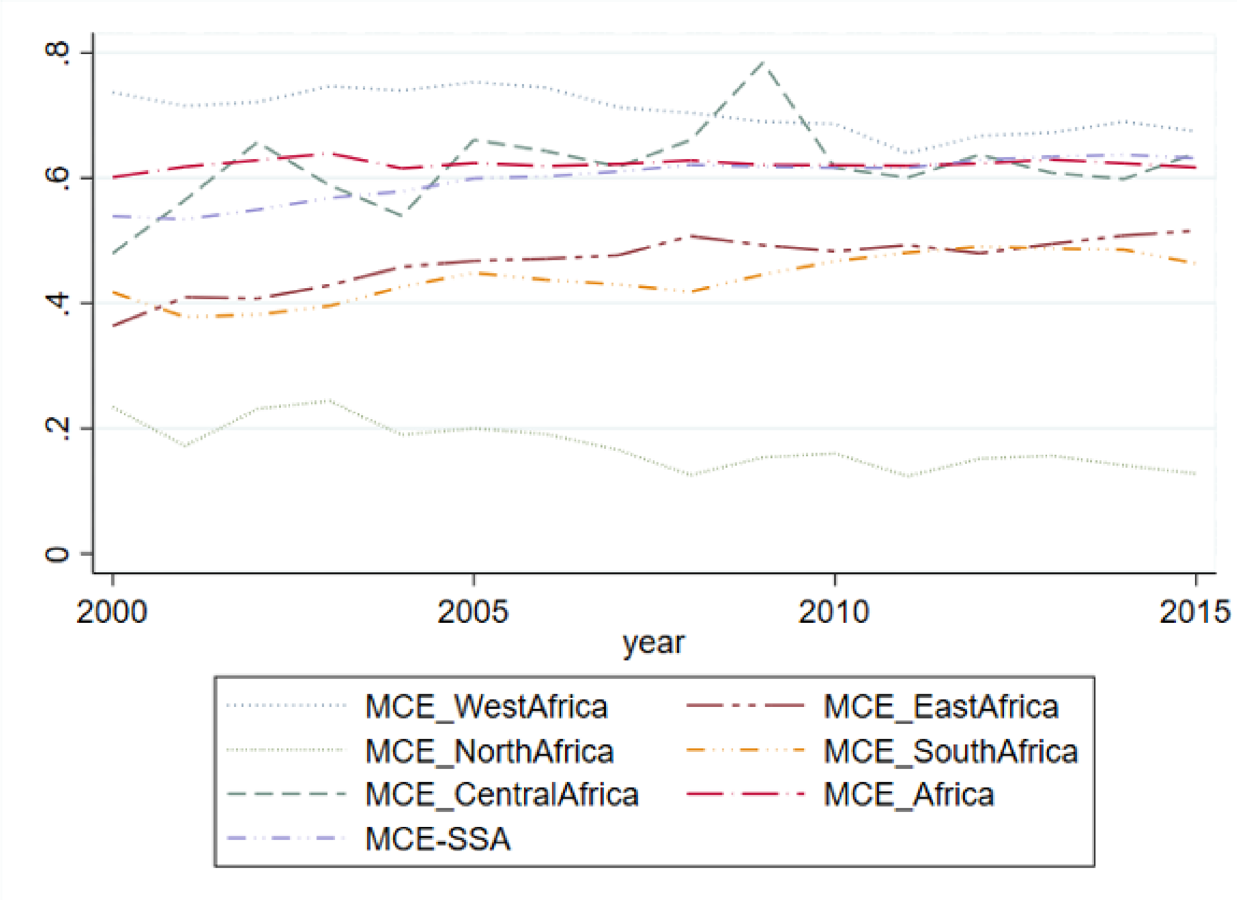

Figure 1: Trend of Average Meta-Cost Efficiency (MCE) of Africa and Regional Frontiers

5.2 Testing the BLC: baseline results -FE regression

The baseline results from the FE regression are shown in Table 5. The results show that monetary policy has a significant negative impact on loan growth in Africa. The results are similar for some of the regions (SSA, Southern and West). The other regions generally showed a negative sign for Policy variable even though it was not significant. From these baseline results, these initial results indicate that the bank lending channel exists in Africa. Cost efficiency however generally showed a consistent positive impact on loan growth in almost all the regressions mostly at 1% significance level. On the controls, only bank size, GDPp.c.g and inflation were significant in some of the regressions. Generally, bank size has a negative impact on loan growth. GDPp.c.g showed a significant positive impact on loan growth as expected and inflation showed negative impact on loan growth with the results for southern Africa showing a positive impact.

5.3 Testing the BLC -2SLS results

To check for the causality between monetary policy and loan growth, the study uses the 2SLS method. Because our model is exactly identified, the Sargan test for over-identification restrictions cannot be calculated. Angrist and Pischke (2009) recommend the picking of the best single instrument and report just-identified estimates using this one only. This is because the just identified IV is median-unbiased and therefore unlikely to be subject to a weak-instruments critique. Another way of examining the exogeneity assumption in the case of exactly identified models, as suggested by Altonji, Elder and Taber (2005) is testing the sensitivity of the estimates to the exclusion and inclusion of control variables. The incremental addition of control variables across columns (1) to (12) in Tables 6a to 6g show that our 2SLS estimate are generally not sensitive to the inclusion and exclusion of control variables. The first-stage F-tests show that the F-statistics are mostly (except for Central Africa) larger than the conventional value of 10 as suggested by Stock, Wright, and Yogo (2002). Also, CBI has a significant impact on monetary policy in the first-sage regression. These results suggest that CBI is sufficiently correlated with monetary policy (MP) variable to serve as a potentially good instrument.

The results from Table 6a are consistent with our conjecture that endogeneity leads to a downward bias in the fixed effect model. The coefficient on MP is negative and statistically significant at the 10% level in all regressions, suggesting that contractionary monetary policy leads to a fall in loan growth. The results confirm earlier evidence by Boughrara & Ghazouani (2010), Matousek & Solomon (2018) and Abuka et al. (2019) who also found evidence of the bank lending channel in country case studies. Generally, banks in Africa respond to contractionary monetary policy shocks through a fall in loan growth. FSimilar results are found in the sub-samples (regions) in tables 6b to 6f. Specifically, the bank lending channel is seen in North Africa, Southern Africa, East Africa and West Africa with contractionary monetary policy having a negative effect on loan growth with 1% significance level. It is only in Central Africa where the bank lending channel is not seen with insignificant coefficient of monetary policy variable even though the sign is negative. These results confirm that a contractionary monetary policy decision through a rise in the monetary policy rate will lead to a fall in loan growth. Generally, banks in Africa respond to contractionary monetary policy shocks through a fall in loan growth.

Moving on to the efficiency variable, the results show that bank efficiency has a significant positive impact on loan growth in almost all the estimations with mostly 1% significance level. This confirms the argument of the study that, banks that are cost efficient are able to have better loan prices and thus are likely to give out more loans than inefficient banks. This confirms the findings of Shamshur and Weill (2019) who found that bank efficiency reduces the cost of credit. This justifies the role of bank cost efficiency in the BLC and its possible moderating role in the BLC. Thus, the introduction of bank cost efficiency in the bank lending channel is novel and must be included as a determinant of credit growth models. On the other controls, only bank size and GDP p.c.g had a significant negative and positive impact respectively in most of the regressions with equity ratio showing positive impact in few instances. These results show that larger banks may not take advantage of their ability to solve information asymmetry problems to give out more loans. Economic growth or development also encourages expansion of credit.

Again, other sources of endogeneity may exist in the model due to the inclusion of the bank-level data. For instance, banks may become bigger or larger because of the growth on their loans. Also, bank capitalization could decrease as the bank increases in size hence bank capitalization may not be a good indicator of liquidity constraints (Olivero, Li & Jeon 2011). Also, when banks decide to keep more liquidity to compensate for stronger financing restrictions, liquidity could therefore be a biased measure of financial constraints. Hence, as further robustness, the study follows the approach of Olivero et al. (2011) and use two lags of the bank specific variables as instruments in the 2SLS estimations. These results are shown in Table 6h. The results are consistent with the earlier findings with the expected sign for the monetary policy variable. The presence of bank lending channel is again confirmed for the full sample and all sub-regions except for North and Central Africa.

Table 5: Bank Lending channel in Africa - with regional blocs - FE regressions

Variable	Africa		SSA		North		Southern		East		West		Central	
ΔMP	-0.258*	-0.257*	-0.368*	-0.250*	0.504	0.360	-1.070**	-1.062**	-0.462**	-0.538***	-1.101*	-1.000	-0.059	-0.062
	(0.145)	(0.145)	(0.217)	(0.136)	(1.299)	(1.275)	(0.468)	(0.466)	(0.188)	(0.163)	(0.632)	(0.622)	(0.204)	(0.203)
CostEff	0.451***	0.460***	0.562***	0.410***	1.510*	1.482*	0.451***	0.460***	0.491*	0.557***	0.522***	0.542***	0.148	0.092
	(0.106)	(0.107)	(0.117)	(0.072)	(0.852)	(0.804)	(0.120)	(0.127)	(0.282)	(0.187)	(0.161)	(0.169)	(0.279)	(0.295)
CAR	-0.078		-0.194		-0.402*		-0.333*		-0.300		-0.159		-0.025	
	(0.062)		(0.138)		(0.241)		(0.178)		(0.239)		(0.180)		(0.026)	
EQUITY		-0.119		-0.050		0.012		-0.163		-0.566		-0.034		0.619*
		(0.199)		(0.165)		(0.268)		(0.368)		(0.373)		(0.390)		(0.360)
LIQ	0.028	0.031	0.076*	0.029	0.030	0.027	0.072***	0.063**	0.077	0.010	-0.136	0.146	-0.070	-0.091
	(0.032)	(0.030)	(0.043)	(0.025)	(0.166)	(0.168)	(0.023)	(0.024)	(0.201)	(0.023)	(0.145)	(0.140)	(0.225)	(0.224)
SIZE	-11.516***	-11.435***	-12.524***	-13.692***	5.517	6.261	-10.315***	-9.845***	-12.945**	-11.700***	-12.966**	-12.681**	-16.900***	-16.958***
	(2.061)	(2.045)	(2.641)	(1.141)	(7.052)	(7.541)	(3.510)	(3.500)	(6.652)	(4.369)	(5.164)	(5.214)	(5.994)	(5.823)
GDP p.c.g	0.296**	0.296**	1.914***	1.835***	0.020	0.019	2.490***	2.506***	3.419***	3.166***	0.702	0.701*	2.100	1.827
	(0.128)	(0.128)	(0.353)	(0.212)	(0.104)	(0.091)	(0.515)	(0.509)	(1.137)	(0.949)	(0.432)	(0.425)	(1.423)	(1.454)
CPI	-0.404**	-0.400**	0.301	-0.389***	2.167*	2.203*	0.430***	0.442***	0.657*	0.700**	-0.952**	-0.990**	-0.724***	-0.732***
	(0.199)	(0.199)	(0.191)	(0.045)	(1.261)	(1.223)	(0.104)	(0.103)	(0.369)	(0.318)	(0.407)	(0.390)	(0.198)	(0.193)
R^2	0.19	0.30	0.30	0.19	0.27	0.26	0.26	0.26	0.22	0.22	0.14	0.27	0.45	0.46
Obs.	1149	2318	963	1851	186	467	359	501	310	388	279	763	15	199

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6a: Bank Lending channel in Africa - 2SLS (instrumenting for monetary policy)

variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔMP	-2.601*	-2.520*	-2.487*	-2.498*	-2.544*	-2.332*	-2.352*	-2.574*	-2.614*	-2.594*	-2.377*	-2.395*
	(1.460)	(1.442)	(1.434)	(1.440)	(1.409)	(1.383)	(1.394)	(1.440)	(1.451)	(1.417)	(1.390)	(1.401)
CostEff		0.300***	0.312***	0.308***	0.271***	0.270***	0.267***	0.291***	0.279***	0.256***	0.256***	0.253***
		(0.077)	(0.078)	(0.079)	(0.079)	(0.089)	(0.078)	(0.078)	(0.080)	(0.079)	(0.079)	(0.078)
CAR			0.076	0.078	0.059	0.059	0.058					
			(0.048)	(0.049)	(0.046)	(0.046)	(0.046)					
EQUITY								0.132	0.162*	0.054	0.041	0.038
								(0.089)	(0.094)	(0.102)	(0.101)	(0.102)
LIQ				-0.007	-0.021	-0.020	-0.020		-0.047	-0.023	-0.021	-0.020
				(0.019)	(0.021)	(0.021)	(0.021)		(0.022)	(0.024)	(0.024)	(0.024)
SIZE					-3.485***	-3.504***	-3.539***			-3.525***	-3.561***	-3.600***
					(0.678)	(0.674)	(0.676)			(0.726)	(0.721)	(0.724)
GDP p.c.g						0.710**	0.563*				0.704**	0.552*
						(0.293)	(0.321)				(0.293)	(0.321)
CPI							-0.333					-0.343
							(0.285)					(0.287)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage regression												
CBI	0.032***	0.032***	0.032***	0.032***	0.032***	0.032***	0.032***	0.032***	0.032***	0.032***	0.032***	0.032***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
1st stage F test	16.98	17.13	17.14	16.99	16.98	16.69	16.59	17.06	16.76	16.75	16.64	16.37
R^2	0.18	0.19	0.20	0.20	0.21	0.23	0.23	0.19	0.19	0.20	0.22	0.22
Obs.	2244	2244	1098	1098	1098	1098	1098	2244	2244	2244	2244	2244

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6b: Bank Lending channel in Sub-Saharan Africa - 2SLS (instrumenting for monetary policy)

variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔMP	-1.588*	-1.562*	-1.564*	-1.533*	-1.576*	-1.356	-1.312	-1.562*	-1.573*	-1.598*	-1.377	-1.331
	(0.936)	(0.936)	(0.932)	(0.933)	(0.901)	(0.878)	(0.853)	(0.926)	(0.929)	(0.901)	(0.878)	(0.852)
CostEff		0.215***	0.236***	0.244***	0.230***	0.229***	0.223***	0.211***	0.204**	0.206**	0.205**	0.199**
		(0.083)	(0.083)	(0.087)	(0.085)	(0.084)	(0.084)	(0.082)	(0.086)	(0.085)	(0.084)	(0.084)
CAR			0.078	0.077	0.060	0.059	0.058					
			(0.051)	(0.051)	(0.048)	(0.047)	(0.047)					
EQUITY								0.300***	0.322***	0.160	0.156	0.151
								(0.111)	(0.023)	(0.123)	(0.122)	(0.122)
LIQ				0.012	0.002	0.003	0.004		-0.009	-0.007	-0.006	-0.005
				(0.017)	(0.019)	(0.019)	(0.019)		(0.023)	(0.024)	(0.024)	(0.023)
SIZE					-4.454***	-4.481***	-4.522***			-4.359***	-4.390***	-4.434***
					(0.814)	(0.809)	(0.811)			(0.847)	(0.844)	(0.847)
GDP p.c.g						0.795***	0.589*				0.798***	0.588*
						(0.310)	(0.349)				(0.310)	(0.350)
CPI							-0.426					-0.436
							(0.340)					(0.341)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage regression												
CBI	0.019***	0.019***	0.019***	0.019***	0.019***	0.020***	0.020***	0.019***	0.019***	0.019***	0.019***	0.020***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
1st stage F test	22.25	22.31	22.31	22.12	22.12	22.04	23.05	22.30	22.07	22..07	21.99	23.02
R^2	0.28	0.29	0.29	0.29	0.31	0.32	0.33	0.29	0.29	0.31	0.32	0.33
Obs.	1735	1735	887	887	887	887	887	1735	1735	1735	1735	1735

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6c: Bank Lending channel in North Africa - 2SLS (instrumenting for monetary policy)

variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔMP	-0.006	-9.609	-8.401	-6.381	-4.501	-20.551	-44.894	-6.927	-7.156	-5.407**	-22.837	-58.833
	(51.946)	(40.832)	(41.920)	(41.451)	(43.501)	(164.277)	(295.685)	(38.734)	(38.755)	(41.213)	(160.195)	(354.832)
CostEff		0.741	0.775	0.730	1.121	-0.222	0.970	0.847	0.699	1.081	-0.245	0.708
		(0.785)	(0.812)	(0.795)	(1.201)	(2.445)	(5.543)	(0.733)	(0.692)	(1.102)	(1.508)	(6.337)
CAR			-0.130	-0.037	0.030	-0.106	-0.114					
			(0.240)	(0.220)	(0.193)	(0.199)	(0.489)					
EQUITY								-0.135	0.027	0.074	0.072	0.061
								(0.279)	(0.244)	(0.257)	(0.296)	(0.250)
LIQ				-0.144***	-0.117***	-0.057	-0.139		-0.150***	-0.127***	-0.066	-0.157
				(0.037)	(0.043)	(0.070)	(1.188)		(0.058)	(0.043)	(0.082)	(0.224)
SIZE					6.212	-1.398	3.541			6.392	-0.891	3.274
					(10.549)	(4.567)	(26.360)			(11.087)	(4.748)	(28.047)
GDP p.c.g						1.521	3.652				1.643	4.645
						(9.810)	(21.314)				(9.531)	(25.786)
CPI							4.664					5.248
							(13.385)					(16.628)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage regression												
CBI	0.003***	0.004***	0.004***	0.004***	0.004***	-0.001	0.000	0.004***	0.004***	0.004***	-0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
1st stage F test	34.17	20.25	19.70	20.01	23.93	0.56	0.01	19.70	19.62	29.35	0.60	0.01
R^2	0.21	0.21	0.22	0.26	0.28	-0.32	-0.83	0.24	0.25	0.25	-0.49	-1.13
Obs.	459	459	183	183	183	183	183	459	459	459	459	459

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6d: Bank Lending channel in Southern Africa - 2SLS (instrumenting for monetary policy)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔMP	-9.296**	-8.686**	-8.423**	-7.991*	-11.171***	-9.990***	-12.001**	-8.007**	-7.513*	-10.506**	-10.830***	-11.815**
	(3.963)	(4.272)	(4.278)	(4.716)	(4.290)	(4.451)	(6.339)	(4.015)	(4.534)	(4.149)	(4.096)	(5.237)
CostEff		0.323**	0.340**	0.338**	0.392***	0.420**	0.467**	0.310**	0.314**	0.379***	0.375***	0.397**
		(0.146)	(0.149)	(0.148)	(0.146)	(0.204)	(0.224)	(0.140)	(0.141)	(0.147)	(0.142)	(0.158)
CAR			0.128	0.108	0.049	-0.002	0.038					
			(0.147)	(0.172)	(0.191)	(0.276)	(0.236)					
EQUITY								0.169	0.135	0.087	0.105	0.136
								(0.164)	(0.201)	(0.227)	(0.224)	(0.243)
LIQ				0.009	0.019	0.060	0.058		0.012	0.009	0.018	0.015
				(0.029)	(0.029)	(0.042)	(0.045)		(0.029)	(0.031)	(0.030)	(0.032)
SIZE					-2.474**	-3.155***	-3.187***			-2.450**	-2.401**	-1.895
					(1.022)	(1.124)	(1.185)			(1.084)	(1.091)	(1.335)
GDP p.c.g						2.466*	3.092*				2.116***	2.400***
						(1.325)	(1.796)				(0.630)	(0.853)
CPI							1.519					0.534
							(1.687)					(0.753)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage regression												
CBI	-0.086***	-0.089***	-0.087***	-0.081***	-0.085***	-0.084***	-0.070***	-0.092***	-0.083***	-0.090***	-0.089***	-0.071***
	(0.008)	(0.010)	(0.011)	(0.015)	(0.014)	(0.013)	(0.016)	(0.012)	(0.015)	(0.014)	(0.013)	(0.015)
1st stage F test	109.65	81.31	61.73	29.40	35.70	39.97	20.01	88.84	31.11	39.90	44.07	22.97
R^2	-0.43	-0.44	-0.15	-0.03	-0.07	0.02	-0.08	-0.38	-0.32	-0.37	-0.24	-0.56
Obs.	437	437	311	311	311	311	311	437	437	437	437	437

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6e: Bank Lending channel in East Africa - 2SLS (instrumenting for monetary policy)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔMP	-0.489	-0.544	-0.769	-0.758	-0.635	-1.174	-1.905	-0.561	-0.568	-0.483	-1.086	-1.621
	(0.724)	(0.724)	(0.836)	(0.831)	(0.784)	(1.145)	(1.351)	(0.718)	(0.714)	(0.688)	(1.002)	(1.162)
CostEff		0.345**	0.509***	0.524***	0.456***	0.442***	0.383**	0.298*	0.243	0.203	0.198	0.172
		(0.152)	(0.180)	(0.166)	(0.162)	(0.165)	(0.173)	(0.161)	(0.167)	(0.167)	(0.168)	(0.174)
CAR			0.739**	0.724**	0.661**	0.657**	0.678**					
			(0.335)	(0.347)	(0.329)	(0.328)	(0.323)					
EQUITY								0.287	0.688*	0.599*	0.599*	0.598*
								(0.234)	(0.382)	(0.350)	(0.350)	(0.347)
LIQ				0.030	0.031	0.020	-0.003		-0.086*	-0.087*	-0.087*	-0.087*
				(0.130)	(0.128)	(0.131)	(0.134)		(0.045)	(0.045)	(0.045)	(0.045)
SIZE					-3.652**	-3.710**	-3.659**			-3.418***	-3.454***	-3.481***
					(1.500)	(1.520)	(1.507)			(1.310)	(1.321)	(1.321)
GDP p.c.g						-6.590	-6.634				-7.379	-7.086
						(6.412)	(6.487)				(6.013)	(5.938)
CPI							3.127**					2.288*
							(1.505)					(1.259)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage regression												
CBI	-1.486***	-1.489***	-1.465***	-1.489***	-1.471***	-1.090***	-0.945***	-1.489***	-1.490***	-1.490***	-1.086***	-0.956***
	(0.037)	(0.037)	(0.038)	(0.039)	(0.040)	(0.039)	(0.039)	(0.037)	(0.037)	(0.037)	(0.034)	(0.033)
1st stage F test	1650.17	1620.36	1480.38	1414.84	1386.57	786.67	591.59	1616.87	1607.22	1595.22	1009.73	829.31
R^2	0.41	0.42	0.45	0.45	0.46	0.46	0.46	0.42	0.43	0.45	0.45	0.45
Obs.	388	388	310	310	310	310	310	388	388	388	388	388

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6f: Bank Lending channel in West Africa - 2SLS (instrumenting for monetary policy)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔMP	-4.344*	-4.449*	-4.148*	-4.152*	-4.571*	-4.414*	-4.428*	-4.268*	-4.270*	-4.639*	-4.483*	-4.495*
	(2.309)	(2.336)	(2.360)	(2.358)	(2.421)	(2.556)	(2.595)	(2.248)	(2.251)	(2.373)	(2.510)	(2.547)
CostEff		0.245**	0.323***	0.323***	0.297***	0.301***	0.303***	0.234**	0.234**	0.265**	0.268**	0.271**
		(0.115)	(0.112)	(0.118)	(0.113)	(0.112)	(0.113)	(0.116)	(0.114)	(0.115)	(0.114)	(0.115)
CAR			0.200	0.200	0.076	0.077	0.077					
			(0.183)	(0.183)	(0.153)	(0.153)	(0.153)					
EQUITY								0.332	0.332	0.113	0.122	0.125
								(0.262)	(0.257)	(0.266)	(0.266)	(0.265)
LIQ				-0.002	-0.027	-0.030	-0.034		-0.000	-0.028	-0.031	-0.035
				(0.147)	(0.142)	(0.142)	(0.144)		(0.150)	(0.143)	(0.144)	(0.146)
SIZE					-8.774***	-8.762***	-8.752***			-9.358***	-9.347***	-9.326***
					(2.347)	(2.345)	(2.340)			(2.657)	(2.658)	(2.657)
GDP p.c.g						0.393	0.505				0.385	0.508
						(0.556)	(0.512)				(0.561)	(0.518)
CPI							0.298					0.325
							(0.557)					(0.551)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage regression												
CBI	-0.706***	-0.704***	-0.703***	-0.705***	-0.706***	-0.663***	-0.659***	-0.705***	-0.707***	-0.708***	-0.664***	-0.661***
	(0.161)	(0.161)	(0.161)	(0.158)	(0.158)	(0.158)	(0.163)	(0.160)	(0.158)	(0.157)	(0.158)	(0.162)
1st stage F test	19.35	19.22	19.13	19.80	19.94	17.55	16.39	19.50	20.08	20.32	17.78	16.66
R^2	0.30	0.31	0.32	0.32	0.34	0.35	0.35	0.31	0.31	0.34	0.34	0.34
Obs.	763	763	279	279	279	279	279	763	763	763	763	763

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6g: Bank Lending channel in Central Africa - 2SLS (instrumenting for monetary policy)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔMP	-4.389*	-3.737**	-3.771**	-5.385*	-2.576	3.998	-0.127	-3.285*	-4.677*	-1.549	2.426	-0.999
	(2.393)	(1.879)	(1.911)	(3.072)	(2.186)	(8.710)	(1.818)	(1.757)	(2.711)	(1.968)	(9.386)	(2.030)
CostEff		1.055*	1.066*	1.381	0.635	-0.469	0.148	0.922*	1.180	0.350	-0.275	0.207
		(0.569)	(0.582)	(0.883)	(0.588)	(1.222)	(0.316)	(0.528)	(0.772)	(0.517)	(1.271)	(0.345)
CAR			0.014	0.021	0.010	-0.013	0.006					
			(0.032)	(0.040)	(0.030)	(0.050)	(0.025)					
EQUITY								0.359	0.439	0.539*	0.361	0.561*
								(0.457)	(0.582)	(0.329)	(0.754)	(0.325)
LIQ				-0.400	-0.364	0.236	-0.255		-0.374	-0.331*	0.054	-0.352*
				(0.374)	(0.236)	(0.886)	(0.162)		(0.328)	(0.194)	(0.994)	(0.197)
SIZE					-11.726***	-19.093*	-11.158***			-12.584***	-17.176	-11.216***
					(4.511)	(10.595)	(2.676)			(3.932)	(11.436)	(2.914)
GDP p.c.g						10.947	2.281			-0.737	7.238	-0.227
						(18.418)	(4.213)			(0.876)	(20.720)	(4.962)
CPI							1.705					1.014
							(1.378)					(1.572)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage regression												
CBI	17.789**	20.596***	20.332***	16.317**	14.767*	-5.637	-16.741	20.999**	17.130**	15.476*	-4.237	-15.865
	(7.821)	(7.800)	(7.823)	(7.588)	(7.811)	(10.166)	(10.535)	(8.422)	(8.205)	(9.268)	(11.136)	(11.277)
1st stage F test	5.17	6.97	6.75	4.62	3.57	0.31	2.53	6.22	4.36	2.79	0.14	1.98
R^2	-2.15	-1.32	-1.35	-3.11	-0.36	-1.32	0.49	-0.93	-2.25	0.16	-0.19	0.35
Obs.	199	199	15	15	15	15	15	199	199	199	199	199

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 6h: Bank Lending channel in Africa - 2SLS (instrumenting for monetary policy and bank level variables)

variable	Full Sample (Africa)		SSA		North		South		East		West		Central	
ΔMP	-0.476***	-0.868***	-0.579***	-0.916***	-3.378	5.938	-2.559***	-2.992***	-0.608**	-0.623***	-4.474*	-3.525**	-0.019	0.330
	(0.182)	(0.254)	(0.188)	(0.266)	(10.095)	(7.227)	(0.599)	(0.656)	(0.243)	(0.197)	(2.394)	(1.536)	(0.144)	(0.226)
CostEff	0.490***	0.335***	0.579***	0.293***	-0.886*	-0.109	0.370***	0.365***	0.822***	0.270*	0.549**	0.472***	0.33	0.450**
	(0.092)	(0.085)	(0.104)	(0.095)	(0.503)	(0.609)	(0.109)	(0.085)	(0.257)	(0.152)	(0.224)	(0.127)	(0.495)	(0.196)
CAR	0.517**		0.650***		0.137		0.134		0.799*		1.221**		-1.006**	
	(0.210)		(0.236)		(0.328)		(0.256)		(0.413)		(0.505)		(0.448)	
EQUITY		0.027		0.345		0.096		0.076		0.544		0.468		-0.803
		(0.183)		(0.325)		(0.142)		(0.187)		(0.373)		(0.468)		(1.326)
LIQ	0.132***	0.136***	0.143***	0.113**	0.109	0.163	0.099***	0.070***	0.201	-0.079	0.449*	0.638***	1.868**	0.280*
	(0.045)	(0.044)	(0.048)	(0.048)	(0.149)	(0.126)	(0.035)	(0.021)	(0.151)	(0.070)	(0.234)	(0.183)	(0.737)	(0.162)
SIZE	-2.874***	-6.050***	-3.244***	-7.713***	-2.217	1.028	-2.502***	-2.671***	-3.789***	-3.818***	-8.066**	-9.670***	-0.730	-11.422***
	(0.644)	(0.827)	(0.676)	(1.040)	(2.752)	(1.073)	(0.752)	(0.760)	(1.281)	(1.038)	(3.234)	(1.506)	(8.026)	(2.942)
GDP p.c.g	2.154***	0.779**	2.083***	0.818***	3.486	-0.720	1.368***	1.899***	2.912**	3.300***	0.745	0.745*	5.077*	7.585***
	(0.424)	(0.330)	(0.431)	(0.355)	(2.274)	(1.662)	(0.515)	(0.417)	(1.322)	(0.940)	(1.006)	(0.425)	(2.835)	(1.729)
CPI	0.332*	-0.256	0.310*	-0.301	0.326	1.239	0.696***	0.505**	0.689*	0.871***	0.559	0.044	4.033***	2.149***
	(0.173)	(0.202)	(0.178)	(0.216)	(1.401)	(1.593)	(0.252)	(0.198)	(0.370)	(0.285)	(1.055)	(0.526)	(1.450)	(0.612)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.27	0.23	0.28	0.24	0.14	0.20	0.25	0.23	0.36	0.40	0.26	0.35	0.74	0.45
Obs.	934	2157	789	1700	125	324	285	415	267	360	216	641	14	171
Hasen Overid. P-Val.	0.130	0.853	0.096	0.252	0.091	0.014	0.600	0.276	0.134	0.387	0.210	0.250	0.594	0.626

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

5.4 Testing the BLC: two-step GMM results

Here, the study uses the two-step sys-GMM approach to estimate Equations 13 and 14. As robustness checks, the study re-examines the baseline equation under the two-step sys-GMM approach. These results are presented in Table 7a. Also, in Table 7b and 7c, the moderating role of bank efficiency in the BLC is examined.

From the tables, the AR (2) test and the Hansen test presented in all the estimations cannot reject the null hypothesis of no second-order serial correlation and the validity of the overidentifying restrictions, respectively. The p-value for the second-order serial correlation in the sys-GMM estimation is greater than 10% in all specifications, hence the null hypothesis of no second-order serial correlation at the conventional significance levels (1%, 5% and 10%) cannot be rejected. Furthermore, from the Hansen test, the null hypothesis of the validity of the overidentifying restrictions at the conventional significance levels cannot be rejected. Overall, the AR (2) tests for second-order serial correlation and the Hansen test of overidentifying restrictions are both satisfied, indicating that the GMM estimates are consistent and efficient. The estimates also indicate that the lag of the dependent variable is significant in all but one of the regressions. This indicates that loan growth persists (Sanfilippo-Azofra et al., 2018). From Table 7a, as expected, it can be seen that a change in monetary policy rate has a significant negative impact on loan or credit growth in the full sample for Africa with at least 5% significance level. This further confirms our earlier results that the bank lending channel of monetary policy exists in Africa. Again, bank efficiency is seen to consistently have a positive impact on credit growth in almost all regressions mostly at 1% significance level. This further supports the earlier results that cost-efficient banks experience higher credit growth than their inefficient counterparts. These results are consistent in the presence of controls.

On the controls, capital ratio is seen to have a significant positive impact on loan growth. This suggests that more capitalized banks are likely to give out more loans than under-capitalised banks. This is seen in the full sample for the whole continent and in all the different regions except for central Africa. The results are similar when we use the equity ratio. Given the paucity of data for risk-adjusted capital measures, the study makes conclusion using the capital ratio and the equity ratio that, less risky banks-banks with higher capital/equity ratio-tend to give out more loans than high risk banks (Kishan & Opiela, 2006). Liquidity also generally showed a statistically significant positive impact on loan growth suggesting that highly liquid banks are more likely to increase their credit supply. North and Central African region however saw a negative impact of liquidity on loan growth. The size of the bank however showed a significant negative impact on loan growth in majority of the estimations across the continent. This suggests that bigger banks do not take advantage of their ability to reduce information asymmetry to grant more loans (Altunbas et al., 2009). GDP p.c.g on the other hand consistently has a significant positive impact on loan growth in all estimations at 1% significance level. Higher economic growth or development accompanies higher loans or credit demand. This is consistent in all the estimations and also consistent with other studies (Jimborean, 2009). Inflation on the other hand has a significant positive impact on credit growth in the full sample and sub-samples except for West Africa. A positive impact of inflation on credit growth implies that banks in these regions properly anticipates inflationary changes and price their loan rate accordingly. Higher inflation may result from higher aggregate demand which corresponds with credit growth. The significant impact of GDP growth and inflation shows the importance of including demand factors in the estimation.

5.5 Testing the BLC: the moderating role of bank efficiency (two-step GMM results)

Here, the study sought to test whether bank heterogeneity in the form bank efficiency influences the bank lending channel. As argued earlier, the role of bank capitalization, liquidity and size have well been tested as heterogenous bank characteristics that affect the bank lending channel (Boughrara & Ghazouani, 2010; Matousek & Solomon, 2018). Surprisingly, the role of bank efficiency in the bank lending channel has been ignored. Here, the study examines the moderating role of bank efficiency in the bank lending channel. The results are presented in Tables 7b and 7c.

The results from the IV results are presented in Table 7b.[1] The 25th, 50th, 75th and 100th percentiles of bank cost efficiency are used to test the role of bank efficiency in the bank lending channel. The results further show the existence of the bank lending channel in Africa. We observe largely that at higher percentiles of bank efficiency, the negative impact of monetary policy on loan growth reduces. This is seen the full sample and in most of the sub-samples. In most cases at the uppermost percentile of bank efficiency, the impact of monetary policy on loan growth is positive. For instance, in the full sample, the impact at the 25th, 50th, 75th and 100th percentile, the impact of monetary policy is -0.985, -0.773, -0.280 and 1.622 respectively. This shows that at higher bank cost efficiency, the impact of monetary policy on loan growth reduces.

We further estimate the moderating role of bank efficiency using the two-step system GMM approach. Here, in the full sample, the results show that the interaction between change in monetary policy rate and bank efficiency has a positive sign and significant at 1% and 5%. The statistically significant and positive coefficient shows that banks that are cost efficient are less responsive to monetary policy contractions. The marginal effect is therefore calculated at the minimum, mean and maximum values of the estimated sample. For instance, in the first estimation for the full sample, the marginal effect at minimum, mean and maximum cost efficiency is significantly negative (at least 5%) with a coefficient of -1.892, -1.020 and -0.585 respectively. This indicates that as banks become cost efficient the negative marginal impact of a contractionary monetary policy of credit growth reduces. The results are similar when the equity ratio is used.

Moving onto the sub-samples, the table also shows similar results as obtained for the continent. The marginal effect reduces with higher bank efficiency. An interesting result is that at maximum levels of cost efficiency or for highly cost-efficient banks (maximum cost efficiency scores), a contractionary monetary policy leads to a positive marginal effect on credit growth. For instance, for the Southern African region from Column 6 of the table, the marginal effects at minimum, mean and maximum cost efficiency are -9.072, -4.165 and 1.774 respectively all significant with at least 5% significance level. The possible explanation is that, if banks are operating under

[1] We also create dummy variables of the percentiles of cost efficiency and estimate using the 2SLS given that the interaction between MP and EFF resulted in weak identification.

the same frontier and given financial globalisation, all other things being equal, a contractionary monetary policy would lead to an increase in bank cost shifting the loan supply curve to the left. However, this impact will be felt most by cost inefficient banks who reduce their credit supply in response to the contractionary monetary policy. Cost efficiency banks are therefore less responsive to monetary policy contraction. This is in line with theoretical reasoning such that cost efficient banks are able to use less inputs to generate the same outputs (loans) and thus would have better loan rate compared to inefficient banks who may have to pass on additional costs resulting from higher policy rate to borrowers. This intuition is in line with the findings of Havranek, Irsova and Lesanovska (2016) who found that more efficient banks tend to react to changes in financial market interest rates more slowly, changing loan rates less frequently and thus smoothing loan rates for their clients. The most cost-efficient banks in the country are even likely to see positive credit growth: given that the marginal effect at maximum cost efficiency is positive. The argument is that borrowers will shift to cost efficient banks that are able to offer the same loans at cheaper rates. Also, considering the globalization of banking markets, borrowers can easily shift to other markets where banks are cost efficient and likely to supply loans at cheaper rates.

This evidence is even stronger in West Africa where the average cost-efficient bank experiences credit growth; marginal effects at minimum, mean and maximum are -4.066, 0.527 and 3.429 respectively. This is not surprising as the efficiency score comparison showed that the West Africa region operates at a higher meta-cost frontier than the other regions. The study however does not find evidence to support the moderating role of bank efficiency in the bank lending channel in North Africa. Overall, the results suggest cost efficient banks are less responsive to monetary policy shocks. The results for the controls are consistent with the earlier estimations.

Table 7a: Bank Lending channel in Africa: two-step sys-GMM

variable	Full sample (Africa)		SSA		North		Southern		East		West		Central	
Lag1. $\Delta Loans$	0.331***	0.590***	0.278***	0.212***	0.570***	0.460***	0.340***	0.403***	0.544***	0.578***	0.373***	0.417***	0.282***	0.245***
	(0.017)	(0.011)	(0.014)	(0.014)	(0.058)	(0.032)	(0.030)	(0.018)	(0.024)	(0.022)	(0.016)	(0.021)	(0.093)	(0.031)
ΔMP	-0.128*	-0.325***	-0.440***	-0.185***	-2.324***	-2.757***	-1.401***	-1.946***	-0.474***	-0.322***	-0.702***	-0.305***	-0.035	-0.116
	(0.073)	(0.048)	(0.042)	(0.072)	(0.807)	(0.729)	(0.288)	(0.168)	(0.092)	(0.070)	(0.175)	(0.116)	(0.103)	(0.166)
CostEff	0.183***	0.149***	0.308***	0.288***	0.137	0.194*	0.174***	0.188***	0.218***	0.122***	0.059**	0.167***	0.165***	0.336**
	(0.031)	(0.009)	(0.026)	(0.013)	(0.102)	(0.104)	(0.037)	(0.028)	(0.044)	(0.034)	(0.029)	(0.033)	(0.055)	(0.133)
CAR	0.080***		0.082***		0.105**		0.053*		0.111***		0.057		0.023***	
	(0.026)		(0.028)		(0.041)		(0.028)		(0.038)		(0.049)		(0.008)	
EQUITY		0.096***		0.092***		0.087***		0.184***		-0.026		0.638***		0.196
		(0.013)		(0.032)		(0.027)		(0.052)		(0.035)		(0.037)		(0.323)
LIQ	0.045***	-0.003	0.052***	0.015**	-0.107***	-0.133***	0.043*	0.029**	0.085**	0.037***	0.098*	0.091***	-0.306***	-0.019
	(0.015)	(0.004)	(0.012)	(0.007)	(0..011)	(0.014)	(0.023)	(0.015)	(0.035)	(0.005)	(0.054)	(0.028)	(0.097)	(0.124)
SIZE	-0.906***	-0.393***	-1.559***	-2.431***	-0.098	-0.227	-0.559*	-0.037	0.205	-0.788**	-2.186***	-1.765***	-7.632***	3.816
	(0.196)	(0.096)	(0.205)	(0.184)	(0.405)	(0.324)	(0.299)	(0.173)	(0.617)	(0.385)	(0.386)	(0.219)	(1.851)	(6.415)
GDP p.c.g	1.684***	0.335***	1.587***	1.258***	0.915***	0.452**	1.331***	1.492***	2.278***	2.614***	2.0851***	0.742***	2.150***	4.415***
	(0.321)	(0.121)	(0.186)	(0.088)	(0.167)	(0.203)	(0.163)	(0.083)	(0.308)	(0.188)	(0.067)	(0.084)	(0.677)	(1.530)
CPI	0.675***	0.278***	0.316***	0.353***	0.156	1.293**	0.445***	0.306***	0.321***	0.460***	-0.214**	-0.642***	1.677***	1.620***
	(0.171)	(0.085)	(0.050)	(0.046)	(0.379)	(0.609)	(0.059)	(0.038)	(0.086)	(0.068)	(0.093)	(0.061)	(0.317)	(0.338)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AR (2)	0.240	0.204	0.946	0.749	0.697	0.755	0.955	0.490	0.348	0.146	0.725	0.981	0.258	0.220
Hansen Overid. P-Value	0.628	0.256	0.274	0.554	0.145	0.364	0.995	0.999	0.993	0.991	0.377	0.998	0.783	0.617
Obs.	1019	2005	864	1614	155	391	324	442	291	360	235	641	14	171

*NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis*

Table 7b: Bank Lending channel in Africa -Percentiles of Efficiency Scores (2SLS)

variable	Full Sample (Africa)		SSA		North		South		East		West		Central	
ΔMP x 25Percecntile	-0.985**	-0.979**	-1.036**	-1.013**	-7.343*	-8.429	-6.431***	-5.882***	-2.252**	-2.520**	-4.999**	-4.599*	-1.978	-0.994
	(0.498)	(0.473)	(0.476)	(0.423)	(4.422)	(15.542)	(2.161)	(2.057)	(1.058)	(1.129)	(2.493)	(2.448)	(1.621)	(1.481)
ΔMP x 50Percecntile	-0.773**	-0.689**	-0.824	-0.740	-6.802	-8.250*	-2.808**	-2.892***	-1.8498	-1.670	-2.123	-3.998*	-1.978	-0.274
	(0.319)	(0.351)	(0.610)	(0.597)	(14.947)	(4.656)	(1.161)	(0.952)	(1.008)	(1.049)	(2.527)	(2.248)	(1.621)	(0.708)
ΔMP x 75Percecntile	-0.280***	-0.284***	-0.244**	-0.253**	-5.192	-2.844	-2.182*	-1.741	-1.684**	-1.803***	-1.787	-2.446	1.159**	0.091
	(0.094)	(0.097)	(0.104)	(0.108)	(5.871)	(6.105)	(1.225)	(1.981)	(0.736)	(0.704)	(2.285)	(2.158)	(0.572)	(1.576)
ΔMP x 100Percecntile	1.622***	1.698***	1.693***	1.758***	4.194	4.140	9.122**	-0.765	-1.628**	-1.358*	0.073	-1.497	1.401	1.162**
	(0.430)	(0.440)	(0.438)	(0.455)	(4.119)	(4.279)	(4.133)	(9.907)	(0.737)	(0.791)	(3.639)	(3.341)	(3.102)	(0.537)
CostEff	0.466***	0.470***	0.465***	0.471***	1.515***	1.811***	0.314***	0.058	0.434**	0.294*	1.118***	0.814***	0.173	0.674**
	(0.069)	(0.070)	(0.078)	(0.084)	(0.455)	(0.429)	(0.103)	(0.382)	(0.178)	(0.169)	(0.156)	(0.179)	(0.307)	(0.344)
CAR	0,134		0.152		-0.261		-0.117		0.496**		1.872***		0.010	
	(0.090)		(0.108)		(0.949)		(0.294)		(0.250)		(0.586)		(0.034)	
EQUITY		0.035		-0.037		-1.240***		3.072		0.455		2.192*		-5.726
		(0.143)		(0.300)		(0.412)		(3.109)		(0.478)		(1.251)		(3.720)
LIQ	0.057	0.067	0.066	0.085	0.968***	1.153***	0.101**	0.007	-0.034**	-0.074	0.766**	0.723**	0.053	0.121
	(0.037)	(0.044)	(0.051)	(0.070)	(0.294)	(0.320)	(0.033)	(0.095)	(0.016)	(0.077)	(0.359)	(0.341)	(0.162)	(0.239)
SIZE	-2.683***	-2.560***	-2.686***	-2.523***	-13.178***	-11.515***	-1.205***	-2.148*	-3.457***	-2.824***	-9.257***	-14.631**	-9.338***	-12.731**
	(0.515)	(0.494)	(0.599)	(0.575)	(4.450)	(4.378)	(0.142)	(1.149)	(0.842)	(0.758)	(1.921)	(5.126)	(3.212)	(5.284)
GDP p.c.g	1.207***	1.217***	1.425***	1.434***	-0.021	-0.029	1.421	1.252**	5.799***	6.198***	0.756*	0.815*	1.305	6.179***
	(0.464)	(0.459)	(0.475)	(0.472)	(0.103)	(0.108)	(1.020)	(0.508)	(1.725)	(1.624)	(0.454)	(0.429)	(1.815)	(1.114)
CPI	0.084	0.080	0.177	0.172	2.565*	2.946**	0.507	0.390	1.496***	1.692***	-0.845	-0.159	1.010	1.390**
	(0.445)	(0.433)	(0.471)	(0.455)	(1.326)	(1.368)	(0.746)	(0.944)	(0.569)	(0.532)	(0.574)	(0.466)	(0.731)	(0.607)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.02	0.03	0.01	0.02	0.11	0.14	0.08	0.02	0.07	0.08	0.18	0.01	0.19	0.12
Obs.	727	1444	612	1157	179	572	199	301	179	252	201	615	14	138
Hasen Overid. P-Val.	0.108	0.117	0.149	0.153	0.669	0.944	0.163	0.185	0.383	0.449	0.600	0.172	0.737	0.687

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

Table 7c: Bank Lending channel in Africa – moderating role of bank efficiency (GMM results)

variable	Full sample (Africa)		SSA		North		Southern		East		West		Central	
Lag1. $\Delta Loans$	0.296***	0.534***	0.540***	0.518***	0.440***	0.539***	0.399***	0.412***	0.536***	0.591***	0.639***	0.471***	0.185	0.163*
	(0.018)	(0.005)	(0.014)	(0.011)	(0.092)	(0.031)	(0.024)	(0.026)	(0.013)	(0.030)	(0.015)	(0.017)	(0.151)	(0.100)
ΔMP	-2.039***	-1.468***	-2.425***	-1.495***	-2.874	-3.540	-7.978***	-10.314***	-2.669***	-2.843***	-7.004**	-0.581	-4.505**	-4.432*
	(0.520)	(0.341)	(0.511)	(0.322)	(4.150)	(6.736)	(2.162)	(1.183)	(0.574)	(1.061)	(2.817)	(2.316)	(2.088)	(2.305)
CostEff	0.179***	0.060***	0.270***	0.273***	-0.463	-0.048	0.244***	0.272***	0.279***	0.176***	-0.070	0.134***	0.167***	-0.246
	(0.027)	(0.012)	(0.023)	(0.013)	(1.115)	(0.030)	(0.059)	(0.035)	(0.063)	(0.052)	(0.049)	(0.041)	(0.057)	(0.251)
ΔMP * CostEff	0.032***	0.010**	0.023***	0.011**	3.035*	0.262	0.110**	0.136***	0.045***	0.049**	0.110***	0.008	0.074**	0.069**
	(0.008)	(0.005)	(0.008)	(0.004)	(1.668)	(0.537)	(0.051)	(0.023)	(0.012)	(0.020)	(0.042)	(0.035)	(0.035)	(0.033)
CAR	0.053**		0.171***		-0.104		0.202***		0.096**		0.282***		0.060***	
	(0.023)		(0.038)		(0.181)		(0.057)		(0.047)		(0.052)		(0.020)	
EQUITY		0.083***		0.058***		0.076***		0.339***		-0.083		0.464***		-0.010
		(0.005)		(0.017)		(0.025)		(0.071)		(0.062)		(0.086)		(0.286)
LIQ	0.028***	0.017***	0.019	0.037***	-0.321***	-0.102***	-0.004	0.012	0.1223***	0.064***	0.107	0.129***	-0.646***	-0.609***
	(0.011)	(0.004)	(0.017)	(0.004)	(0.081)	(0.015)	(0.023)	(0.017)	(0.027)	(0.009)	(0.070)	(0.050)	(0.214)	(0.200)
SIZE	-1.028***	-0.503***	-0.261	-1.155***	-2.560**	-0.805**	-0.562	-0.514*	0.044	-0.349	-0.825	-1.559***	-8.732***	-6.605**
	(0.168)	(0.073)	(0.192)	(0.119)	(1.061)	(0.388)	(0.551)	(0.263)	(0.554)	(0.546)	(0.635)	(0.545)	(2.826)	(2.823)
GDP p.c.g	1.406***	1.164***	1.888***	1.271***	2.375***	1.763***	1.712***	2.739***	1.992***	2.355***	2.470***	0.683***	4.031***	3.592***
	(0.202)	(0.070)	(0.163)	(0.074)	(0.707)	(0.414)	(0.325)	(0.189)	(0.213)	(0.228)	(0.209)	(0.217)	(1.066)	(1.401)
CPI	0.309***	0.369***	0.269***	0.317***	1.549	-0.374	0.648***	0.343***	0.275***	0.458***	-0.733***	-1.088***	2.118***	2.329***
	(0.105)	(0.038)	(0.055)	(0.041)	(1.450)	(0.252)	(0.119)	(0.081)	(0.085)	(0.097)	(0.142)	(0.153)	(0.426)	(0.755)
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AR (2)	0.694	0.229	0.297	0.114	0.203	0.723	0.820	0.517	0.340	0.124	0.550	0.963	0.304	0.226
Hansen test (P-Value)	0.841	0.741	0.818	0.776	0.763	0.992	0.839	0.738	0.983	0.989	0.999	0.569	0.869	0.980
Obs.	1019	2005	864	1614	155	391	307	415	291	360	235	615	14	171
Marginal effect														
Minimum	-1.892***	-1.465***	-2.147***	-1.369***	-	-	-6.974***	-9.072***	-1.477***	-1.540***	-4.066**	-	-2.634**	-2.702*
	(0.263)	(0.340)	(0.422)	(0.271)			(1.7070	(0.975)	(0.276)	(0.537)	(1.709)		(1.219)	(1.475)
Mean	-1.020***	-0.811***	-0.928***	-0.773***	-	-	-2.901***	-4.165***	-0.274***	-0.228***	0.527***	-	0.182	-0.099
	(0.085)	(0.085)	(0.133)	(0.082)			(0.399)	(0.180)	(0.0840	(0.039)	(0.168)		(0.135)	(0.346)
Maximum	-0.585**	-0.529***	-0.311	-0.524***	-	-	1.791	1.774**	1.242***	1.433**	3.429***	-	2.396**	1.959**
	(0.236)	(0.125)	(0.251)	(0.122)			(2.387)	(0.861)	(0.432)	(0.662)	(1.145)		(1.130)	(0.864)

NB: All variables are as defined earlier. * Significance at 10%, ** Significance at 5%, *** Significance at 1%. Robust standard errors in parenthesis

6 Policy Discussion

Central banks could underestimate the needed change in interest rates to influence bank credit and hence economic activities if the impact of changes in monetary policy on bank credit is not accurately assessed. This study is therefore relevant in examining the existence of the bank lending channel of monetary policy in Africa by examining the role of bank efficiency in this relationship. The results show that bank lending channel exists in Africa. This has important policy implication for central banks and monetary policy authorities as the bank lending channel can be used as a transmission channel for monetary policy decisions to achieve their monetary policy objective. Unlike other regions especially in developed markets where the effect of the bank lending channel has dwindled, the bank lending channel still remains relevant in Africa. As argued earlier, given that most households and firms in Africa depend on bank loans to finance consumption and investment respectively, the bank lending channel can be an effective way for central banks to achieve their monetary policy objective like inflation targeting. The implication is that a contractionary monetary policy reduces bank credit which will reduce consumption and investment leading to a reduction in aggregate demand and ultimately a reduction in inflation. Inflationary targeting central banks can pursue this objective by relying on the bank lending channel.

The results also showed that bank cost efficiency has a positive impact on loan growth. This implies that banks that are cost efficient are likely to give out more loans than the inefficient counterparts. This is because cost efficient banks can offer cheaper loan rates and can therefore experience higher loan growth. The policy implication for monetary policy is that cost efficient banks may undermine the effectiveness of the bank lending channel. The study therefore examined the role of bank efficiency in the bank lending channel and found that indeed cost-efficient banks are less responsive to monetary policy shocks. Thus, the marginal decrease in credit growth is lower for efficient banks than the inefficient banks in response to a contractionary monetary policy. Theoretically, an increase in the policy rate increases banks' cost hence their rate on loans. Cost efficient banks however are able to supply the same amount of loans at cheaper rates compared to the inefficient ones. If so, the policy implication is that the intended impact of monetary policy contraction on credit supply would be less for cost efficient banks than would be for inefficient banks. Indeed, given the competitive nature of the banking industry and if firms or consumers are able to borrow from different banks even in different countries with minimal or no cost then these borrowers can easily shift from inefficient banks who are likely to pass on the full cost rise to them. They would rather move to cost efficient banks who would offer competitive rates. This argument is supported by the findings as the marginal effect of monetary policy contraction on credit growth reduces with efficiency banks and even turns to a positive marginal effect for the most cost-efficient banks. Even for West Africa, banks with average cost efficiency would tend to benefit as borrowers move from inefficient banks to them. Monetary authorities should therefore examine the efficiency of banks in their markets to properly fashion out the appropriate monetary policy interest rate to achieve their objective. It would be important to understand the dynamics of the efficiency of banks in order to fashion out the appropriate tool to control bank credit or money supply. In highly cost-efficient banking markets, the intended impact of monetary policy contraction for instance would be weakened. In these situations, other monetary policy tools like the reserve requirement can be used concomitant to the policy rate.

7 Conclusion

The bank lending channel of monetary policy was tested in Africa. New evidence is provided by incorporating the level of efficiency of banks. The stochastic metafrontier approach was used to estimate efficiency scores of banks in Africa while the 2SLS and two-step system GMM techniques are used to test the bank lending channel. The study has established that the bank lending channel of monetary policy exists in Africa. The study further shows that bank efficiency leads to higher loan growth. The results also show that cost efficiency weakens the effectiveness of the bank lending channel in Africa.

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