Monetary Policy and the Banking Sector in South Africa

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Abstract

We find that monetary policy influenced South African Bank Lending between 2004 and 2014 predominantly through the bank lending channel (BLC). Our results show that the supply of funds is more sensitive to bank size, capitalization and efficiency in the short-term. We also examined the sensitivity of private loans, mortgages and credit card loans to banks with different bank characteristics. Private loans were more sensitive than mortgages to bank size and capitalization. On the other hand, credit card loans is not influenced by the BLC. Finally, we found evidence for asymmetry in the interest rates.

Keywords: Bank Lending Channel, Efficiency, Panel Data, South Africa

JEL Classification: C23, C26, E52, N17

1. Introduction

Since the Global Financial Crisis in 2007, central banks have been concerned with credit risk. The South African banking sector has been financially sound and this has partly contributed to a buoyant credit extension to the corporate sector. Furthermore, it also has credit operations across Africa. Since the global financial crisis in 2007, there has been a weakness in global economic growth and a decline in commodity crisis. The decline in trade and commodity prices has led to weakened economic growth in Africa. It almost contributed to a change in South Africa's credit rating. Over the last twenty four months, these events have prompted the South African Reserve Bank (SARB) to increase the reserve rate. This is to reduce bank's exposure to credit risk in South Africa. Secondly, it is increase the financial resilience of the banking sector because it has credit operations in other African financial markets.

In South Africa, the transactions banking business is the backbone of the banking industry. Evidence from The Asian Banker Research (2015) suggests retail banking is largest in South Africa (41%) followed by Kenya (32%) and Nigeria (24%). Therefore, the banking system in South Africa is essential for the supply of loans vital for financial development. Prior to the global financial crisis, there has been a drive to remove credit ceilings, introduce measures to develop money markets, stock markets, banking systems as well as financial regulation. This

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has made a South Africa a destination for Foreign Portfolio Investment which in turn has increased its role in the cross-border lending market in Africa.

There have been a number of studies on the impact of monetary policy on the South African banking system (see Sichei, 2005, Ground and Ludi, 2006, Lungu, 2007 and Hsing and Hsei, 2014). Nevertheless, we have discovered a gap in the literature as the more recent studies have not applied modern panel data techniques to current bank level data on SA. This is with respect to the distribution of monetary policy shocks in the banking system post-apartheid. The bank lending channel (BLC) argues that the sensitivity of loans to changes in monetary policy depends on differences in bank characteristics (Ashcroft, 2006 and Matousek and Sarantis, 2009). For e.g. smaller banks are more likely to reduce the supply of loans in response to monetary policy changes than larger banks. The importance of the BLC has arisen again following the global financial crisis. Research by Black et al. (2010) have pointed out that the sensitivity of loans to monetary policy is likely to differ depending on the type of loans bank offer. Further evidence by Karagiannis(2010) points to asymmetry in interest rates as another consequence of the global financial crisis. This has implications for the potency of interest rates on the supply of loans relative to money supply via the BLC.

Our study contributes to the ongoing research by analysing the impact of monetary policy shocks on bank loans over the period 2004 to 2014. Such a study, will enable us to analyse distribution of monetary policy shocks following the restructuring and consolidation process in the South African banking system. It also contributes to the current discussion about the behaviour of banks who supply traditional business loans vs banks who supply more risky loans e.g. mortgages in response to a monetary shock. Secondly, the study contributes to the discussion on the efficiency of the South African banking sector in the context of financial globalization. If efficiency matters for the BLC, then this means that they could be further room for structural reform and increased competition.

In particular, our main results are as follows: Monetary Policy affects the supply of loans through the Bank Lending Channel (BLC). Secondly, monetary policy in South Africa depends on bank characteristics (size and capital) which is consistent with studies for Transition Economies (Matousek and Sarantis, 2009). Thirdly, we find evidence of asymmetry interest rates which suggests informational asymmetry among large banks. Fourthly, monetary policy also depends on efficiency. Therefore, efficiency is an important bank characteristic and should be included in the BLC. Finally, private loans and mortgages loans are more sensitive to the BLC than credit card loans.

The rest of the paper is as follows: Section 2 provides an overview of the Literature on the BLC in developed countries with particular emphasis on Africa. Section 3 outlines the methodology and measuring allocative efficiency in the banking industry. Section 4 discusses the results and Section 5 is the conclusion.

2. Literature Review

Within the general literature, there has been a lot of studies on the impact of monetary policy shocks on bank behaviour through the Bank Lending Channel in Developed and Transition economies respectively. A summary of key literature on the BLC is shown in table 1 below. Among the recent literature are Akinci et al. (2013) who demonstrate that supply of loans is sensitive to monetary policy via the money and bank lending channels respectively. With respect to the BLC, they find that the supply of loans is more sensitive to liquidity and capital. Aiyar et al. (2016) find that smaller banks are more sensitive to changes in monetary policy than larger banks. However, both large and small banks are sensitive to changes in capital requirements.

Table 1: A Summary of Key Literature on the BLC in Developed Countries.

Author	Main Findings
Favero et al. (1999)	Did not find the presence of the BLC in Germany, France, Italy and Spain in 1992.
De Bondt (1999)	BLC found to be present in Germany, Belgium and the Netherlands.
Kishan and Opiela (2000)	BLC found to be present in the U.S between 1980 and 1995. The supply of loans is more sensitive to bank size irrespective of the levels of capitalization.
Altunbas et al. (2002)	BLC found in 11 European countries in the EMU. The supply of loans is more sensitive to bank capital.
Kakes and Sturm (2002)	BLC found to be present in Germany. The supply of loans is sensitive to bank size.
Ehrmann et al. (2003)	BLC found to be present in Germany, France, Italy and Spain using micro and aggregate data.
Gamborta (2005)	BLC found to be present in Italy. The supply of loans is sensitive to capitalization and liquidity.
Lungu (2007)	Mixed results found for the existence of the BLC in South African Developing Countries (SADC) from 1990 to 2006.
Matousek and Sarantis (2009)	BLC found to be present in 8 CEE countries. The supply of loans is sensitive to bank size and liquidity.
Black et al. (2010)	BLC found to be more sensitive among U.S banks that supply mortgage loans extensively to sub-prime communities.
Wu et. al (2010)	Find that the increasing presence of foreign banks across in Emerging Markets in Asia, Latin America and Central and Eastern Europe weakens the effectiveness of the BLC.
Gambacorta and Marques-Ibanez(2011)	Finds significant changes in the operation of BLC EU member states and the U.S following the 2007 financial crisis. The supply of loans is sensitive to banks with short-term funding as well as banks with

	more profitable but volatile non-interest income activities.
Brei et al. (2013)	Find for banks in 14 Advanced Countries that the supply of loans is more sensitive to capitalization during a banking crisis once injections of new capital rises above a critical threshold.
Cantero-Saiz et al. (2014)	BLC is more sensitive for Euro-Zone countries with higher sovereign debt risk. However, this is only during periods of contractionary monetary policy.
Oliviero et al. (2011a)	BLC is weakened by the consolidation process in 18 Asian and Latin American countries.
Aiyar et. Al (2016)	The BLC operates through small banks rather than large banks. It is changes in capital requirements that affect both small and large banks.
Akinci et a. (2013)	BLC and Money lending channel both operate in the Turkish banking system. Within the BLC, the supply of loans is more sensitive to liquidity and capital.

source: adapted from Solomon O.H and Matousek, R. (2016).

On the other hand, there have been few studies on the BLC in South Africa. Lingu(2007) found mixed results on the existence of the BLC in South African Developing Countries (SADC) using data from 1990 to 2006. Hsing and Hsei, (2014) using Structural VAR Models identify the BLC in South Africa using aggregate data. However, a study by Simpasa et al. (2014) failed to identify the BLC using data on Zambia. Finally, Abuka et al. (2015) found the BLC to be present in Uganda. Furthermore, an increase in the interest rate reduces the probability that loans are granted and the volume of local currency loans to borrowers. In this study, they find that the impact of monetary policy depends on bank capital. Mishi and Segaye (2012), estimate the BLC in South Africa using panel data analysis. Their finding identifies the BLC and demonstrate the importance of banks in the monetary transmission mechanism. A key finding is the role of bank size in the transmission of monetary policy shocks.

To the best of our knowledge, there has been no empirical study on the BLC in South Africa that controls for bank specific characteristics and efficiency. Therefore, we have discovered a gap in the literature with respect to the analysis of BLC and potential interactions of bank specific characteristics and efficiency using disaggregated bank data. Furthermore, our study is also novel in that we study the effect of BLC in South Africa using different types of loans. In our study, we look at total loan supply as well on private loans, mortgages and credit card loans.

3. Data and Methodology

We use quarterly data from 2004 to 2014 in our empirical analysis of the BLC channel. Owing to data availability, we use annual data over the same period to analysis the role efficiency in the BLC. Our sample comprises of 17 commercial banks in South Africa. Of this number, 5 are foreign banks.

Our dynamic panel model is adopted from Ehrmen et al. (2003). In summary, equation (1) below relates the supply of aggregate loans to monetary policy controlling for bank characteristics such as size, liquidity and capitalization. Macroeconomic indicators are included in order to take into account the monetary transmission mechanism. Finally, the model includes interaction terms between the bank characteristics and monetary policy to test for the presence of the BLC. The detailed specification of equation (1) is as follows:

$$\Delta Log(L_{it}) = \alpha_i + \sum_{i=0}^{1} \beta_1 \Delta log(L_{it-1}) + \sum_{i=0}^{1} \delta_j \Delta R_{t-j} + \sum_{i=0}^{1} \lambda_i \Delta GDP_{t-j} + \sum_{J=0}^{1} \theta_i \Delta CPI_{t-j}$$

$$+ \sum_{i=0}^{1} \eta_i \, (own)_t + \sum_{j=0}^{1} \gamma_i z_{it-1} + \sum \omega_i z_{it-1} \, \Delta R_{t-j} + \varepsilon_{it} \ldots (1)$$

where N denotes the number of banks, T is the time period, J is the number of lags and Δ is the first difference operator. Lit denotes the size of total bank loans for each bank i.. We also experiment with using Private loans, Mortgage loans and Credit Card loans as alternative depend variables. Rt-j denotes the short-term monetary policy instrument. GDPt-j denotes Gross Domestic Product ,CPIt-j denotes the Consumer Price Index and ownt is a dummy variable for whether the bank is foreign owned. The dummy variable takes a value of 0 if the bank is not foreign owned and 1 if the reverse is the case. zi denotes the vector of three bank characteristics: bank size, liquidity and bank capitalization. Finally, zit Rt-j denotes the interaction between bank specific characteristics and the monetary policy instruments. Our approach to calculating the bank characteristic variables: bank size, liquidity, capitalization come from Ehrmann et al. (2003), Gambacorta (2005), Matousek and Sarantis (2009). These are defined in equations (3) through (5) below:

$$S_{it} = \log A_{it} - \frac{\sum \log A_{it}}{N_t} \ldots (3)$$

$$Liq_{it} = \frac{Liq_{it}}{A_{it}} - \frac{1}{T} \sum_t \left(\frac{1}{N} \sum_I \frac{L_{it}}{A_{it}} \right) \ldots (4)$$

$$Cap_{it} = \frac{Equity_{it}}{A_{it}} - \frac{1}{T}\sum_{t}\left(\frac{1}{N}\sum_{t}\frac{Equity_{it}}{A_{it}}\right) \ldots (5)$$

Bank size (S_{it}) is defined as the log of Total Assets (A_{it}). In order to control for the trend in size, Total Assets (A_{it}) for each bank is normalized by subtracting the log of total assets for each bank from the sample average (N_t). Liquidity (Liq_{it}) is defined as the ratio of Liquid Assets(L_{it}) to Total Assets (A_{it}). Capitalization (Cap_{it}) is defined as the ratio of Equity ($Equity_{it}$) to Total Assets (A_{it}). (Liq_{it}) and (Cap_{it}) are also normalised by subtracting from the sample average for each single period and over the whole period.[5]

To test for the existence of the BLC, we include interaction terms between size, liquidity, capitalization and the interest rate respectively. In South Africa, the repo is the key interest rate and is used the monetary policy instrument in our analyses. For clarity, we seek to test three hypotheses on the existence of the BLC:

- Hypothesis 1: Lending by smaller banks reduces in response to contractionary monetary policy. So, larger banks are less sensitive to monetary policy changes.
- Hypothesis 2: Lending by less liquid banks reduces in response to contractionary monetary policy. So, more liquid banks less sensitive to monetary policy changes..
- Hypothesis 3: Lending by less capitalised banks reduces in response to contractionary monetary policy. So more capitalised banks are more sensitive to changes in monetary policy.

Therefore, we expect the signs of the three hypotheses respectively to be positive. We also examine if there is a three-way interaction between two of the bank characteristics and the monetary policy instrument. This is to examine if a three-way interaction has a significant impact on loan growth in

[5] This approach was adopted Ehrmann et al.(2003)

South Africa. Specifically, we test the following three-way interactions and expect a-priori a positive relationship in response to a contraction in monetary policy:

$S_{it-1}Liq_{t-1}\Delta R_t, S_{it-1}Liq_{t-1}\Delta R_{t-1}, S_{it-1}Cap_{t-1}\Delta R_t, S_{it-1}Cap_{t-1}\Delta R_{t-1}, Liq_{it-1}Cap_{t-1}\Delta R_t,$
$Liq_{it-1}Cap_{t-1}\Delta R_{t-1}.$

3.1 Efficiency

We also consider the role of bank efficiency in the BLC. We expect a-priori that more efficient banks increase the supply of loans in response to changes in monetary policy. We follow the approach of Akinci et al. (2013) to construct efficiency scores for our model obtained using Stochastic Frontier Analysis. Using this method, two kinds of efficiency scores are estimated: technological (allocational efficiency) and cost efficiency. Furthermore, we use statistical significance (p-values) to determine whether efficiency (two-way and three-way interactions) should be added to our model. This enables us to model efficiency as a fourth bank characteristic.

3.2 Interest Rate Asymmetry

We also use this approach of variable addition tests to determine whether to include a dummy variable (Dummy_r) to determine whether upward or downward interest rates have different effects on loan supply. Dummy_r takes a value of 1 if the interest rate falls and 0 otherwise. If we have a positive value, then this is evidence of interest rate asymmetry because it shows that effect on loan supply changes when the policy rate decreases. Our motivation for including this dummy variable comes from (Karagiannis et al. 2010). Therefore, we expect the sign of Dummy_r to be positive.

3.2. Model Estimation and Robustness Tests

Equation (1) was estimated using the Arellano-Blundell- Bond-Bover[6] (A-B-B) two-step system estimator i.e. GMM. We use this method for three reasons: (i) our model includes a lagged dependent variable. (ii) the lagged dependent variable was found to be significant and (iii) the method is consistent with with Ehrmann et al. (2003) who uses dynamic panel model to examine the reaction of bank loans to monetary policy. As a result, we do not estimate our models using

[6] See Blundell and Bond (1998)

pooled or fixed effects estimation respectively. The A-B-B two step estimator is applied because it is efficient and robust to heteroscedasticity, auto-correlation and cross-correlation. The consistency of this estimator depends on the robustness of the instruments. The robustness of the instruments are tested using the Sargan's test for over-identifying restrictions and tests for 1st order and 2nd order auto-correlation. We expect to not reject the null hypothesis that the model is over-identified by the additional instruments. We also expect to not reject the null hypothesis of no second-order auto-correlation. Typically, the GMM is applied when the sample size is large but the time period is short. According to Windmeijer(2005), when GMM is applied to a small sample size, there is a downward bias in the confidence intervals and therefore standard errors. The bias increases when the estimation uses a large number of instruments. Our main results have a moderately large sample of 749 observations. There are 17 cross-sections and the number of instruments range from 13 to 16. This is less than the number of cross-sections and ensures valid inference. In our estimation, the bias in our two-step standard errors are corrected by using Windmeijer (2005) correction procedure.

Our procedure for estimation is as follows: First we estimate the BLC as stated in equation (1). Then using the variable addition tests, we experiment with the inclusion of three- way interaction terms to see if they add to the model's significance. These results are reported in Table 2. Secondly, using the original specification we include the dummy_r variable to test for the presence of asymmetry in interest rates. This means we test if there are differences on the effect on loan supply when the central bank either increases or decreases in interest rates. These results are reported in Table 3. We then proceed to estimate the BLC with efficiency variables. These results are reported in Table 4 and 5. Table 6 presents the results of the BLC using private loans and mortgage loans as the dependent variable. Finally, Table 7 presents the results of the BLC using credit card loans as the dependent variable. From Tables 2 to 7, we report the coefficients with the t-ratios in parenthesis. The robustness tests are reported at the end of the table. The results in all the tables show that we do not find evidence of second-order auto-correlation. Also, we are unable to reject the null hypothesis that our model is over-identified. Therefore, our instruments are valid and satisfy the condition of being weakly exogenous.

4.0 Results

Table 2 presents the results of the BLC using total supply of loans as the dependent variable. We only report the significant results which is evidence that supports the BLC and where the interest rate has a direct effect on the supply of loans.

Model 1 reports the results where size is interacted with the interest rate. Model 2 reports the results where bank capitalization is interacted with the interest rate. Model 3 reports of the results of the three-way interaction between size, capitalization and rate. Model 4 reports the results of the three-way interaction between size, capitalization and rate after a one-year lag. In Model 1, there is

a positive and significant relationship between the interaction of size and the repo rate and the supply of loans at the 10% level. Therefore, we find evidence in support of Hypothesis 1 where larger banks are less sensitive to changes in monetary policy. We find a positive and significant result between size and loan supply at the 5% level. Therefore, size is an important bank characteristic in the transmission of monetary policy shocks. The dummy variable is negative and significant at the 10% level. This means that foreign banks reduce the supply of loans when the repo rate increases. In Model 2, there is a positive and significant relationship between the interaction of capitalization and rate after a one-year lag. This supports Hypothesis 3 where more capitalized banks are less sensitive to changes in monetary policy. We also find a direct effect between the repo rate and the supply of loans. The relationship is positive and significant at the 5% level. Interestingly, there is a negative and significant relationship between bank capitalization and the supply of loans at the 1% level. This means that more capitalized banks are less likely to supply loans and suggests evidence of credit rationing. In Model 3, the three-way interaction between $S_{it-1}Cap_{t-1}\Delta R_t$ is positive and significant at the 5% level[7]. Therefore, this supports the BLC hypothesis that larger and more capitalised banks supply more loans when the repo rate rises. There is a positive and significant relationship between the interest rate and the supply of loans at the 5% level. This is opposite to what we expect given Hypothesis 3. Our result suggests that the retail banking market is driven by the credit channel rather than the interest rate channel. Finally, we do not find any evidence in support of Hypothesis 2. There is no significant relationship between the interaction of liquidity and the repo rate and the supply of loans. We also found no evidence of a three-way interaction between the following bank characteristics and the policy rate:

$S_{it-1}Liq_{t-1}\Delta R_t, S_{it-1}Liq_{t-1}\Delta R_{t-1}, Liq_{it-1}Cap_{t-1}\Delta R_t, Liq_{it-1}Cap_{t-1}\Delta R_{t-1}$.

Table 2: GMM ESTIMATION OF THE BLC WITH TOTAL SUPPLY OF LOANS AS DEPENDENT VARIABLE

	(Model 1)	Model 2	Model 3	Model 4
Dependent Variable	Total Loans	Total Loans	Total Loans	Total Loans
$\Delta T.Loans_{it-1}$	**0.884***** (17.52)	**0.972***** (36.24)	**0.997*****(86.72)**	**0.977*****(28.7)**
$GDPG_{t-1}$	0.000 (0.12)	-0.000(-0.02)	-0.003(-0.93)	-0.002(-0.50)
$Inflation_{t-1}$	0.018(1.19)	-0.003(-0.37)	**-0.011****(-2.42)**	-0.000(-0.08**)**
$\Delta Rate_{t-1}$	0.094(1.53)	**-0.039****(-2.51)	**0.006****(1.99)**	-0.002*(-0.34)
CAP_t	-	**-3.060*****(-2.66)	-	-
$CAP_{t-1}\Delta Rate_t$	-	0.061(0.76)	-	-
$CAP_{t-1}\Delta Rate_{t-1}$	-	**0.277*(**1.80)	-	-
$Size_{t-1}\Delta Rate_t$	**0.004***(1.73)	-	-	-
$Size_{t-1}\Delta Rate_{t-1}$	-0.012(-1.63)	-	-	-

[7] We also find a significant and positive relationship between $S_{it-1}Cap_{t-1}\Delta R_{t-1}$ and the supply of loans is positive and significant at the 5% level. This is reported in the appendix.

$Size_{t-1}$	**0.088***(1.71)	-	-	-
$Size_{it-1}CAP_{t-1}\Delta Rate_t$	-	-	**0.009****(2.18)	-
Liq_{t-1}	-	-	-	0.129(0.41)
$Liq_{t-1}\Delta Rate_t$	-	-	-	-0.00(0.34)
$Liq_{t-1}\Delta Rate_{t-1}$	-	-	-	0.00(0.782)
Dummy	**-0.649***(1.88)	-0.300(-0.87)	0.019(0.18)	**-0.349(-2.24)**
_cons	0.354(1.35)	**0.772***(1.65)	0.042(0.29)	0.382(1.03)
N	731	730	731	731
N_g	17	17	17	17
J	16	13.000	16	13
ar1(p-value)	0.013	0.015	0.019	0.023
ar2(p-value)	0.104	0.115	0.130	0.147
Sargan(p-value)	0.826	0.697	0.433	0.328

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.1 Evidence of Interest Rate Asymmetry

We apply the general -to -specific approach by sequentially deleting bank characteristics as well as the insignificant interactions (two-way and three-way) between the bank characteristics and the repo rate. This continues until we get significant results with either the bank characteristic or the latter in Model's 5 through 7. Our key variable of interest rate is *Dummy_r* which tests for the presence of interest rate asymmetry or symmetry. Here the idea is to test whether there is any difference in the effect of loan supply between increasing or decreasing interest rates. Table 2 presents the results. Model 5 estimates the BLC with size as the bank characteristic. There is a positive and significant relationship between the size of the bank and loan supply at the 10% level. The interaction between size and rate is not significant and this fails the test for the BLC hypothesis. There is a negative relationship between *Dummy_r* and loan supply at the 10% level showing evidence of no difference on the effect on loan supply when the interest rate either increases or decreases. Model 6 and Model 7 estimates the BLC with a three-way interaction between two bank characteristics and the repo rate. In Model 6, the interaction between $S_{it-1}Liq_{t-1}\Delta R_t$ is positive and significant at the 5% level. This means that for larger and more liquid banks, there is a difference on the effect on loan supply when the central bank decreases interest rates. supply more loans in response to a decrease in the repo rate. This is evidence of interest rate symmetry. Model 7 shows a positive and significant relationship between $S_{it-1}Cap_{t-1}\Delta R_t$ at the 10% level. There is also positive and significant relationship between *Dummy_r* and loan supply at the 10% level. This also suggests interest rate symmetry. This means that when the interest rate decreases, there is a difference on the effect on loan supply for capitalised and liquid banks respectively. Overall, the results in Model 5 suggest the presence of informational asymmetry in the banking sector.

Table 3: GMM Estimation of The BLC - Evidence of Interest Rate Asymmetry

	Model 5	Model 6	Model 7
Dependent Variable			

	Total Loans	Total Loans	
$\Delta T.Loans_{it-1}$	**0.876*****(17.39)	**0.992*****(33.36)	**1.008*****(19.89)
$GDPG_{t-1}$	-0.002(-0.47)	-0.002(-0.44)	0.001(0.14)
$Inflation_{t-1}$	-0.008(-0.61)	0.004(0.65)	-0.013(-1.20)
$\Delta Rate_{t-1}$	0.010 (0.48)	-0.004(0.65)	-0.013(-1.20)
CAP_t	-	-	-1.449(-1.32)
$Size_{t-1}CAP_{t-1}\Delta Rate_{t-1}$			**0.015***(1.74)
$Size_{t-1}Liq_{t-1}\Delta Rate_{t-1}$		**0.049****(2.32)	
$Size_{t-1}$	**0.055*****(2.86)	-	-
Dummy	**-0.513***(-2.32)	0.432(0.584)	-
Dummy_r	**-0.058***(-1.94)	**0.061****(2.46)	**0.083****(2.22)
_cons	**0.900****(2.09)	-0.111(-0.34)	**0.089****(1.87)
N	730	730	730
N_g	17	17	17
J	16	13	13.000
ar1(p-value)	0.02	0.011	0.015
ar2(p-value)	0.222	0.135	0.11
Sargan(p-value)	0.615	0.195	0.572

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.2 Efficiency and the BLC

In Table 4, we report the results for the addition of efficiency variables (using both cost and technological measures). Owing to data availability, we use annual data for 16 banks from 2004 to 2014. Model 8 reports the results for the effect of efficiency in the BLC using a technological(allocative) measure of efficiency. Model 9 report similar results but using cost measures of efficiency. Based on model 1, the inclusion of two-way interacted efficiency variable(efficiency and interest rate) was done using the variable addition tests. The robustness tests are reported at the end of the table. We do not find evidence of second-order auto-correlation. Also, we are unable to reject the null hypothesis that our model is over-identified. Therefore, our instruments are valid and satisfy the condition of being weakly exogenous.

In Model 8, we find that the interaction between technological (allocative) efficiency and the interest rate has a positive and significant impact at the 1% level. This means that more efficient banks supply loans when the interest rate rises. However, the former has a negative and significant relationship after a lag of one year. This does not support the BLC hypothesis and suggests that the full impact of monetary policy on the supply of loans controlling for efficiency lasts for one year.

In Model 9, we find that the interaction between cost efficiency and the interest rate has a positive and significant impact at the 10% level. This occurs after a lag of one year. This means that cost efficient banks supply more loans when the interest rate rises. This supports the BLC but it is weakly significant. The fact that this is weakly significant in comparison to Model 8, suggests that banks may be operating more of technological efficiency.

Table 4: Tests of the addition of Efficiency Variables to the BLC

	Model 8	Model 9
Dependent Variable	Technological (Allocative) Measure of Efficiency	Cost Measure of Efficiency
$\Delta T.Loans_{it-1}$	**1.057*****(10.87)	**1.070*****(10.53)
$GDPG_{t-1}$	**-0.020***(-1.92)	-.0318(0.154)
$Inflation_{t-1}$	**-0.070****(-2.65)	**-.0827***(-1.65)
$\Delta Rate_{t-1}$	**0.124*****(4.75)	-.083(0.326)
All_t		
$All_{t-1}\Delta Rate_t$	**0.036*****(7.27)	
$All_{t-1}\Delta Rate_{t-1}$	**-0.087*****(-4.00)**	
$Cost_t$		
$Cost_{t-1}\Delta Rate_t$		.017(0.63)
$Cost_{t-1}\Delta Rate_{t-1}$		**0.270***(1.86)
Dummy	0.0439(0.46)	.043(1.01)
_cons	-0.735(-1.01)	-.839(-0.69)
N	160	160
N_g	16	16
J	12	10
ar1(p-value)	0.026	0.044
ar2(p-value)	0.432	0.826
Sargan(p-value)	0.993	0.946

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Model 10, we take our analysis a step further by including three-way interacted variables to the models give in Table 3. Table 5 reports the probability values of the t-tests from the inclusion of three-way interacted variables using both technological and cost measures of efficiency.

Table 5 shows that we can include the three-way interaction between $All_{t-1}\Delta Rate_t Size_{t-1}$, $All_{t-1}\Delta Rate_t Liq_{t-1}$ and $All_{t-1}\Delta Rate_t Cap_{t-1}$ respectively to the parsimonious GMM model in Model 8. This is because they are all individually positive and significant when added to Model 8. The results show that efficiency increases the capacity of large, liquid and more capitalized banks to supply loans in response to contractionary monetary policy.

Using cost measures of efficiency, we find that the interaction between $Cost_{t-1}\Delta Rate_t Size_{t-1}$ and $Cost_{t-1}\Delta Rate_t Cap_{t-1}$ to the parsimonious GMM model in Model 9. The results show that cost efficiency increases the capacity of large and more capitalised banks to supply loans when the interest rate increases. Among the three bank characteristics, liquidity is the least significant and this corresponds to previous results that liquidity is a significant factor in the BLC.

Table 5: Tests of the Addition of Three-way Interacted Efficiency Variables to the Model reported in Table 3

	Model 10
Technology (Allocative) Measure of Efficiency	p-values
$All_{t-1}\Delta Rate_t Size_{t-1}$	0.000
$All_{t-1}\Delta Rate_t Liq_{t-1}$	0.074
$All_{t-1}\Delta Rate_t Cap_{t-1}$	0.000
Cost Measure of Efficiency	
$Cost_{t-1}\Delta Rate_t Size_{t-1}$	0.000
$Cost_{t-1}\Delta Rate_t Liq_{t-1}$	0.356
$Cost_{t-1}\Delta Rate_t Cap_{t-1}$	0.000

4.3 Estimating the BLC Using Dis-aggregated Loans

In Table 6, we report the results of the BLC using private loans and mortgage loans respectively as dependent variables. In column (1), we find support for the BLC as there is a positive and significant interaction between size and the interest rate at the 5% level. Therefore, when the interest rate rises, larger banks supply more private loans. When we compare the results to column (4) with mortgage loans, we find no support for the BLC as the larger banks reduce the supply of mortgage loans when the interest rate rises. Therefore, we can conclude that within the private loans market, monetary policy is sensitive to the size of the bank. Traditional loans are the still the dominant type of loans compared to mortgage loans which are more risky in the retail bank market. In column (2), more capitalised bank supply more private loans. This is significant at the 10% level and is similar to the results in column (3) for mortgage loans.

Table 6: GMM ESTIMATION OF THE BLC WITH PRIVATE LOANS AND MORTGAGE LOANS AS DEPENDENT VARIABLE

	(1)	(2)	(3)	(4)
Dependent Variable	Private Loans	Private Loans	Mortgage Loans	Mortgage Loans
$\Delta Loans_{it-1}$	**0.979***** (22.50)	**0.963*****(19.28)	**0.993*****(27.48)	**0.944***** (16.00)
$GDPG_{t-1}$	-0.012 (-1.34)	0.003(0.51)	-0.023(-0.94)	-0.066(-1.59)
$Inflation_{t-1}$	-0.06(-1.33)	**-0.011*(**1.73)	**-0.104***** (-2.62)	0.031(0.60)
$\Delta Rate_{t-1}$	0.161(1.35)	-0.064(-1.46)	-0.079(-1.45)	0.024(0.51)
CAP_t		**-4.071****(-2.14)	-	-
$CAP_{t-1}\Delta Rate_t$		**0.510***(1.92)	**1.644***(1.80)	-
$CAP_{t-1}\Delta Rate_{t-1}$		-	**-1.621***(-1.91)	-
$Size_{t-1}\Delta Rate_t$	**0.031****	-	-	**-0.011***(-1.80)

	(2.46)			
$Size_{t-1}\Delta Rate_{t-1}$	**-0.038*** **(-1.85)**	-	-	-
$Size_{t-1}$	-0.12(1.43)	-	-	
$Size_t$		-	-	0.088(1.15)
Dummy		-		
_cons	-1.22(-1.39)	0.934(1.29)	**1.175*****(4.07)	0.189(0.58)
N	706	706	503	503
N_g	28.000	17	13	13
J	10.000	13	10	21
ar1(p-value)	0.033	0.038	0.071	0.053
ar2(p-value)	0.531	0.770	0.735	0.341
Sargan(p-value)	0.969	0.497	0.854	0.930

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 7, we report the results of the BLC using credit card loans respectively as dependent variables. The results clearly shows no support for the BLC and suggests that credit card loans.

Table 7: GMM ESTIMATION OF THE BLC WITH CREDIT CARD LOANS AS DEPENDENT VARIABLE

	(1)	(2)
Dependent Variable	Credit Card Loans	Credit Card Loans
$\Delta Credit\ CardLoans_{it-1}$	**0.812*****(20.24)	**0.684*****(3.92
$GDPG_{t-1}$	**0.255***(1.88)	-.088(-0.58)
$Inflation_{t-1}$	0.047(0.38)	-.161(-0.72)
$\Delta Rate_{t-1}$	0.002(0.01)	.068(0.26)
CAP_t	-	-
$CAP_{t-1}\Delta Rate_t$	1.932(0.96)	-
$CAP_{t-1}\Delta Rate_{t-1}$	**-1.121***(-3.02)	-
$Size_{t-1}\Delta Rate_t$		.005(0.16)
$Size_{t-1}\Delta Rate_{t-1}$		
$Size_t$		.284(1.48)
Dummy	**-1.21***(-3.02)	-2.124(1.46)
_cons	1.058(1.62)	Dropped
N	706	380
N_g	9	9
J	10	13
ar1(p-value)	0.033	0.037
ar2(p-value)	0.531	0.228
Sargan(p-value)	0.969	0.889

5. Conclusion

Our results shows the existence of the BLC in South Africa. This is similar to previous attempts to estimate the BLC in South Africa. However, we go further by using a more current dataset using disaggregated bank data. We also estimate the BLC using different measures of efficiency and using disaggregated loan data. Using the Arellano-Bond GMM method, our results suggest that smaller and less capitalised are more responsive to changes in monetary policy. This is consistent with evidence from developed and transition countries. It also showed that efficiency has a significant relationship with loan growth and that it also matters for the transmission of monetary policy. Therefore, efficiency is an important bank characteristic in the BLC and should be included as an additional factor in the BLC. Using disaggregated loan data, we are able to find that private loans are more sensitive to changes in monetary policy than mortgage loans. This suggests that traditional bank loans are still the dominant types of loans provided in the retail banking market. Further work, should be done to analyse whether the BLC works through alternative monetary policy instruments such as money supply. This is significant given the fact that interest rates have been steadily declining since the 2008 global financial crisis.

Our results suggest that further analysis is needed to examine bank behaviour in South Africa following the global financial crisis. This is because evidence suggests that bank behaviour has changed (Gambacorta and Marques-Ibanez, 2011). The fact that bank size are significant in the BLC suggest that informational asymmetry is significant in South Africa. This seems consistent with the finding of asymmetry in interest rate when size is used as a bank characteristic. Also, our finding that bank capitalisation is significant in the BLC also suggests that the liberalisation and restructuring process has contributed in strengthening the impact of the BLC.

Finally, our finding on the significance of efficiency of the BLC in South Africa suggests a further probe into whether the foreign banks are more efficient than local banks. This follows the work of Isrik and Hassan(2003) which suggests that on average foreign banks are more efficient than local banks. Owing to data availability, we did not have a large sample of foreign banks. It would be interesting to find out how foreign banks have influenced the retail lending market.

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