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INVESTIGATING THE BANK-LENDING CHANNEL IN SOUTH AFRICA: A VAR APPROACH

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Abstract

The monetary policy transmission mechanism can broadly be categorised into three separate channels: the interest rate channel, the credit channel and the other asset price channel. This paper seeks to examine the bank-lending channel of the credit channel of monetary policy in South Africa by making use of structural vector auto-regressions (SVAR's). The pass-through effects of a change in the repurchase (repo) rate on bank deposits and loans and output, are tested using a parsimonious vector error correction model (PVECM). The Johansen (1988) cointegration procedure is used to test for a demand- or supply-driven bank-lending channel. In this way, the validity and effectiveness of the monetary policy regime in South Africa is tested and evaluated.

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## CONTENTS

1   INTRODUCTION

The monetary policy transmission mechanism can broadly be categorised into three separate channels, which operate simultaneously: the interest rate channel, the credit channel and the other asset price channel. The transmission of a monetary policy decision theoretically affects output via these mechanisms. This paper seeks to examine the bank-lending channel of the credit channel of monetary policy in South Africa. The credit channel can be regarded as an important view of monetary policy transmission (Schmidt-Hebbel 2003), as it explains the effects of monetary policy on investment and inventories, it offers insights into the effects of financial innovation on monetary policy potency, and, it exhibits the distributional effects of monetary policy on both lenders and borrowers. It has also been suggested (Schmidt-Hebbel 2003) that in order for the credit channel to function, the following conditions must be met: bank loans must be an important source of funds for firms; the Central Bank must be able to constrain banks' abilities to lend; bank-dependent borrowers should exist; and, imperfect price adjustments are necessary for monetary policy to affect real activity.

Presently, the South African Reserve Bank's main instrument of monetary policy is the repo (repurchase) rate. Before 1998, the Bank rate was used as the main monetary policy tool in much the same manner as the repo rate is today. It is expected that a change in the repo rate has direct effects on interest rates in the interest rate channel, on equity prices and the exchange rate in the other asset price channel, and on bank reserves and bank-lending in the credit channel. Monetary policy thus targets the demand for and supply of goods and services, the interaction of which ultimately determines output fluctuations and/or inflationary pressures.[**] The above linkages are briefly illustrated in Figure 1.

[**]   If the current economic environment is one of excess demand, then the final outcome will be one of inflationary pressure and not increased output. If, however the economy is facing excess supply, then increased output rather than inflationary pressure will be the final result.

Figure 1*: The monetary policy transmission mechanism*
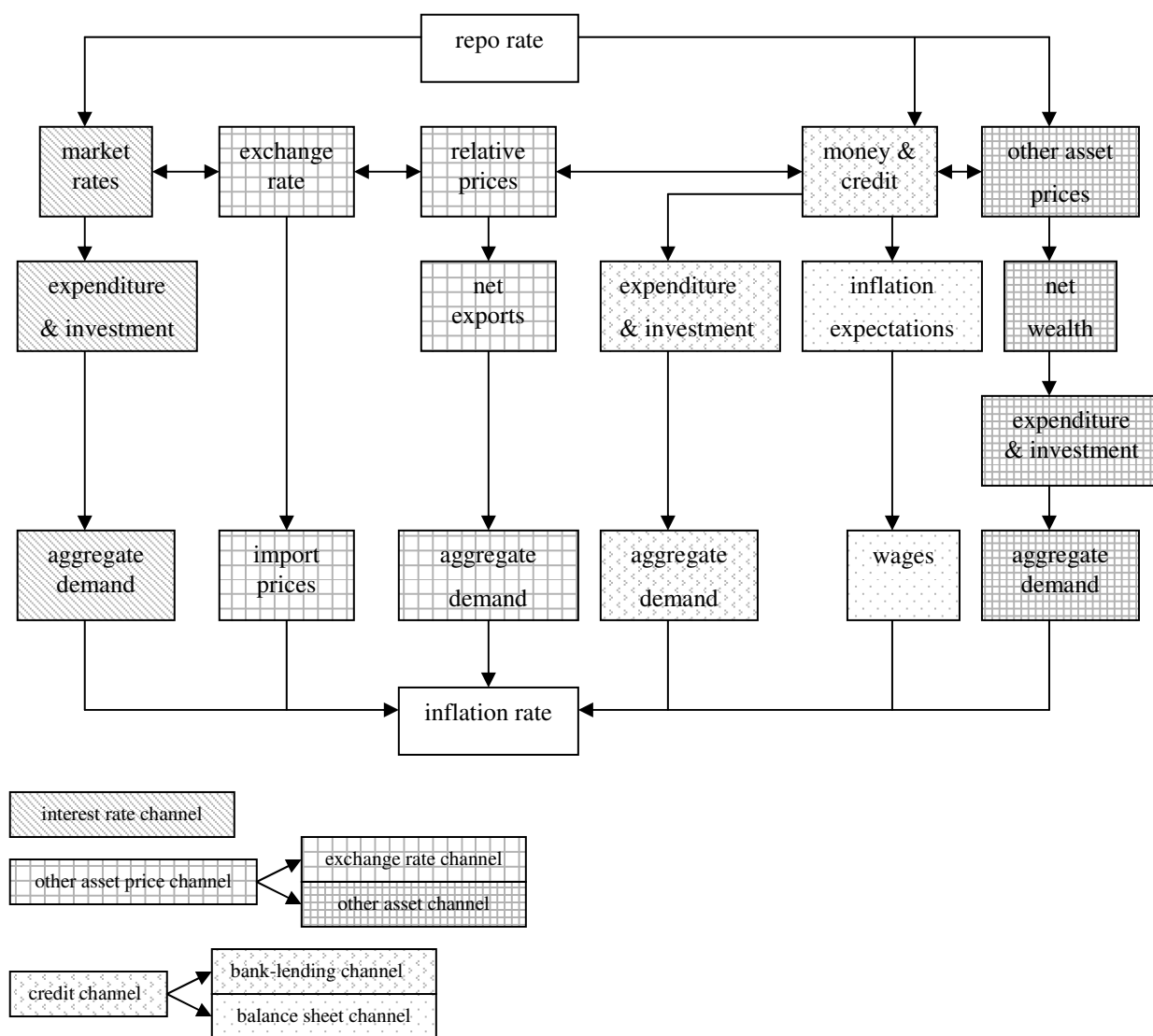
Source*: Bank of England (1999:3) and Smal & de Jager (2001:5)*

Of interest to us are the credit channel, and more specifically the bank-lending channel (BLC). The BLC will be estimated using a VAR approach in conjunction with the Johansen (1988) procedure. The motivation behind using a VAR approach is due to the inherent capabilities of VARs to incorporate endogeneity. In other words, in a VAR system, everything affects everything else. This is also beneficial in capturing feedback effects in a transmission mechanism such as the BLC.

There are two possibilities regarding the final outcome of this modelled BLC:

If bank loans are demand-driven, contractionary monetary policy will decrease bank loans due to increased costs of borrowing, and thus via the money multiplier, decrease bank deposits. Lower bank loans will imply lower private consumption expenditure and investment, and thus lower output. Thus, a credit-demand-driven BLC transmission would look as follows:

$$\uparrow \text{repo} \rightarrow \downarrow \text{bank loans} \rightarrow \downarrow \text{bank deposits} \rightarrow \downarrow I, \downarrow C \rightarrow \downarrow Y$$

If, however, bank loans are supply driven, then contractionary monetary policy will lower credit limits due to higher possible bank earnings, thereby increasing bank loans, which will increase bank deposits, increasing private investment and consumption, which will increase output. Thus, a credit-supply-driven BLC transmission would look as follows:

$$\uparrow \text{repo} \rightarrow \uparrow \text{bank loans} \rightarrow \uparrow \text{bank deposits} \rightarrow \uparrow I, \uparrow C \rightarrow \uparrow Y \;^{\dagger\dagger}$$

The supply transmission channel above may seem confusing and in complete contrast to conventional economic thought. However, it should be kept in mind that this is based on the fact that banks are seeking to maximise $r_L L + r_b B - r_d D$, where r_L, r_b and r_d are the interest rates on loans, bonds and deposits respectively (Kashyap and Stein 1993:22). Thus an increase in the potential earnings from bank loans, $r_L L$, would provide incentive to increase the supply of these profit-earning loans.

The structure of the remainder of this paper is as follows. A brief history of monetary policy in South Africa over the past three decades in section 2 is followed by a literature review of previous research on the BLC in section 3. Section 4 provides a description of the data used. The VAR and Johansen procedure methodology used are then discussed in section 5, which precedes the empirical results of section 6. A conclusion completes the paper.

[††] See Appendix A for a mathematical exposition of the rationalisation of the BLC's transmission.

2   HISTORY OF MONETARY POLICY IN SOUTH AFRICA

Monetary policy in South Africa, although historically always associated with low inflation targets, has evolved over the past three decades with the dynamically changing economic conditions the country has been facing (Strydom 2000:1).

The political isolation of South Africa in the 1960s and early 1970s had the effect of inward facing economic policies. Thus, the monetary policy of the 1970s and early 1980s consisted mainly of direct controls, such as interest rate controls, liquid asset requirements, cash reserve requirements and credit ceilings, all aimed at curbing growth in the money stock (Strydom 2000:2). However, the ineffectiveness of liquid asset requirements – which were easily compliable with by commercial banks, due to their cyclical behaviour – lead to a downward bias on interest rates, thereby promoting, rather than discouraging, monetary expansions. It was this inefficiency that prompted the introduction of credit ceilings (Strydom 2000:2).

Furthermore, international disruptions, such as the oil price shocks of 1973 and 1979, and the collapse of the Bretton Woods system, exposed the rigidity of South African monetary policy, evident in escalating inflation rates in the 1970s, peaking at 15.7 per cent in 1975 (Strydom 2000:4). This lead to the appointment of the Gerhard de Kock Commission of Enquiry into the Monetary System and Monetary Policy in South Africa in 1977. Preceding the release of the Commission's final report in 1985, a dual exchange rate system was introduced to South Africa in 1979: the financial rand was a free-floating market-based currency for capital transactions, whilst the commercial rand was artificially held at higher levels to attract foreign investment. This dual system was abolished in 1983 and replaced by a floating rate with Reserve Bank intervention, which, due to various disturbances such as the Rubicon speech, economic sanctions and the debt-standstill agreement, performed very poorly (Strydom 2000:4). Thus, the 'finrand' was reintroduced in 1985 and finally abolished in March 1995.

The release of the De Kock Commission's report in 1985, whose findings were implemented as from 1986, signified a major shift in the monetary policy "mind-set"

in South Africa. It was advised that sustainable economic growth would never be possible in an environment of high inflation (Stals 1997:1). Thereafter, M3 money supply targets became the Reserve Bank's monetary policy strategy, using the Keynesian principles of changing the discount rate (the Bank rate) to affect credit demand (Strydom 2000:4). These money targets worked very efficiently while South Africa was in a period of economic isolation during the 1980s and early 1990s, but were very difficult to control in the 1990s when the South African economy gradually began to "open up". Van der Merwe (in Smal & de Jager, 2001:2) also notes that the perceived monetary transmission mechanism became distorted due to the dynamic world markets of the time, and thus price stability via controlled money targets was generally unattainable.

Accordingly, in the mid- to late-1990s, the South African Reserve Bank began to take a more eclectic approach to monetary policy decision-making, which, according to Stals (1997:3), included monitoring a wider range of indicators, such as changes in bank credit extension, overall liquidity in the banking sector, the yield curve, changes in official foreign reserves, changes in the exchange rate of the rand, and inflation movements and expectations. This approach was enhanced in 1998 by the replacement of the discount window by the marginal lending facility of the repurchase system and consequently, the Bank rate was replaced by the repo rate. The South African Reserve Bank altered their previously eclectic approach in February of 2000, when the Minister of Finance announced that inflation targeting would be the Reserve Bank's sole objective in protecting the value of the currency. Currently, the Reserve Bank's main monetary policy objective is to maintain CPIX inflation between the target band of three to six per cent, using discretionary changes in the repo rate as its main policy instrument.

3   LITERATURE REVIEW

"Whether the bank-lending channel is operative, is not clear" (Hubbard 1995:71). This being arguably the most obscure of the monetary transmission mechanisms, little work, particularly using VAR analyses and particularly on the South African economy, has been done on the BLC as a separate transmission mechanism. There is

much to be found on the entire monetary policy transmission mechanism as a whole, since this is a more representative and realistic analysis of monetary policy to undertake. However, it is precisely the fact that most literature available is inconclusive on the existence and magnitude of the BLC that prompted us to analyse this channel separately, and thus add to the sparse research about the channel at hand.

Using the loan-supply and -demand model detailed in Appendix A, Bernanke and Blinder (1988:438) estimated money and credit demand equations. They found that credit demand shocks should be dealt with by expansionary monetarist-based monetary policy, not by contractionary credit-based monetary policy. Conversely, in the face of a money demand shock, the correct policy would be an expansionary credit-based monetary policy, and not contractionary monetarist-based monetary policy. In other words, they concentrated on the loan demand transmission, rather than the loan supply transmission. However, they emphasised that money transmission (i.e. the balance sheet channel of the credit channel) was much more effective than the BLC transmission.

Romer & Romer (1990) assessed the credit channel transmission mechanism, and particularly the BLC, in the USA during various periods of monetary tightening in the presence of credit market imperfections. In doing so, they split the credit channel into two broad views: the money view, similar to the balance sheet channel, which emphasises the role of banks' liabilities and not banks' assets, in monetary policy transmission; and the lending view (the BLC), which focuses on the role played by banks' assets, as well as that played by asymmetrical information. Using OLS and Instrumental Variables techniques, Romer & Romer (1990) estimated the St. Louis equations covering periods of monetary tightening, and found little evidence of a BLC. Thus, the money view seems to play more of a role in the credit channel than the BLC.

Kashyap *et al* (1993) tested Romer and Romer's (1990) approach by comparing the behaviour of bank loan substitutes, commercial paper, before and after the "Romer dates" of monetary tightening in the USA. The result was that the volume of commercial paper increased after the monetary tightening, leading to the conclusion that the volume of bank loans decreased.

Meltzer (1995) analysed the US BLC from a monetarist's stance, and performed regressions for the period of the Great Depression and for the Post-war Era. He found little evidence of the existence of the BLC in either period (Meltzer 1995:67-68).

Ferri and Kang (1999:195-196) noted that it is difficult to interpret empirical evidence when analysing the effect of a negative shock on an economy, as the size of the negative shock is usually relatively small, which then causes a chain of detrimental effects beyond the size of the original shock. Thus, the ideal platform for analysing the role of the banking sector in monetary transmission is after the occurrence of a large negative shock, such as the Korean exchange rate crises of 1997-98. Thus, Ferri and Kang (1999) used a panel of micro-level individual bank data to test for the existence and operation of the credit channel. Their findings included the fact that the BLC played a large role in the transmission of the Korean crises.

Kashyap and Stein (2000) used a twenty-year panel of every insured bank in the USA (resulting in approximately one million observations) to test the existence of the BLC. They found that in the class of small banks, changes in monetary policy matter more for the lending of those banks with the least liquid balance sheets, and they go on to state that "it is hard to deny the existence of a lending channel of monetary transmission" for the US (Kashyap and Stein 2000:425).

Kakes (2000:63) noted that a problem with prior research into the BLC was the fact that there was no differentiation between changes in the volume of credit after a monetary policy shift due to either credit demand, or credit supply – "in the former case, a lending channel would be irrelevant". It is with this in mind that Kakes (2000) uses the Johansen (1988) technique and a vector error correction model (VECM) analysis to estimate loan demand and supply equations for the Netherlands, thereby testing the validity of the BLC in that country. He found that the market for bank credit is dominated by demand rather than supply, and therefore, the BLC is not an important monetary transmission mechanism in the Netherlands.

Erhmann *et al* (2001) performed analysis on the European economy using a simple loan demand-loan supply model. They found, after performing an error-correction

type regression, that monetary policy tightening in the Euro area leads to a decrease in bank lending. This implies a dominance of loan demand over loan supply.

Hülsewig *et al* (2001) performed an analysis on the German economy very similar to that of Kakes's (2000) paper on the Dutch economy. They also performed a VECM analysis, and used Johansen's (1988) procedure to estimate loan-demand and -supply equations, as well as an equity equation. They conclude that the BLC in Germany is effective through both loan demand and loan supply.

Alfaro *et al* (2003) used an SVAR (structural VAR), not a VECM, to analyse the BLC in Chile. Conclusions were based on the outcomes of the impulse response functions, and it was found that the BLC does exist in Chile.

The work done by Kakes (2000) and Hülsewig *et al* (2001) are the basis of and inspiration for this paper.

4   DATA

Quarterly data from the first quarter of 1987 (after the implementation of the De Kock report's findings) to the last quarter of 2004 was used. The series used are seasonally adjusted and are converted to natural logarithms. In the case of monthly data being the only data available, the averages over three month periods were used to create quarterly data. The data used are discussed in Table 1 below.

The repo rate, the monetary policy instrument, is included to mirror loan supply, whilst loan demand is covered by GDP, as in Hülsewig *et al* (2001:9) and Kakes (2000:65).

All data is found to be non-stationary according to the Augmented Dickey-Fuller and Phillips-Perron unit root tests (see Appendix B for the test results).

Table 1*: Description of data used*

Data Series	Description & Transformations	Source
Loans	All loans from the monetary sector, current prices, natural logarithm	South African Reserve Bank Quarterly Bulletin, KBP1338K
Deposits	All deposits to banks, current prices, natural logarithm, quarterly data taken as average over three month periods	South African Reserve Bank Quarterly Bulletin, KBP1077M
GDP	Expenditure on GDP, current prices, natural logarithm	South African Reserve Bank Quarterly Bulletin, KBP6006L
Repo	1987Q1 to 1998Q2 – Bank rate; from 1998Q2 to 2004Q4 – repo rate, quarterly data taken as average over three month periods	South African Reserve Bank Quarterly Bulletin, KBP1419W (Bank rate data on request from the SARB)

5   METHODOLOGY

Due to the fact that the data is non-stationary, a VECM analysis, rather than an SVAR analysis, is performed. Thereafter, the Johansen (1988) cointegration procedure is conducted to estimate a loan equation. Johansen (1988) allows one to estimate multiple long run relationships between a set of non-stationary variables, via cointegrating vectors, as well as any short run dynamics in these variables, in the VECM. This is in line with the Granger representation theorem.

Suppose x_t is a vector of n variables, which can then be expressed as:

$$x_t = \sum_{i=1}^{\rho} A_i x_{t-i} + \varepsilon_t \text{ where } \varepsilon_t \sim iid(0,\Omega) \qquad \dots 1$$

Consequently, the VECM representation of x_t is:

$$\Delta x_t = \pi x_{t-1} + \sum_{i=1}^{\rho-1} \pi_i \Delta x_{t-i} + \varepsilon_t \qquad \dots 2$$

where $\pi = -[I - \sum_{i=1}^{\rho} A_i]$ and $\pi_i = - \sum_{j=j+1}^{\rho} A_j$.

π is the cointegrating space of the VECM and is represented by $\pi = \alpha \cdot \beta'$. α is the loading matrix of dimension n x r, and β is the matrix of cointegrating vectors of dimension n x r. Since it is not possible to use conventional OLS to estimate α and β, Johansen's (1988) full information maximum likelihood estimation can be used to determine the cointegrating rank of π, and use the r most significant cointegrating vectors to form β, from which a corresponding α is derived.

6 EMPIRICAL RESULTS

In the spirit of Kakes (2000) and Hülsewig *et al* (2001), a four variable VAR with two lags is estimated, using the variables specified in Table 1 above, on which the Johansen (1988) procedure is conducted, in attempt to determine credit demand and credit supply. The estimated VAR is stable, since no roots lie outside of the unit root circle.[‡‡]

The Johansen cointegration test is used to determine the number of cointegrating relations in the estimated VAR. Table 2 shows the outcomes of both the trace and the maximum eigenvalue tests. It is found that two cointegrating vectors are to be applied under a model with a linear trend in the data, an intercept and trend in the cointegrating equations, but no trend in the VAR. Thus, the rank of the system is equal to 2. This is in contrast to both Kakes (2000) and Hülsewig *et al* (2001), whom both found their systems to be of rank = 3.

Table 2*: Johansen cointegration test*

Test	Statistic	p-value	No. CE's
Trace	19.80662	0.2359	2
Maximum Eigenvalue	13.20643	0.3117	2

The unrestricted cointegrating coefficients estimated according to the above Johansen cointegration procedure are in Table 3.

[‡‡]   See Appendix C for the stability test.

Table 3: *Unrestricted cointegrating vectors*

Loans$_t$	Deposits$_t$	GDP$_t$	Repo$_t$	Trend
41.24050	-57.30615	-4.994613	10.13641	0.725948
0.504242	20.08676	15.64784	-3.226644	-1.136252
-17.28723	-3.890434	-10.05043	5.115670	1.089424
5.220378	-10.26588	22.47467	-4.848650	-0.502170

A VECM is estimated in order to account for short-run variations in the cointegrating relationships. The visual representation of this hypothesised unrestricted VECM with two cointegrating vectors can be written as:

$$
\begin{bmatrix} \Delta loan_t \\ \Delta deposit_t \\ \Delta gdp_t \\ \Delta repo_t \end{bmatrix} = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} & \gamma_{24} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} & \gamma_{34} \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & \gamma_{44} \end{bmatrix} \begin{bmatrix} \Delta loan_{t-1} \\ \Delta deposit_{t-1} \\ \Delta gdp_{t-1} \\ \Delta repo_{t-1} \end{bmatrix} +
$$

$$
\begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} & \beta_{51} \\ \beta_{12} & \beta_{22} & \beta_{32} & \beta_{42} & \beta_{52} \end{bmatrix} \begin{bmatrix} loan_{t-1} \\ deposit_{t-1} \\ gdp_{t-1} \\ repo_{t-1} \\ c \end{bmatrix} + \begin{bmatrix} \varepsilon_{lt} \\ \varepsilon_{dt} \\ \varepsilon_{gt} \\ \varepsilon_{rt} \end{bmatrix}
$$

... 3

Certain long run restrictions are imposed on the cointegrating coefficients, partially so as to normalise the cointegrating relations. Since the objective is to estimate either a loan demand or a loan supply equation, restrictions are imposed such that cointegrating equation I (CE I) is normalised with respect to loans, so as to reflect a 'loan equation', i.e. β_{11} is set equal to 1. Thus, since one loan equation will be estimated, the underlying dynamics of that one equation will signify either loan demand or loan supply tendencies in the market. The aim is to analyse the transmission from repo to loans, so the effects of GDP and deposits are set equal to zero in CE I, i.e. $\beta_{13} = \beta_{12} = 0$. This is in essence capturing the first 'link' in the BLC.

Cointegrating vector II (CE II) is normalised with respect to deposits ($\beta_{22} = 1$), with the effect of GDP being excluded, $\beta_{23} = 0$. CE II is as such capturing the second 'link' in the BLC, from repo through to loans and then to deposits.

Weak exogeneity tests were performed on the elements of the loading matrix, and it was found that the following variables in the PVECM could be regarded as weakly exogenous: loans and repo in CE I; and GDP and deposits in CE II.

The above long- and short-run restrictions are jointly significant according to a log-likelihood test, which has an LR statistic of $\chi^2(5) = 8.781264$ and p-value = 0.118113. The cointegrating space is over-identified, and the cointegrating vectors are shown in Table 4.

Table 4: *Over-identified cointegrating space*

	Loans$_t$	Deposits$_t$	GDP$_t$	Repo$_t$	Constant	Trend
CE I	1	—	—	0.186281	-12.37304	-0.030432
CE II	-0.94867	1	—	-0.144756	0.113398	-0.002406

The normalizations and restrictions on the cointegrating coefficients render it possible to interpret CE I as a loan supply/demand equation, as below (t-values in brackets).

$$loans_t = -0.186\,repo_t + 12.373 + 0.03\,trend \qquad\qquad ...4$$
$$(-2.14667)$$

Thus, it would seem from Equation 4 that an increase in the repo rate decreases loans, so therefore bank loans in South Africa are in fact demand driven, rendering Equation 4 to be a loan demand equation. This in essence nullifies the BLC according to Kakes (2000:63), which is most effective when loans are supply driven (i.e. an increase in the repo rate would encourage banks to lend more, due to profit motives). In fact, the interest-elasticity of bank-credit demand is estimated to be –0.484 (the product of the estimated coefficient and the repo rate sample mean for the period under consideration).

CE II shows that an increase in bank loans will increase deposits, via the money creation process. CE II also shows that an increase in repo serves as a profit motive for private lenders to increase their bank deposits, as shown in Equation 5 (t-values in brackets).

$$deposits_t = 0.949\,loans_t + 0.145\,repo_t - 0.113 + 0.002\,trend \qquad \text{... 5}$$

$$(13.5087) \qquad (8.37186)$$

The loading coefficients of the parsimonious VECM (PVECM) referred to above are shown in Table 5. The loading coefficients of CE I can be interpreted as follows: 11.8 per cent of the deviation from equilibrium of the loan demand Equation 4 is corrected for in the first quarter thereafter by deposit adjustments, and 5.8 per cent of the deviation from equilibrium of the loan demand Equation 4 is corrected for in the first quarter thereafter by GDP adjustments.

The loading coefficients of CE II can be interpreted as follows: 73.9 per cent of the deviation from equilibrium of the deposit Equation 5 is *caused by* loan adjustments, and 5.8 per cent of the deviation from equilibrium of the deposit Equation 5 is corrected for in the first quarter thereafter by repo adjustments.

Table 5: *Loading matrix of PVECM (t-values in brackets)*

	Loans$_t$	Deposits$_t$	GDP$_t$	Repo$_t$
CE I	—	-0.117994	-0.057771	—
	—	[-4.30278]	[-2.96596]	—
CE II	0.729355	—	—	-0.057771
	[6.03483]	—	—	[-2.96596]

The residuals of the two cointegrating equations are mean-reverting about zero and are stationary. Table 6 shows that the estimated PVECM satisfactorily passes the residual tests with the null hypotheses of normal residuals, no autocorrelation and no heteroskedasticity respectively at the one per cent level of significance.

Table 6: *Diagnostics*

	Test	Statistic	p-value	Conclusion
Normality	JB (joint)	14.92819	0.0606	
	Kurtosis (joint)	7.418436	0.1154	Normal residuals
	Skewness (joint)	7.509756	0.1113	
Autocorrelation	LM (2)	16.24957	0.4357	No autocorrelation
Heteroskedasticity	χ^2 (230)	251.0622	0.1625	No heteroskedasticity

The PVECM can now be used to evaluate impulse responses of the variables in the VAR. These show the impact of a change in the innovations of one endogenous variable on the actual levels of another endogenous variable of the VAR. These are estimated according to a lower triangular Choleski decomposition, where the impulse response, the effect of a one unit change in the structural innovations of i at period t ($\varepsilon_{i,t}$) on j at period $t + s$ (j_{t+s}), is equal to $\Theta_{ji,s} = \dfrac{\partial j_{t+s}}{\partial \varepsilon_{i,t}}$.

Figure 2 shows the impulse response functions graphically over ten quarters (the average time taken for a monetary policy decision to impact the economy is between three and six quarters (Smal & de Jager 2001:6)). The results show the effects of a contractionary monetary shock (an increase in the repo rate) on loans, deposits and GDP.

Figure 2: *Impulse response functions of estimated PVECM*


Response to Cholesky One S.D. Innovations
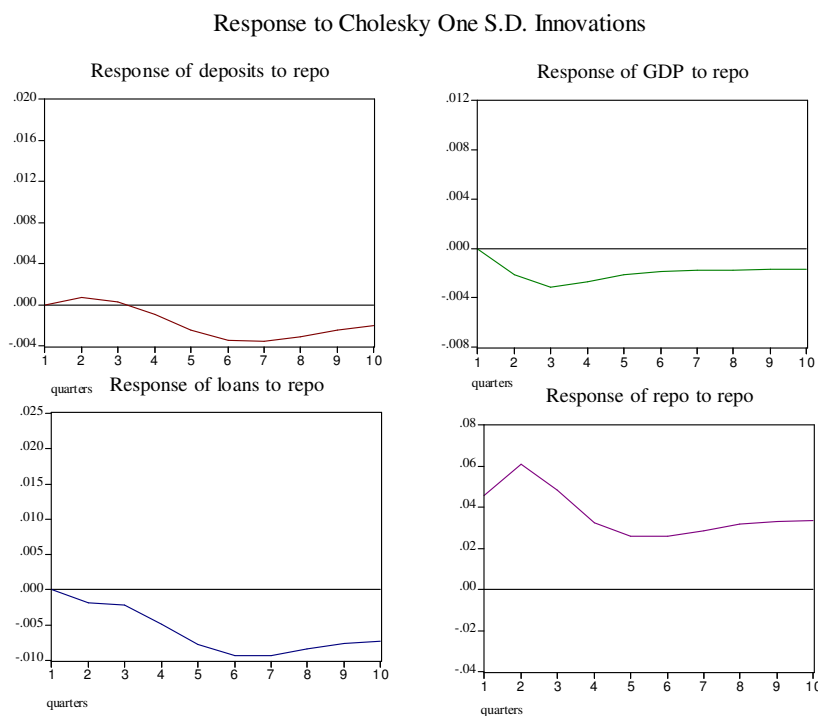
In response to a monetary policy shock, loans decrease over the entire period, confirming demand-driven loans. Deposits respond to the repo rate hike by slightly

increasing at first (due to the short-run profit motives of lenders), but then decrease from quarter 2 onwards. Although this result is in contrast to Equation 5, it is in fact consistent with demand-driven bank loans (Equation 4), as an increase in repo will decrease loans, and thus decrease deposits via the money creation process. GDP decreases due to the repo shock, and again proves the BLC to be demand-driven.

A variance decomposition analysis is used to isolate the relative importance of each random innovation affecting the variables of the VECM. The results of this analysis can be found in Figure 3

Figure 3: *Variance decomposition analysis of estimated PVECM*
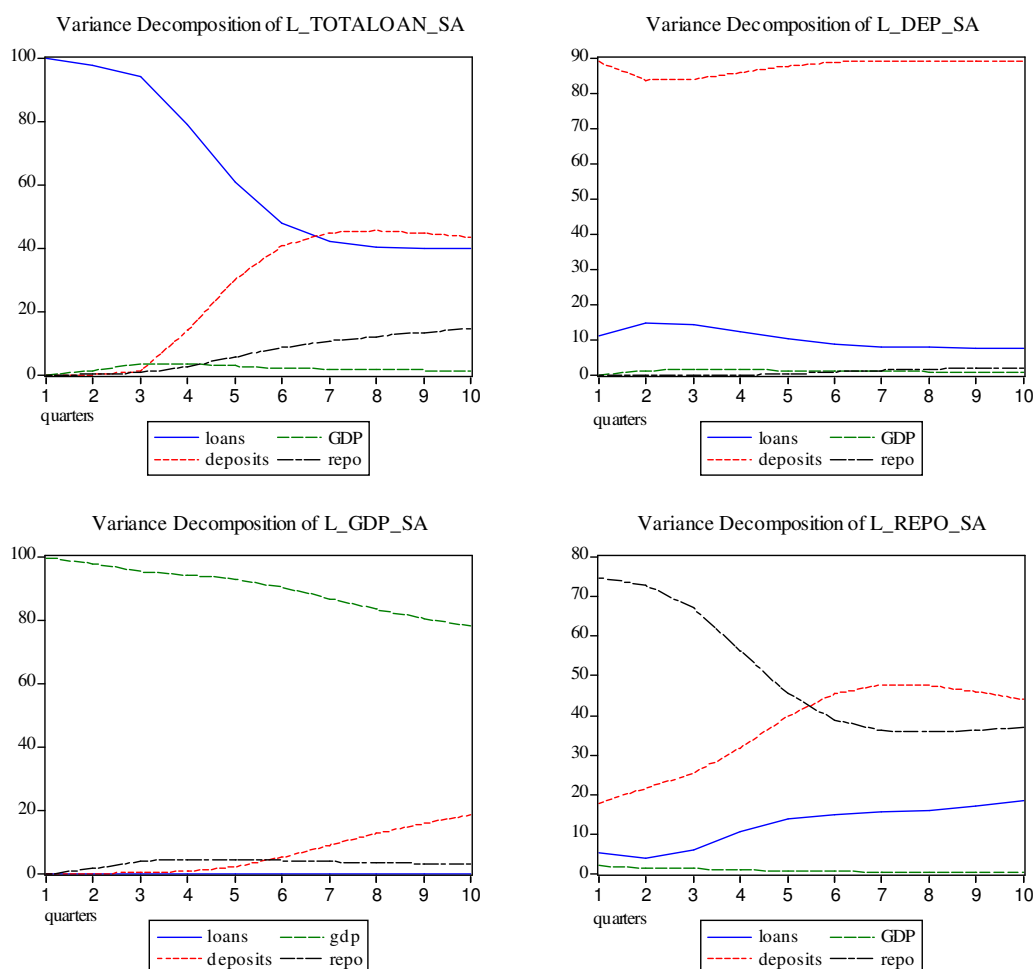
The variance in loans is mostly accounted for by itself, until the seventh quarter, when deposits account for 44.8 per cent of the variation in loans. Repo accounts for 14.8 per cent of the variation in loans in the tenth quarter.

Over all ten quarters, deposits account for approximately 88 per cent of the variation in itself, with loans accounting for between 11 and 8 per cent in the first and tenth quarters respectively.

Initially, GDP accounts for the 99 per cent of the variation in itself. However, the contribution of deposits to variation in GDP increases quite substantially to 18.6 per cent in the tenth quarter, whilst the contribution of GDP declines to 78 per cent.

Initially, the repo rate contributes to 75 per cent of the variation initself. However, deposits end up contributing 44 per cent of the variation in repo after ten quarters, whilst loans and repo each ultimately contribute approximately 19 per cent and 37 per cent respectively to the variance in repo.

7   CONCLUSION

The monetary policy transmission mechanism can broadly be categorised into four separate channels: the interest rate channel, the credit channel, the exchange rate channel and the other asset price channel. This paper examines the BLC of the credit channel of monetary policy in South Africa by making use of structural vector auto-regressions (SVAR's).

A BLC is estimated using the Johansen (1988) techniques, and the resulting estimated coefficients point towards demand-driven, rather than supply-driven, bank lending. The pass-through effects of a change in the repurchase (repo) rate on bank deposits and loans and output, are tested using impulse response functions and variance decomposition analysis from a parsimonious vector error correction model (PVECM).

It is found, using the abovementioned techniques, that loans in South Africa are governed by consumer demand, and not by bank supply. This tends to disprove the fact that the bank-lending channel has effectively worked as a tool of monetary policy in South Africa, since this would imply supply-driven loans (Kakes 2000:63).

The implications of demand-driven loans in South Africa can possibly be ascribed to the inherent credit-subsidised consumer behaviour of South African consumers. The fact that demand-driven loans in essence nullify the BLC and thus invalidate its existence provides motive for further research into the reasons for an absent BLC. It may be accredited to a mismatch between firms and consumers seeking out loans, and the banks seeking to supply those loans, which could be caused by asymmetric information, high administrative costs of matching each others requirements, or a lack of appropriate technologies.

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APPENDIX A: MATHEMATICS OF THE BANK-LENDING CHANNEL [§§]

In accordance with Bernanke and Blinder's (1988) groundbreaking work on the credit channel, a model consisting of three assets, money, loans and bonds, will be used, and an explanation of only the loan market ensues.

Loan demand:

$$L^d = L(\overset{-}{\rho}, \overset{+}{i}, \overset{+}{y}) \qquad \dots 6$$

where ρ is the interest rate on loans, i is the interest rate on bonds and y is GNP, which captures the transactions demand for credit.

Loan supply:

In deriving the loan supply, it is necessary to equate the assets (reserves $(R)^{***}$, bonds (B) and loans (L^s)) of a bank's balance sheet to the liabilities (deposits, D). Therefore, the bank's simplified balance sheet would equate assets to liabilities,

$$R + B + L^S = D \quad \therefore \quad \tau D + E + B + L^S = D \quad \therefore \quad E + B + L^S = D(1-\tau) \qquad \dots 7$$

If it assumed that portfolio proportions depend on the rates of return on the available assets, then the loan supply dependent on the share of deposits is

$$L^S = \lambda(\overset{+}{\rho}, \overset{-}{i})D(1-\tau) \qquad \dots 8$$

with similar equations for the shares of bonds and excess reserves.

Loan market equilibrium:

$$L(\rho, i, y) = \lambda(\rho, i)D(1-\tau) \qquad \dots 9$$

The money market will be in equilibrium when the supply of deposits, bank reserves multiplied by the money market multiplier, is equal to the demand for deposits.

$$D(\overset{-}{i}, \overset{+}{y}) = m(\overset{+}{i}) \cdot R \qquad \dots 10$$

[§§] Source: Bernanke and Blinder (1988:435-436).
[***] Where reserves consist of required reserves, τD, and excess reserves, E, i.e. $R = \tau D + E$.

Solving Equations 9 and 10 will give the loan interest rate as a function of bond rates, GNP and bank reserves

$$\rho = \phi(\overset{+}{i}, \overset{+}{y}, \overset{-}{R}) \qquad \dots 11$$

The South African BLC's transmission can thus be mapped out as follows: an increase in the repo rate, which increases i, will increase ρ in Equation 11, and according to Equation 8 above, the increase in ρ will increase the supply of loans. The higher i will also increase the supply of deposits, $m(i) \cdot R$, according to Equation 10. There is of course a conflict in Equation 8, as the increased ρ will increase loan supply but the higher i, which caused the increase in ρ, will decrease the supply of loans. The final effect on output? Unknown! Herein lies the BLC problem!

APPENDIX B: UNIT ROOT TESTS

The null hypothesis being tested is:

H_0: Residuals do have a unit root, i.e. there is non-stationarity

A significant ADF or PP test statistic will result in this hypothesis being rejected.

Table 7: *ADF and PP unit root tests*

Series	Model	ADF [†††]	ADF	ADF	PP [‡‡‡]	PP
		Lags	$\tau_\tau, \tau_\mu, \tau$	Φ_3, Φ_1	Lags	
Loans	Trend	0	-2.685	4.197	3	-2.782
	Intercept	0	-1.236	1.527	3	-1.274
	None	0	11.654	---	3	10.491
Deposits	Trend	0	-3.169 *	7.858 ***	3	-3.132
	Intercept	0	-2.498	6.242 ***	3	-2.069
	None	0	14.310	---	3	9.967
GDP	Trend	0	-2.144	10.766 **	3	-2.323
	Intercept	0	-4.226	17.860 ***	3	-4.796 ***
	None	0	18.239	---	3	12.867
Repo	Trend	1	-2.873	16.345 ***	3	-1.893
	Intercept	1	-2.275	20.741 ***	3	-1.463
	None	2	-0.376	---	3	-0.383
Δ Loans	Trend	0	-7.138 ***	25.552 ***	3	-7.029 ***
	Intercept	0	-7.128 ***	50.804 ***	3	-7.030 ***
	None	5	-1.363	---	3	-3.322 ***
ΔDeposits	Trend	0	-6.290 ***	19.810 ***	3	-6.333***
	Intercept	0	-5.936 ***	35.230 ***	3	-5.962 ***
	None	4	-1.460	---	3	-2.195 **
ΔGDP	Trend	0	-7.626 ***	29.151 ***	3	-7.608 ***
	Intercept	0	-6.223 ***	38.725 ***	3	-6.227 ***
	None	3	-1.217	---	3	-1.799 *
ΔRepo	Trend	1	-5.125 ***	8.785 ***	3	-4.414 ***
	Intercept	1	-4.711 ***	11.135 ***	3	-4.293 ***
	None	1	-4.738 ***	---	3	-4.318 ***

*   *Statistically significant at 10% level of significance*
**   *Statistically significant at 5% level of significance*
***   *Statistically significant at 1% level of significance*

[†††]   Augmented Dickey Fuller unit root test (Dickey and Fuller 1979).
[‡‡‡]   Phillips Perron unit root test (Phillips and Perron 1988).

APPENDIX C: VECM STABILITY TEST

Table 8: *Stability test*

Root	Modulus
0.991728 - 0.017769i	0.991887
0.991728 + 0.017769i	0.991887
0.777676 - 0.225040i	0.809582
0.777676 + 0.225040i	0.809582
0.236612 - 0.415575i	0.478213
0.236612 + 0.415575i	0.478213
-0.055223 - 0.155352i	0.164875
-0.055223 + 0.155352i	0.164875

No root lies outside the unit circle.
VAR satisfies the stability condition.