Investigating the bank lending channel using disaggregate bank loans

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Abstract

This paper investigates the monetary policy transmission through the bank-lending channel in South Africa during the period 2002M1 to 2014M7 using disaggregated bank level data. The paper aims to answer three related questions: does the bank lending channel exist? If yes, is the effect the same across bank sizes? And has the volatility of the banks' balance sheet changed over time? Overall the results are supportive of the bank lending channel and that bank size does matter. The results for the TVP-VAR indicate that the variables are more responsive during period of increasing risk, like the financial crisis. The results suggest that during period of uncertainty, monetary policy have a stronger influence.

1 Introduction

In the words of Hosono and Miyakawa (2014), the effects of the global financial crisis on the lending activities by the banks and the subsequent monetary policy actions by the central banks to revive the economies have re-ignited the interest in the lending channel. Even though the South African central bank has not yet employed unconventional monetary policies, it is no doubt that the credit channel has a significant effect on a consumption-driven economy like South Africa. In South Africa, the financial sector is estimated to be almost three times the size of the economy,with assets of the banking industry being a little over 100% of gross domestic products[1].

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[1]South Africa: Financial system stability assessment, IMF (December 2014) and SARB Banking Supervision Annual Report (2013).

Within the banking industry, there is both high concentration and interconnectedness. Therefore, high credit impairment to the banks' balance sheet will no doubt trigger a systemic risk to the economy.

In this paper, we re-explore the lending channel in South Africa in the quest to answer a chain of three related questions. Firstly, we want to test if the lending channel exist in South Africa, with specific interest to its strongest impact on the selected loan categories. Secondly, if the answer to the first question is yes, then we want to know whether monetary policy is transmitted differently to banks of different sizes. And lastly, we are interested in finding out if there are changes in the transmission mechanism over the last 12 years. This paper presents some new supporting empirical evidence, specifically on the last two questions.

According to Gumata, Kabundi and Ndou (2013), the monetary policy transmission literature in South Africa has focused on the interest rate channel. In an attempt to provide a full spectrum of the five different channels of the monetary policy transmission, the authors investigate the effects of a 100 basis point positive shock across all channels. They use a large Bayesian vector autoregression (LBVAR) model for the period 2001Q1 to 2012Q2. For the purpose of this paper, we are only interested in the results related to the lending channel. Their results indicate that the lending channel is the third most important channel in the overall ranking of the five channels, and the strongest of the credit channel. Therefore the authors concluded that a contractionary monetary policy affect the loan supply more than the loan demand. Even though these results are supportive of the lending channel, analysing the data at an aggregate bank level hides some of the differences in the way the monetary policy shock is transmitted to different economic agents due to bank characteristics. This means that the results of the paper might be driven by the big banks and not necessarily applicable to the small banks, given the market share of the big banks. That is, even though the paper addresses the first question, it does not shed some light on the subsequent question two.

As highlighted in Sichei (2005) and subsequently, Mishi and Tsegaye (2012), bank characteristics does matter in the lending channel[2]. Both papers find evidence that small banks are more sensitive to a tight policy shock than the big banks. However, similarly to the Gumata *et al.* (2013), the papers also suffer from a different type of aggregation effect. In this case, the aggregation of loans might hide the heterogeneity of loans highlighted by Gertler and Gilchrist (1993) and Den Haan, Sumner and Yamashiro (2007). These two papers find that a contractionary monetary policy shock increases non-financial corporate loans while decreasing consumer and real estate loans. Therefore, in this case, the Sichei (2005) and Mishi and Tsegaye (2012) papers

[2] Hosono (2006) also finds the same results for Japan.

do address question two of our empirical approach, and fail to give further insights into question one. It is this divergence of results that we are attempting to address in the first two questions. Lastly, the paper aims to add to the current literature by using a different methodology that will help us to investigate if the above discussed variables respond differently to a tight policy shock over time. That is, has the financial crisis or the regulatory changes in the banking and financial sector as a whole had any effect on how banks adjust their loan portfolios following a policy shock?

We utilise both the Bayesian structural vector autoregression (VAR) and the Time-Varying VAR with stochastic volatility to answer the empirical questions. Unlike the current South African literature, and following Bernanke and Gertler (1995), we use monthly data. This increases both the frequency of our data and as discussed in Bernanke and Gertler (1995), provides fine timing of the response of loan categories as compared to quarterly data, especially if some loans are more responsive to a monetary policy shock. In the Bayesian structural VAR, we specifically test for the credit channel at both the aggregate and the disaggregate bank levels. This empirical approach of using both aggregate and disaggregate levels follows that of credit market imperfections for small firms by Gertler and Gilchrist (1993). However, here we adopt the work by Kashyap and Stein (1995). In their paper, the authors argue that just like the small firms, small banks are also subject to credit market imperfections. The TVP-VAR with stochastical volatility methodology used in this paper is the same as that used in the United States (US) by Primiceri (2005) and Benati and Mumtaz (2007) amongst others in extending the analysis of the effects of monetary policy actions during Burns and Volcker-Greenspan periods.

At the aggregate bank level, we find that the lending channel does exist in South Africa, supporting Sichei (2005), Mishi and Tsegaye (2012), and Gumata *et al.* (2013). In particular, we find that real estate loans respond more to a tight policy shock. The increase in corporate loans and inventories strongly support the view that banks extend more credit to corporate to finance inventories. Unlike Gumata *et al.* (2013), we actually find a significant increase in credit impairment.

Re-estimating the models at the disaggregate bank level, *i.e.* by bank sizes, provide some support that the lending channel is transmitted differently across different. Furthermore, the results indicate that small banks incur an increase in bank losses quicker than the small banks and the possibility that small businesses that rely on corporate loans from small banks might be locked out of the credit market, following a tight monetary policy. Interestingly and contrary to the international literature (amongst others Bernanke and Blinder (1992), Gertler and Gilchrist (1993), Kashyap and Stein (1995)), the results for securities holdings for the big banks indicate that they invest more (rather than sell off, as the conventional literature predicts) in securities after a tight monetary policy.

Lastly, the results for the TVP-VAR model with stochastic volatility indicate that (1) in most cases, there is less volatility after 2009 and (2) the variables are more responsive during periods of high uncertainty like the financial crisis. Specifically for the big banks, we also find some variability in the variables associated with the Basel 2.5 regulatory changes. In summary, the results for the Bayesian structural VAR at the disaggregate bank level add new findings that have been missed in the current literature. Whereas the results for the TVP-VAR model with stochastic volatility is a completely new addition to the literature.

The remainder of the paper is organised as follows. Sub-section 1.1 presents the evolution of the South African banking industry. In section 2, we discuss the literature review. Section 3 provides the methodology used in the paper. Section 4 documents the results. The last section concludes.

1.1 Basic characteristics of the banking sector

This section provides a non-theoretical background on selected financial indicators of the banking sector between 2002Q1 and 2014Q3. The paper covers the six local banks[3] that dominate the local retail market. The categorisation of the banks by bank size is taken form the South African Reserve Bank (SARB). The big four banks mainly serve the middle and high-income earners, whereas the other two banks (referred to here as the small banks) mostly serve the low-income earners through unsecured lending operations[4]. The ratio of total loans to total assets for the big and small banks averaged 76% and 85% respectively during the sample period. The big four banks currently have market share of 83.3%, 35% and 64.7% in the banking sector, assets in life insurance and assets under management, respectively[5].

The South African banking sector has been acclaimed for its financial soundness amidst the global financial crisis. Amongst the reasons for financial stability in the retail lending is the National Credit Act (NCA) of 2007 and macro-prudential practises. Recently, the latest development of the African Bank in 2014, continuing increase in household debt and credit impairment has put the banking sector under great scrutiny by the rating agencies. The concerns are justified given the increase in loans (both secured and unsecured). Consumers have enjoyed low interest rate environment since April 2010 when the prime rate fell below 10.5%, which can explain

[3]The local banks are the South African banks which are required to have deposits with the South African Reserve Bank (SARB).

[4]The big banks include Standard Bank, Nedbank, FirstRand and ABSA bank while the small banks include Abil and Capitec. These banks do not offer mortgage loans and have low corporate loans in their loan books.

[5]South Africa: Financial system stability assessment, IMF (December 2014).

some of the increase in credit demand. However, the subdued macroeconomic growth and high indebtedness of consumers has put consumers under financial strain, and creating a vicious circle of low growth.
Figures 1 to 8 present selected basic characteristics of the six banks which dominate the local retail market, in real terms. Figure 1 shows the year-on-year growth of the liabilities and loans of the big banks. We can see that there is a positive relationship between the two variables, with growth in liabilities outpacing growth in loans for most parts of 2003 to the second quarter of 2011. The impact of the global financial crisis is also evident, with negative growth during the period. Figure 3 presents the loan components of the big banks. Mortgage loans and overdrafts and advances to the private sector make up more than 60% of total loans and advances for the big banks during the sample period. Given the significant market share of the big banks,this indicate that they are central to both the real economy and financial system. The balance sheet of the small banks is different from that of the big banks. Figure 2 and 4 report the growth of both liabilities and loans and components of the loans for the small banks respectively. The growth in liabilities for the small banks exceed the growth in loans during November 2004 to June 2009. Interesting to note that, unlike the big banks, there was positive growth in loans during the crisis. Unsecured lending, especially overdrafts, loans and advances to the private sector, accounted for at least 70% of the loan portfolio. The undiversified loan portfolio of the small banks makes them more vulnerable to increasing household debt and other internal negative macroeconomic factors. However, as highlighted in Laeven, Ratnovski and Tong (2014), small banks pose small systemic risk to the overall banking sector due to their non-complex and non-fragile business model; not-so significant risk to overall liquidity; and less involvement in market-based activities. The recent curatorship of one of the small banks without any systemic risk to the banking sector provides proof.

Figures 5 and 6 show the funding liabilities of the banks. In Figure 5, we can see that the big banks have consistently maintained the deposits to total funding liabilities ratio between 85% and 90%, with deposits denominated in foreign currency averaging 2.3% of total deposits over the sample period. The funding for small banks has been unstable. Figure 6 indicates that the banks have relied on non-deposits funding between 2002 and 2007. This was then followed by more funding from fund managers which has declined from over 60% to now less than 20%. Deposits denominated in foreign currency average 0.1% of the total deposits over the sample period.

Lastly, Figures 7 and 8 present the non-risk weighted capital-to-asset ratio for the big and the small banks and the capital adequacy ratio reported by the big banks for Basel requirements, respectively. We can see that small banks have high capital-to-asset ratio than the big banks. The non-risk weighted capital-to-asset ratio is consistent with general view that big banks hold less capital than the small banks, Laeven et al. (2014). The big banks have maintained capital adequacy levels well above the Basel's requirements[6]. The current IMF report indicate that the banks are more vulnerable to increasing household debt, and that an increase in interest rate would significantly increase the probability of default especially for unsecured credit. However, the report suggests that the banks would be able to absorb the credit losses due to their high capital buffers.

[6]The SARB implemented Basel II on 1 January 2008, Basel 2.5 from 1 January 2012, and Basel III on 1 January 2013 (SARB Financial Stability Review).

Figure 1: Assets and Liabilities for the big banks

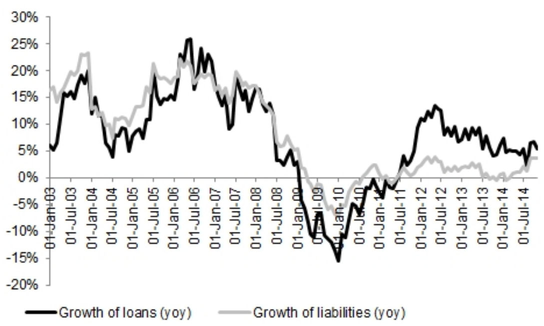


Figure 2: Assets and Liabilities for the small banks

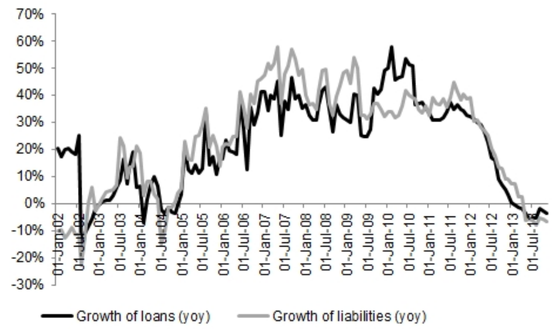


Figure 3: Composition of loans for the big banks

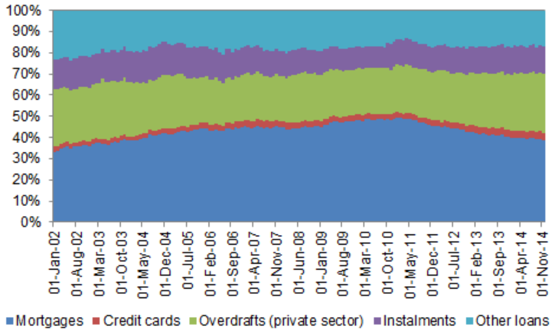


Figure 4: Composition of loans for the small banks

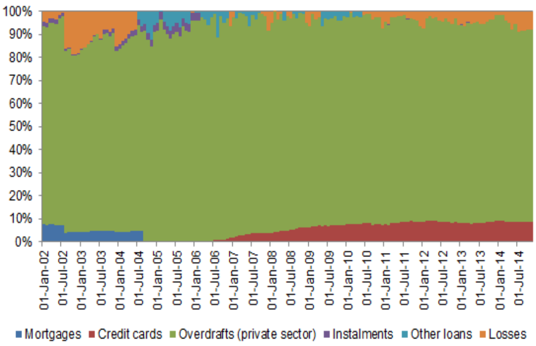


Figure 5: Composition of liabilities for the big banks

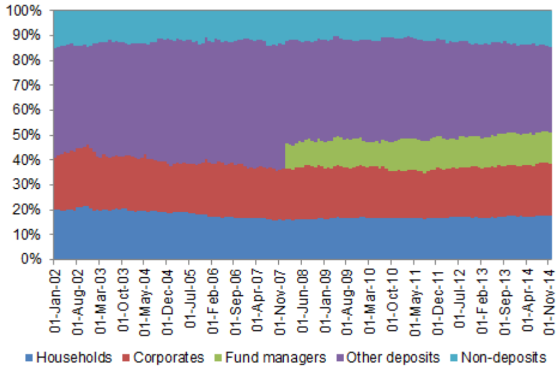


Figure 6: Composition of liabilities for the small banks

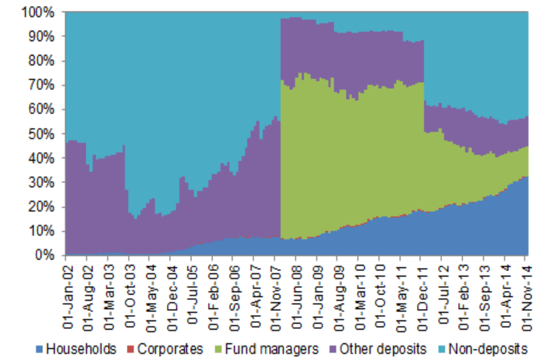


Figure 7: Non-weighted asset-to-capital ratio

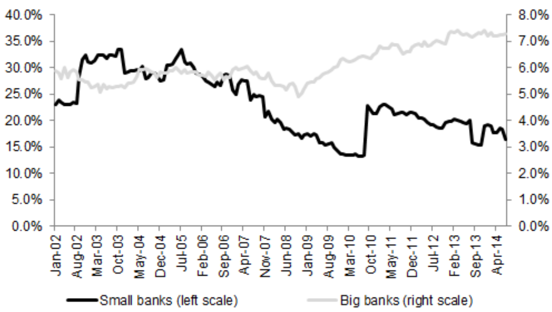
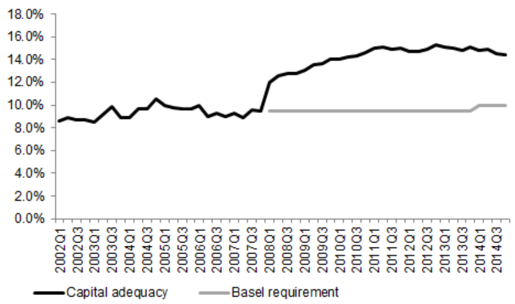


Figure 8: Capital adequacy for the big banks



2 Theory

The credit channel theory[7] tells us that information asymmetry between bank lenders and borrowers creates a wedge between the cost a borrower incurs in raising external/non-bank credit. Through this wedge, referred to as the external finance premium in the literature, monetary policy has some amplifying effect on interest rates. And it is this external finance premium that helps to explain some of the puzzling results that cannot be explained by the traditional interest rate channel. One of the puzzling results is the large impact of monetary policy on long-term assets like real estate that cannot be simply explained by the traditional interest rate channel[8]. According to Bernanke and Gertler (1995), the two possible linkages between the monetary policy authority's actions and the credit market are the balance sheet channel and the bank lending channel. The bank lending channel, as defined by Bernanke and Gertler (1995), is the effect of monetary policy on commercial banks' loan supply schedule and therefore on bank-dependent borrowers. Therefore whilst the balance sheet channel directly looks at the borrowers' balance sheet, the bank lending channel indirectly look at the transmitted effects to the borrowers' balance sheet through the lenders' balance sheet.

According to Romer and Romer (1990) in reference to Bernanke and Blinder (1988), the existence of the lending channel depends on the following two conditions: the first condition is that there should be perfect substitutability between banks liabilities (transaction deposits and certificates of deposits) and securities issued outside the banking system, like commercial papers. The second condition is that the reserve requirements on transaction deposits and certificates of deposits must be the same. If the second condition does not hold, then monetary policy will work through the liability side. For example, if the reserve requirements on certificates of deposits are lower than on transaction deposits, banks can easily offset the effects of tight monetary policy through issuing more certificates of deposits.

Gertler and Gilchrist (1993) investigate the credit market imperfection using small and big manufacturers. They argue that small borrowers are more sensitive to credit market imperfections/information asymmetries than large borrowers due to their less diversified balance sheets and smaller collateralised net worth relative to the big borrowers. These borrowers find it hard to raise non-bank funding. Therefore they incur higher borrowing costs or get locked out of the credit market.

Analogously, Kashyap and Stein (1995) argue that the same credit market imperfections that constrain credit to the small firms or borrowers can also be applied to small bank. According to the authors, credit market imperfections create cross-

[7] Bernanke and Gertler (1989,1995).

[8] See Bernanke and Gertler (1995).

sectional differences across different bank sizes after a tight monetary policy shock. As in the theory for small and big non-financial firms, small banks also face higher costs relative to the big banks in raising external non-deposit funding, which is an increasing function of the amount raised. This marginal cost can arise either from the adverse selection problem;advertising or high return to attract investors.

Proving the lending-channel-induced cross-section difference across banks after a contractionary monetary policy shock can be seen as a two-stage process. The first stage of the test is to prove that the central bank's policy actions have some effects on the asset side (and therefore the lending) of the bank's balance sheet. Then the second stage of the test is to further prove that the changes in lending are heterogeneous amongst banks of different sizes. Each stage requires its own identification in order to discriminate against other competing theories that can produce similar results. In the first stage, there need to be some evidence that a tight monetary policy results in loan supply effects. The loan supply curve must shift inward instead of the loan demand curve (in the extreme case of loan demand inelasticity) or that the net effects at the new loan market equilibrium results from loan supply effects, i.e. the loan supply curve shifts inward more than the loan demand curve. These are the arguments of Bernanke and Blinder (1988) paper.

For the second stage, there need to be evidence that the impact of the lending channel depend on the size characteristic of the bank. In proving this second stage, which they refer to as the cross section tests, Kashyap and Stein (1995) developed a two assets two liabilities model. The asset side consist of loans and securities and the liability side of deposit and non-deposit external funding. Equilibrium in the model can either be achieved by assuming a homogeneous loan demand market or a heterogeneous loan demand market[9].The two cross section tests require the following responses after a tight monetary policy shock: (1) the lending volume of small banks should decrease more than that of the big banks; and; (2) securities holding of small banks should also decrease more than that of the big banks. As discussed in their paper, and repeated here for completion, the results for securities holding are not easy to obtain in both models. If the cost of raising external funds is higher for small banks, they will be less willing to cut securities during a tight monetary policy. Therefore further conditions are required for (2) to hold: (I) loan demand shocks should not differ across bank sizes; and (II) loan demand should be fairly inelastic. According to the authors, the last condition does not hold in the homogeneous model. Therefore in summary, a tight monetary policy creates cross section differences for banks of different sizes only if both conditions (1) and (2) with its sub-conditions

[9] The main difference between the two is that in the heterogeneous market, each bank has its own monopoly power with its customers.

hold in the heterogeneous equilibrium model.

Bank size and information asymmetry are not the only factors that would create cross section differences. Other factors include liquidity and capital, Hosono (2006). Banks with more liquid assets tend to be less responsive to a contractionary monetary policy shock. Lastly,capital-abundant banks tend to respond less to monetary policy shock than capital-scarce banks.

2.1 Evidence to the theory

The main loan categories used in the literature[10] are commercial and industrial (C&I), real estate, and consumer loans. The disaggregation of loan data into these categories has two advantages. The first advantage is that these loans represents two sectors: the household and the corporate sector. Analysing the transmission mechanism provides insight into how monetary policy actions affect these two sectors. The second advantage is that the maturity of the loans differs. Consumer and C&I loans tend to be more short- to medium-term with high returns for banks while real estate loans are long-term and considered low risk-return assets since they are mostly collateralised, Den Haan *et al.* (2007). Therefore, inference of the response of banks to a monetary policy shock can give insight into risk-return behaviour.

The results for bank loan portfolios by Gertler and Gilchrist (1993) indicate that a rise in the Fed funds rate reduces total bank loans. Closer analysis of the disaggregated bank credit indicate that consumer and real estate loans decrease for about eight quarters after the shock while the results for business credit are insignificant. Therefore, they attribute the decline in total loans to consumer and real estate loans. When they looked at the compositional or cross-section effects, the results find that business loans to large firms increase while that to small firms fall after a contractionary monetary policy shock. They concluded that tight monetary policy fall more on small firms. Den Haan *et al.* (2007) find that real estate and consumer loans decrease after a tight monetary policy action,with the reduction being significant between the second half of the first year and the third year. Corporate loans increase and is significant within the first year until about the fourth year. The reasons cited by the authors for this balance sheet adjustment are "hedging and safeguarding of capital adequacy ratios". These results do prove the Bernanke and Gertler (1995) story that a transitory shock like the monetary shock can affect long-term assets like real estate loans. The results also indicate that analysing the bank lending channel through aggregate loans instead of the loan categories does not provide a clear picture of how the monetary shocks are transmitted to different sectors of the economy.

[10] Amongst others Gertler and Gilchrist (1993) and Den Haan *et al.* (2007).

For the results of the response of small versus big banks to monetary policy, Kashyap and Stein (1995) find that the loan volume for small banks is more sensitive to a monetary policy shock than that of the big banks, irrespective of using total loans or C&I loans. Hosono (2006) finds that total loans for regional (small) banks declined more than of major (big) banks for Japan. The author concluded that monetary policy fall more on small banks.

Turning to the empirical results for South Africa: most of the literature has focused on aggregate loan data. Sichei (2005) uses panel data to investigate the effects of bank lending channel on bank characteristics between the period of 2000 to 2004. The author finds a positive and significant partial effect of monetary policy on bank size. That is, a contractionary monetary policy affects small banks and their customers more whereas large banks are able to cushion the effects of the shock[11]. Mishi and Tsegaye (2012) extend Sichei (2005) paper. They improve the study by increasing the sample size to 2009 and only analysing South African controlled commercial banks, as opposed to all registered banks in Sichei (1995). Similar to Sichei (2005), they also find that bank specific characteristics (bank size) is positive and significant, indicating that smaller banks respond strongly to a contractionary monetary policy shock than big banks. Though the two papers found evidence of "*cross-section differences*" across different bank sizes, the empirical studies results have some shortcomings. As discussed by Kashyap and Stein (1995), the results of total loans may be driven by aggregation effects of different loan categories. If there is heterogeneous loan demand of different categories of loans, the results of tight monetary policy might favour big banks. As we already discussed above, big banks tend to lend corporate and real estate loans whereas small banks do not offer real estate loans (or any type of mortgage loan). In this case, a tight monetary policy that reduces real estate loans and consumer loans and increases C&I loans can also produce results that favour big banks if the decrease in real estate and consumer loans is offset by the increase in corporate loans (and therefore producing a marginal or insignificant change in total loans).

To our research, only Gumata *et al.* (2013) have analysed the bank lending channel using disaggregate quarterly bank loan data for the whole banking sector. The sample period is from the first quarter of 2001 to second quarter of 2012. Their overall results indicate that the lending and bank balance sheet channels (credit channels) are the third and fourth (out of the five) most important monetary policy transmission channel. The results for the bank lending channel indicate that mortgages advances, total loans and advances and credit to the private sector decrease after a tight mon-

[11] Loan included are other private sector loans and advances;and foreign currency loans and advances with specific and general provision for bad and doubtful debts included.

etary policy shock. The response for total loans and advances becomes significant a year after the shock and lasts until the tenth quarter. The results for credit to the private sector is significant and indicate that credit increases first in the first two or three quarters before decreasing. From the results, we can also notice a small and insignificant increase in total loans and advances in the first quarter. This might indicate that the increase in credit to the private sector initially outweighs the reduction in mortgages and other loans. However, the paper does not look at "*cross-section differences*" among bank sizes.

2.2 Arguments for cross-sectional differences in South Africa

This paper follows that of Gertler and Gilchrist (1993) and Kashyap and Stein (1995) in two ways. At the aggregate bank level, we want to test the theory that different loan categories respond differently to a tight monetary policy shock. We then disaggregate the loan data into bank sizes to gain more insight into the behaviour of different bank sizes. At this disaggregate bank level, we want to test if the response of loan volume and securities for the small banks are more sensitive to a monetary policy shock. The empirical tests at the disaggregate bank level are from Kashyap and Stein (1995) with a simple modification. Unlike Kashyap and Stein (1995), we use both non-financial corporate loans and consumer loans instead of total loans or just C&I loans. Before we discuss the assumptions, it is important to point out some of the similarities and differences of the bank characteristics in Kashyap and Stein (1995) analyses. In their paper, on the asset side, big banks hold more loans and less cash and securities than the small banks. The authors argue that this supports their model's assumption that small banks prefer larger cash and securities to avoid the need to raise external finance at a high cost and short notice. Contrary, in South Africa, the big banks hold a slightly less percentage of loans than the small banks and therefore a more larger securities as a fraction of total assets. The other difference is that unlike in their analyses, small banks in South Africa do not offer any mortgage loans during the sample period. On the liability side, in their paper, over 80% of the funding for small banks is from deposits, with big banks having a lesser percentage. Taken together with fact that the small banks did not borrow much from the Fed market, the authors argued that this also supported their model assumption that small banks find it hard to raise external funding. In South Africa, this is the opposite.

Beside these differences in the structure of the bank sizes, the main assumption underpinning our empirical questions is that small banks do face credit market imperfections relative to the big banks. As we have already established above, small banks heavily depend on non-deposit funding during the sample period, whereas the big banks have maintained deposits to liabilities ratio of over 80% over the same period. Therefore, it is plausible to assume that small banks face higher cost of raising external finance either by spending more on advertising costs or paying higher rates to constantly attract investors. Knowing this, investors can also take advantage of the vulnerability of the small banks' reliance on non-deposit funding and request high premiums. Moreover, the fact that non-deposits are not insured by the SARB and that the small banks are not considered a systemic risk to the financial sector or economy warrant even higher premiums by the investors.

This assumption can be supported by comparing the behaviour of the deposits by fund managers between the small and the big banks in Figures 5 and 6. The figures indicate possible high risk-return behaviour by the fund managers for the small banks. It is also interesting to see the pull-off by the fund managers from small banks in the events leading to the African Bank crisis in August 2014. Now in order for the small banks to recover the high cost of raising non-deposit funds, they will need to charge high interest rates on credit to the private sector. The current NCA regulation's maximum interest rate of 32% on unsecured lending does offer room for banks to recover high costs. Another option is for them to engage in high lending risk in order to increase the loan volumes.

Another assumption concerns the capital-adequacy requirements on banks. In South Africa, the capital-adequacy requirements for Basel regulations are only imposed on the domestically systematically important banks (D-SIB). Therefore, we can assume that small banks will have more capital than the big banks. This assumption can be supported by the non-risk weighted capital-to-asset ratio in Figure 7 and the results of tight monetary policy on bank capital by Sichei (2005). The results indicate that there is a negative relationship between capital-asset ratio and bank loan, which was not surprising since small banks had high capital-asset ratio in his sample. This implies that small banks' lending volume may be less responsive than the big banks after a monetary policy shock.

Though the paper does not look at the balance sheet channel, we can deduce some implications about the household sector from the results of the cross-sectional differences[12]. The first implication is that low income earners have limited access to credit and investment options. Thus, they are most likely to depend on unsecured lending to smooth their consumption. Middle to high income earners have a wide access to credit,with the option of switching between credit card, overdrafts on cheque accounts,short-term loans and withdrawal mortgage facilities. Over and above these options, they also have investments they can utilise during tough economic periods. If consumer loans for the small banks decrease more relative to the big banks, it would

[12] Sichei(2005) also suggest that the condition that there are bank-dependent customers in South Africa generally hold given the structure of the economy.

mean that monetary policy fall more on low income earners and small businesses. This would suggest that this group is shut off from the credit market. The second implication follows from the first implication. With limited credit options, we expect small banks to experience credit impairment that is either higher or quicker than that of the big banks. Possible reasons that this might not hold will suggest that the loan demand curve by low income earners is inelastic or that small banks take high risk after a tight policy shock and extend credit to the poor. The first reason is not plausible since it would mean that low income earners are insensitive to tough economic periods.

3 Empirical methodology

3.1 Data

To conduct the empirical study, we use the bank loan data. The loan data consist of loans to the household sector (consumer loans and real estate loans) and non-financial corporate sector. The data is obtained in the BA900 report from the South African Reserve Bank(SARB). The report consists of data for the seven big banks that are required to submit monthly balance sheet data for regulatory purposes. However, we only cover six of the seven banks in the empirical study[13]. The advantage of the chosen sample period is that there are no mergers during the period, which makes it easy to categorise the banks. The data for inventories is obtained from Quantec. The variables included in the models include interest rate, consumer loans, non-financial corporate loans, real estate loans,securities,inventories and credit impairment. Similarly to Cogley and Sargent (2005), we use the discount rate on the 91-day Treasury bills as the monetary policy instrument. Consumer and corporate loans are overdrafts, loans and advances extended to the household and non-financial corporate sector. Real estate loans are residential mortgages to the household sector. We use the commercial paper, promissory notes (PNs), bills,bankers' acceptance and other similar unspecified assets as securities. Inventories are total inventories of the economy. Lastly, credit impairment is in respect of loans and advances. The data is in monthly frequency. All the data except for the interest rate is in real terms and detrended using the Hodrick-Prescott (HP) filter with lamda set at 14 400. The sample period starts from January 2002 to July 2014.

[13]One bank is excluded from the study as it does not have bank loan in its balance sheet.

3.2 Model estimation

The vector autoreggressive analysis has two sub-sections: the structural VAR and the TVP-VAR. Using Christiano, Eichenbaum and Evans (1998), we also identify the monetary policy shock using the following equation:

$$S_t = f(-t) + \Phi_s \xi_t^s \tag{1}$$

where S_t is the monetary policy instrument,f is a linear function,$(-t)$ is the information set that the monetary authority takes into consideration when making policy decisions and $\Phi_s \xi_t^s$ is the random monetary policy shock with ξ_t^s being the exogenous shock and Φ_s as the standard deviation of the policy shock. The information set contains credit extended to the private sector:with main focus on consumer loans, real estate loans and corporate loans;securities;credit impairment;and inventories as some measure of the economy. The inclusion of inventories is to test the theory that banks extend credit to the non-corporate firms to fund the increase in inventories due to reduction in demand or sales after a tight monetary policy shock. The economic interpretation of the exogenous policy shock (ξ_t^s) adopted in the paper is that it captures the measurement error in the current available data to the monetary authorities when making policy decision at the Monetary Policy Committee (MPC) meeting[14].

3.2.1 Structural Vector Autoregressive model

The first two empirical questions are estimated using three Bayesian structural VARs models, using monthly data for the six banks. The first model is a six variable model with interest rate, consumer loans, non-financial corporate loans, real estate loans, inventories and credit impairment. It is estimated at an aggregate bank level (consolidation of the big and small banks), and is intended to represent the response of the banking sector to monetary policy. The model also serves as a benchmark model. In the second model, we re-estimate the first model using the interest rate and bank specific variables: consumer loans, non-financial corporate loans and credit impairment at a disaggregate bank level[15]. And lastly, in the third model, we replace credit impairment with securities.

Below is a brief summary of the general Bayesian structural vector autoregression (B-SVAR) model from Blake and Mumtaz (2012). Equation (2) presents the VAR (2) model[16] ,

[14] See Christiano et al.(1998).

[15] Only one small bank offered real estate loans until third quarter of 2004. Therefore the response for real estate loans should be similar to the aggregate model.

[16] Please consult chapter 2 in Blake and Mumtaz (2012) and Robertson and Tallman (1999) for extensive explanation of the model and the code; and priors.

$$Y_t = c + B_1 Y_{t-1} + B_2 Y_{t-2} + \nu_t \tag{2}$$

$$E(\nu_t' \nu_s) = \Sigma \text{ for } t = s \tag{3}$$

$$E(\nu_t' \nu_s) = \Sigma \text{ for } t \neq s \tag{4}$$

$$E(\nu_t) = 0 \tag{5}$$

which can be written in a compact form:

$$Y_t = BX_t + \nu_t \tag{6}$$

with $X_t = \{c_i, Y_{it-1}, Y_{it-2}\}$. Equation (6) can further be re-written as

$$y = (I_N \otimes X)b + V \tag{7}$$

where $y = vec(Z_t)$,$b = vec(B)$, and $V = vec(v_t)$. Restriction on the coefficients of the lagged variables of the dependent and independent variables are imposed using the independent normal inverse Wishart (IW) distribution. According to Blake and Mumtaz (2012), the independent normal inverse Wishart (IW) prior allows for different treatment of the lagged variables. The prior of the VAR coefficients (b) and the VAR coefficient covariance matrix (Σ) are given by equation (8) and (9) respectively,

$$p(b)\tilde{\ }N(\widetilde{b_0}, H) \tag{8}$$

$$p(\Sigma)\tilde{\ }IW(\widetilde{S}, \alpha) \tag{9}$$

where $\widetilde{b_0}$ and H represent the prior mean (vector) and covariance of the prior, respectively, with dimensions of $(N \times (N \times P + 1)) \times 1$ and $(N \times (N \times P = 1)) \times (N \times (N \times P + 1))$, respectively. And $\widetilde{S}$ and α represent the prior scale matrix and degrees of freedom. The prior scale matrix is an $N \times N$ diagonal matrix with the diagonal elements given by equation (10), where σ_i are the variances of the residuals and λ_0 is the measures the overall tightness of the prior on the covariance matrix

$$\frac{\sigma_i}{\lambda_0} \tag{10}$$

The covariance of the prior (H) is determined using equation (11),

$$H = \widetilde{S} \otimes \widetilde{H} \tag{11}$$

with $\widetilde{H}$ given by equation (12) for the coefficients on lamdas and (13) for the constant term.

$$(\frac{\lambda_0 \lambda_1}{l^{\lambda_3} \sigma_i})^2 \tag{12}$$

$$(\lambda_0 \lambda_4)^2 \tag{13}$$

Starting with equation (12), l is the lag of the regressors. The parameter λ_0 controls the tightness of the prior on the covariance matrix and is not set as the term is cancelled out in equation (11). The parameter λ_1 is the standard deviation of the prior for the ii-th element of the B_1 matrix in equation (2). As the parameter approaches 0, the prior on the coefficients of own first lag is imposed more tightly. λ_3 measures the degree to which coefficients of lags higher than 1 are likely to be 0. As λ_3 increases, the coefficients in the matrix B_2 in equation (2) are shrunk to zero. Lastly, from equation (13), λ_4 controls the prior variance on the constant term. As the parameter approaches zero, the constant term is shrunk to zero.

The marginal posterior distributions are simulated using the Gibbs sampling algorithm. We follow Den Haan *et al.* (2006) and others in the literature by assuming that the benchmark specification is that interest rate does not respond to the contemporaneous variables. To achieve this, the models are estimated with interest rate ordered first. The structural shocks are recovered by imposing a lower triangular matrix to the innovations on the A_0 matrix.

$$\Sigma = A_0' A_0 \tag{14}$$

This identification can be justified by the fact that commercial banks have to spend some time to consolidate the data from different divisions before submitting their balance sheet to the central bank. Therefore the central bank can only observe the loan data and respond with a lag. However, any policy actions by the central banks can have a contemporaneous effect on decisions by the banks and therefore how they adjust their loan portfolios. For example, if the central bank increase interest rate, banks can decide to reduce the number of new loans approved.

The optimal lag length selected using the Akaike Information Criterion is 2. The parameters to control the prior are set on the following assumptions: each variable respond more to the first lagged independent variables. Given the high-frequency of the data, we also assume that the independent variables with p=2 are half as important relative to the independent variables with p=1 in informing the decisions of the central bank. Therefore, the prior restrictions are set as: $\lambda_1 = 0.1$,$\lambda_3 = 0.05$ and $\lambda_4 = 1$.

3.2.2 Time-varying Vector Autoregressive model

We then extend the B-SVAR models to investigate if the responses of the variables to a monetary policy shock changes over time. We use the time-varying coefficients VAR with stochastic volatility to re-estimate the models. As discussed in Primiceri (2005), the advantage of this methodology is that it allows the data to determine if there is time variation to the linear structure of the model instead of imposing the homoscedasticity in the innovations as done in the Classical Linear Regression models and the previous discussed model. The series in Figure 1 and 2 indicate that there has been a change in the means for both the liabilities and assets of the banks. The period under study covers both the financial crisis, aggressive monetary policy cycle, and regulatory changes in both the local and international environment. The models from the previous section are re-estimated. Similarly to Primiceri (2005), we estimate the models in three-variables sub-samples to reduce the number of parameters to be estimated and also for computational efficiency. As in the previous section, two lags are used to estimate the models.

Equation (2) can be re-written as

$$Y_t = B_{0,t} + B_{1,t}Y_{t-1} + B_{2,t}Y_{t-2} + \nu_t; Var(\nu_t) = \mu_t \tag{15}$$

with $\nu_t \sim N(0, \mu_t)$ where the covariance matrix is allowed to vary. The relationship between the innovations and the structural shocks is such that $A_t\nu_t = \varepsilon_t$ and the $Var(\varepsilon_t) = H_t$. The time-varying covariance matrix is factorised as:

$$\mu_t = A_t^{-1}H_t(A_t^{-1})' \tag{16}$$

with H_t and A_t are defined as:

$$H_t = \begin{bmatrix} h_{1,t} & 0 & 0 \\ 0 & h_{2,t} & 0 \\ 0 & 0 & h_{3,t} \end{bmatrix} \text{ and } A_t = \begin{bmatrix} 1 & 0 & 0 \\ a_{21,t} & 1 & 0 \\ a_{31,t} & a_{32,t} & 1 \end{bmatrix} \tag{17}$$

Following the Primiceri (2005) and Benati and Mumtaz (2007), let $\beta_t = [B_{0,t}, B_{1,t}, B_{2,t}]$ and $\theta_t = vec(\beta_t')$. Similarly, let a_t be the non-zero and non-one elements of the A_t matrix and h_t be the vector of the diagonal elements of the H_t matrix. Therefore the time-varying coefficients evolve as random walks such that:

$$\theta_t = \theta_{t-1} + \omega_t; Var(\omega_t) = Q \tag{18}$$

with $\omega_t \sim N(0, Q)$,

$$\ln h_t = \ln h_{t-1} + \xi_t; Var(\xi_t) = Z_i \text{ for } i = 1..3 \tag{19}$$

and

$$a_t = a_{t-1} + \eta_t; Var(\eta_t) = D \tag{20}$$

And we also assume that a block-diagonal structure for V, such that:

$$V = var \begin{pmatrix} \mu_t \\ \omega_t \\ \eta_t \\ \xi_t \end{pmatrix} \sim N(0, V) \tag{21}$$

$$V = \begin{bmatrix} I_3 & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & D & 0 \\ 0 & 0 & 0 & Z \end{bmatrix} \text{ and } Z = \begin{bmatrix} \sigma_1^2 & 0 & 0 \\ 0 & \sigma_2^2 & 0 \\ 0 & 0 & \sigma_3^2 \end{bmatrix} \tag{22}$$

The structure of D also follows a block-structure:

$$D = \begin{bmatrix} D_1 & 0_{1\times 2} \\ 0_{2\times 1} & D_2 \end{bmatrix} \tag{23}$$

with $D_1 = Var(\eta_{21,t})$ and $D_2 = Var(\eta_{31,t}, \eta_{32,t})'$.

Priors

The first 40 months (which are referred to as T_0), from January 2002 to April 2005, are used as the pre-sample to calibrate the starting values for the prior distributions for the states and the hyperparameters. Starting with the prior distributions for the states: following the literature (Primiceri (2005), Cogley and Sargent (2005) and Benati and Mumtaz (2007)), the pre-sample is used to estimate an ordinary least squares (OLS) VAR model with coefficients (θ_0) and variance covariance matrix ($g_{0|0}$). The initial starting values for the states is $\theta_{0|0} = vec(\theta_0)'$ and the initial state covariance is $g_{0|0}$.

For the hyperparameters, Q, D and Z, the priors are as follows: the prior for Q , which determines the variability in θ_t is inverse Wishart

$$p(Q) \sim IW(Q_0, T_0) \tag{24}$$

with degrees of freedom T_0 and scale matrix Q_0. Following Primiceri (2005), the scale matrix Q_0 is set to $g_{0|0} \times T_0 \times \gamma$. The scaling factor γ is set to 1.0×10^{-4}, the same as Primiceri (2005) and Benati and Mumtaz (2007). The priors for D_1 is an inverse Gamma

$$p(D_1) \sim IG(D_{10}, T_0) \tag{25}$$

and for D_2 is an inverse Wishart

$$p(D_2) \sim IW(D_{20}, T_0) \tag{26}$$

with $D_1 = 10^{-4}$ and $D_2 = \begin{pmatrix} 10^{-4} & 0 \\ 0 & 10^{-4} \end{pmatrix}$. Lastly, the prior for Z is an inverse Gamma

$$p(Z) \sim IG(Z_0, \nu_0) \tag{27}$$

The identification of the structural shocks is achieved through sign restrictions from the estimated B-SVAR models from section 4.1.. This is to ensure that the effects of the structural shocks on the variables are consistent with that from the B-SVAR models. The procedure followed in identifying the structural shocks is the one used in the literature. Let $\mu_t = P_t C_t P_t'$ be the eigenvalue-eigenvector of the covariance matrix μ_t, and $\widetilde{A}_{0,t} = P_t C_t^{1/2}$. Then draw and $N \times N$ matrix K from a $N(0,1)$ distribution, and take a QR decomposition of K, such that $K = Q \times R$. This lead to a structural impact matrix of $A_{0,t} = \widetilde{A}_{0,t} Q'$. The draw that satisfies the imposed sign restrictions is then used to compute the impulse response functions.

Following Cogley and Sargent (2005), we adopt the Metropolis within Gibbs algorithm by Blake and Mumtaz (2012) to do the simulation for the draws[17]. The simulations are based on 100 000 replications, with the last 10 000 iterations retained for inference. We check for convergence using the serial correlation on the retained iterations. The results indicate convergence in all cases except for $\ln h_{i,t}$[18].

4 Results

4.1 Structural Vector Autoregressive results

This sub-section reports the results of the B-SVAR models to a one standard deviation innovation to a monetary policy instrument. In particular, we address the first two empirical questions: does the lending channel exist in South Africa? And, is it transmitted differently to banks of different sizes? The impulse response functions show both the median responses and the 68% error bands. The results are presented in percentage points to allow for easy interpretation. For interest rates, a 0.1% is interpreted as a 10 basis points.

[17] The procedure for the simulation of the posterior distribution follows that of Blake and Mumtaz (2012) handbook.

[18] The results failed to converge even after 200 000 iterations.

4.1.1 Re-visiting the lending channel

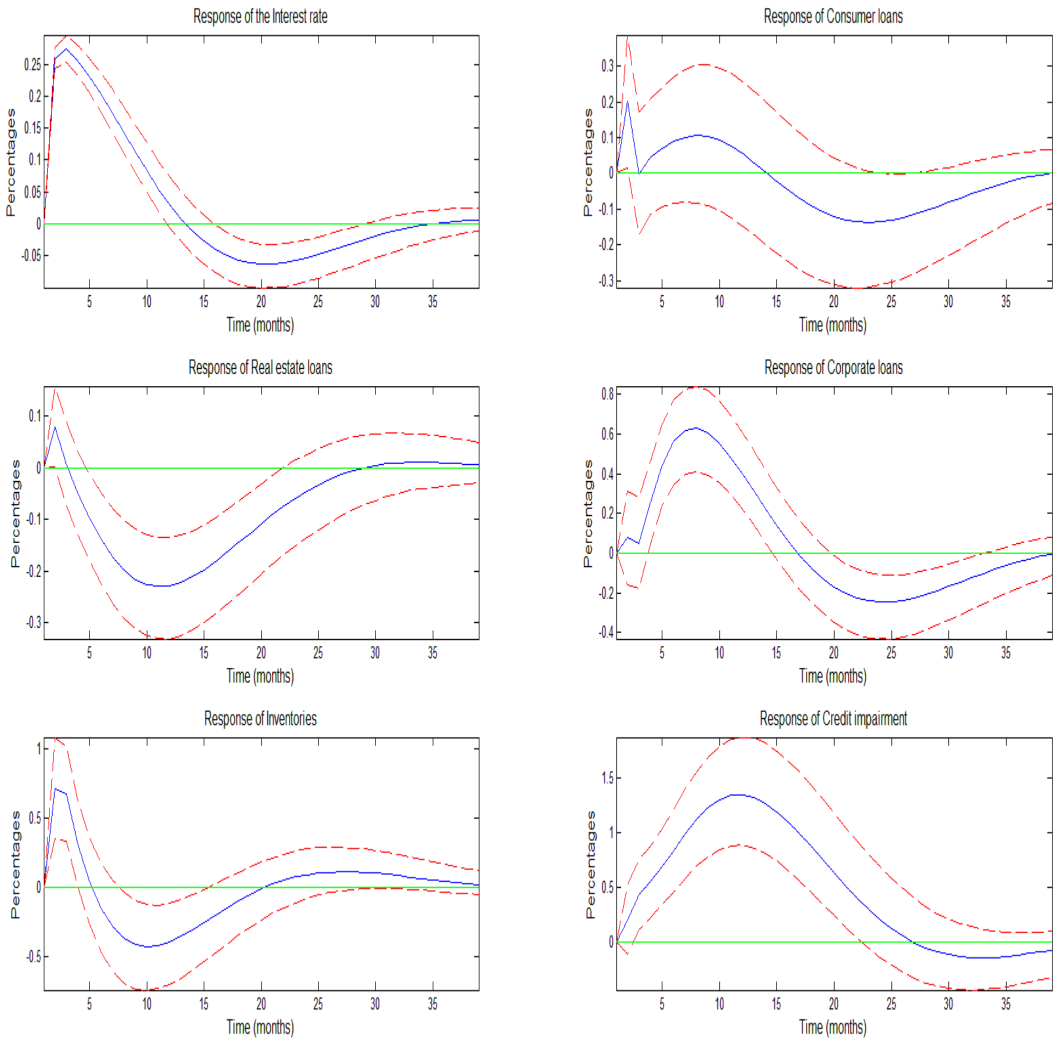
Figure 9 presents the estimated impulse response functions of the VAR system with interest rate, consumer loans, non-financial corporate loans, real estate loans, inventories and credit impairment to a positive one standard deviation shock. The results are for the aggregate banks and therefore serve as a benchmark results for the disaggregate bank level results. The results are related for the first question. A one standard deviation in monetary policy results in a contemporaneous 0.25% or 25 basis point increase in interest rate.

The top right-hand panel indicate that the results for consumer loans are small and nonetheless insignificant. According to the results in the middle panel, real estate loans begins to decrease about 3 months after the contractionary monetary policy shock, and reaching its minimum at 0.25% after 10 months. Consistent with literature, corporate loans increase to as high as 0.6% 8 months after the shock.

The results for inventories in the bottom left panel indicate that a contractionary monetary policy increases inventories in the first 3 months, afterwhich they decrease. The results are consistent with that of Bernanke and Gertler (1995), where inventories increase in the first 3 or 4 months before decreasing. Lastly, from the bottom right panel, we can see that credit impairment increases and peaks at about 1.5% 12 months after the shock. The increase of the impairment is significant. If we look at the increase in credit impairment taking into consideration the results of the different loan categories, it is does not seem that the decrease in real estate loans alone is responsible for this. It follows that banks incur losses outside the current bank loan portfolio in the model after a tight policy shock. Overall, the results for the bank loan portfolios are consistent with the literature. That is, banks extend more credit to the corporate sector and less to the household sector (real estate and credit loans) following a monetary policy shock. Therefore, banks do adjust credit from low risk and long-term assets to short-term assets. Another interpretation for the results relates to the interest elasticity of the demand for credit components to a monetary policy shock. The estimate is calculated by dividing the initial impact of policy shock on loan component by the initial impact of the policy on interest rate[19]. The calculated estimates are 0.3 for consumer and real estate loans and 0 for corporate loans. The results indicate that the short-run money demand elasticity for the loan components is small.

[19] See Christiano et al.(1998,p23).

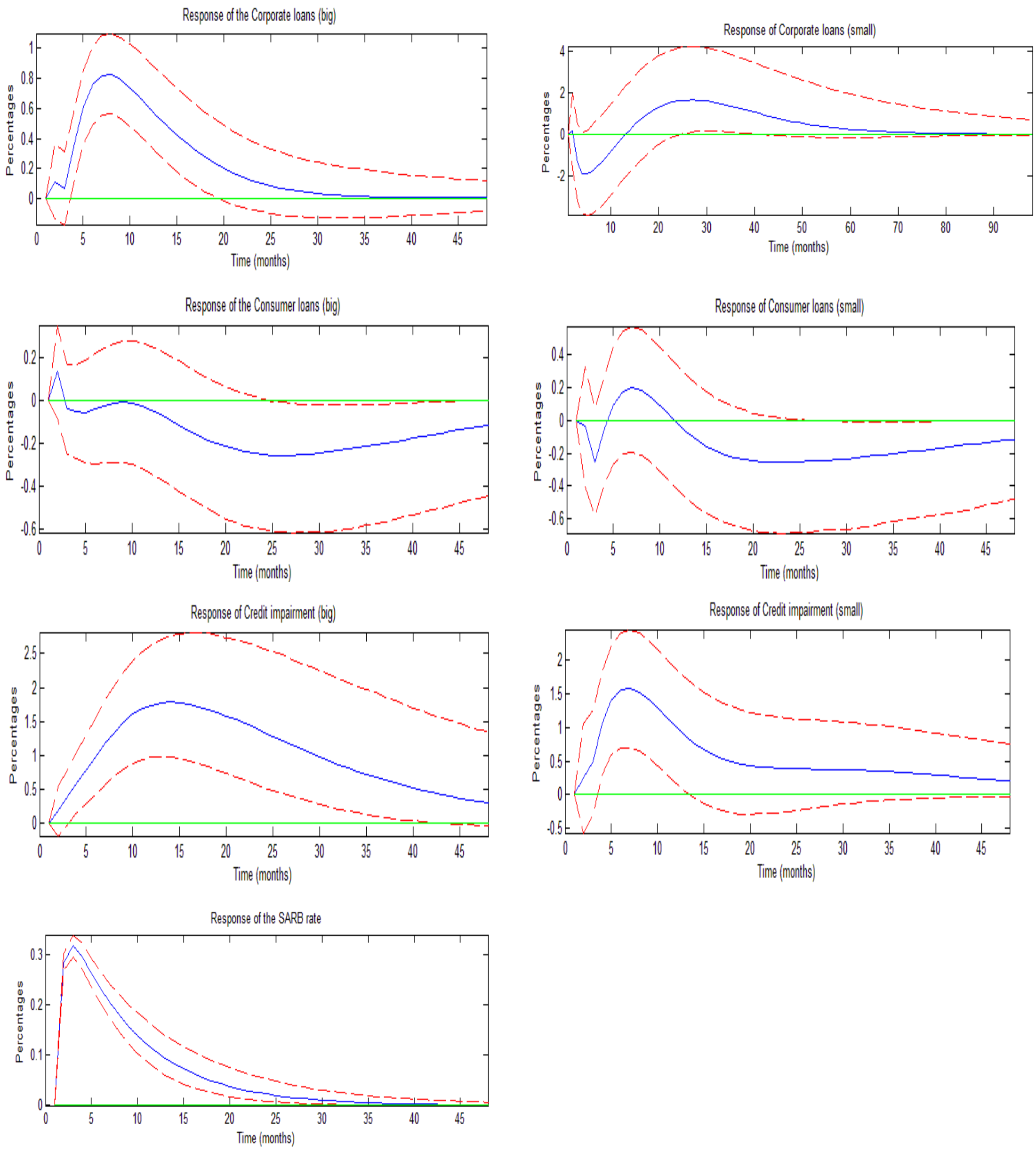
Figure 9: Aggregate response of loan categories to a monetary policy shock



4.1.2 Does bank size matter?

So far, we have established that a tight policy shock does have a negative impact on real estate loans and credit impairment, consistent with Gertler and Gilchrist (1993), Den Haan *et al.* (2007) and Gumata *et al.* (2013). Now, we are interested in investigating how banks of different sizes compare to these benchmark results. Firstly, we present the results of the bank sizes using the same specification from the aggregate model. However, since only the big banks offer real estate loans, we exclude it from the disaggregate models. The results are presented in Figure 10. Here a one standard deviation in monetary policy results in a 0.3% increase in interest rate. Starting with the results for corporate loans, we can see that a contractionary monetary policy has different effect across bank sizes. The results for big banks are the same as that of the benchmark model. However, for the small banks, corporate loans actually decrease, even though the results are insignificant across bank sizes. Lastly, both the big and small banks see an increase in their credit impairment of about the same magnitude after a policy shock. The results indicate that small banks experience the maximum impact first, with credit impairment peaking after 7 months, approximately 4 months before the big banks. The first possible explanation is that low income earners default quicker than middle to high income earners due to limited credit options. This can happen if these low income earners are recession sensitive. The other explanation can be given by the fact that small banks rely heavily on unsecured loans, of which most are bad loans. Therefore a small monetary policy shock would induce a quicker defaults of these loans. Overall, the results do indicate that analysing monetary policy transmission with disaggregate loan data provide more insight into the behaviour of bank loans after a shock.

Figure 10: Disaggregate response of loan categories to a policy shock



Next we modify our model specification and replace credit impairment with security holdings. As already discussed, analysing the movement in both the lending volume and securities provides a more stringent test for the loan supply story. If our theory that monetary policy impact the small banks more than the big banks, then we would expect to see a bigger decline in both loans and securities for the small banks. The results for this specification are presented in Figure 11. Again, a one standard deviation in monetary policy shock results in a 0.3% increase in interest rate. In this specification, we can see that the results for corporate loans for the small banks are now significant. Corporate loans for the small banks falls to a little over 3% after 5 months. There is some robustness to the results for big banks. The results for consumer loans still remain insignificant across bank sizes. Contrary to literature[20], the results for the securities indicate that the big banks increase their securities holdings in the first 2 months and only start selling off thereafter. However, the sell off is statistically insignificant. Unlike the big banks, the small banks disinvest in securities. Kakes and Sturm (2002) find similar results for the banks in Germany. In their paper, there is a contemporaneous increase (though insignificant) increase in security holdings for the big banks, whereas other bank categories show a contemporaneously (and significant) decrease in security holdings. The authors concluded that unlike other bank categories, the big banks do not need a "buffer of liquid assets" during a contractionary monetary policy.

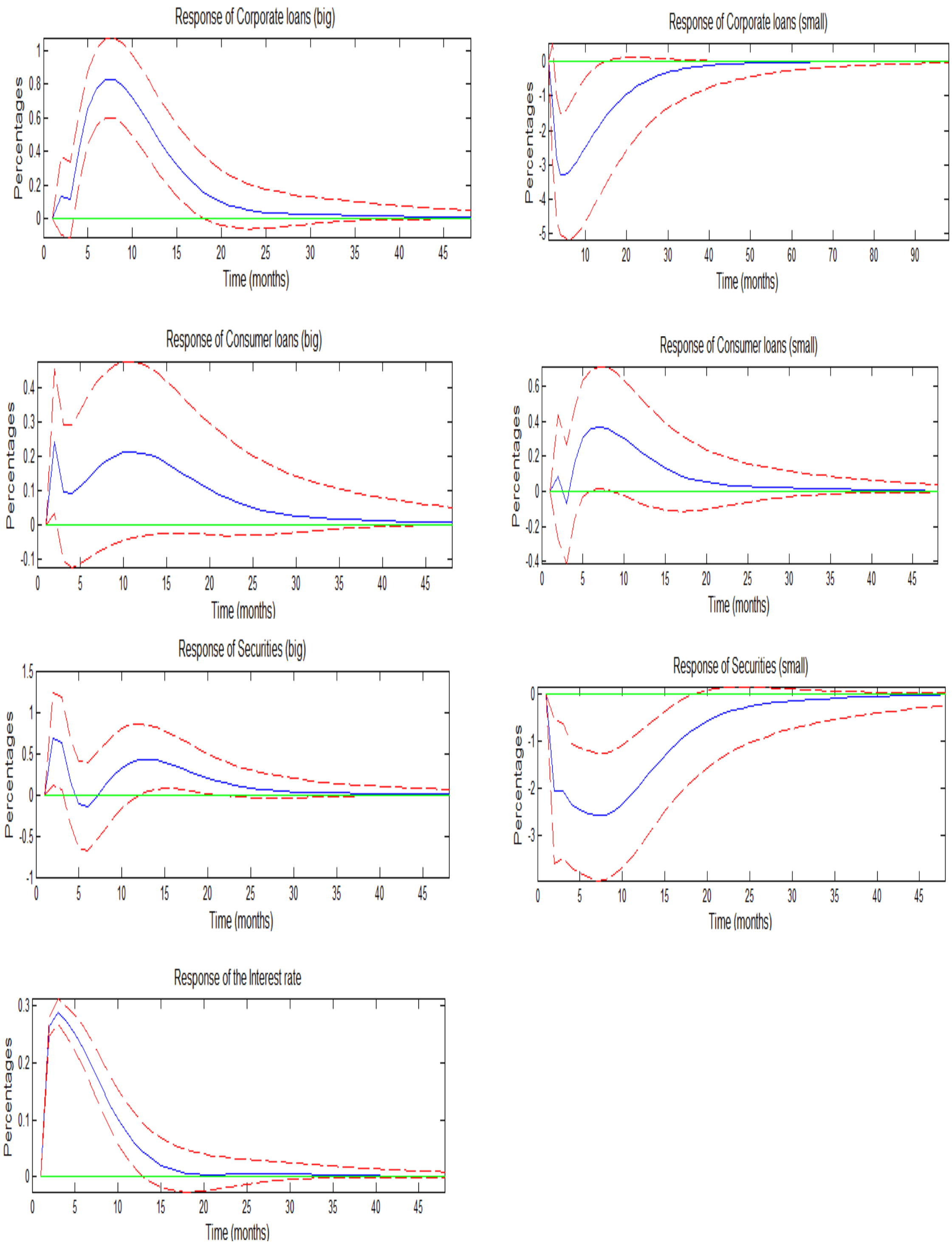
Even though the results that corporate loans for the small banks are sensitive to the model specification, there is some evidence that a tight monetary policy affect the small banks more than the big banks.

The results for corporate loans are interesting and could be explored for further research. If small banks lend to small and medium firms, then the decrease in corporate lending might indicate that either small firms do not carry much inventories and therefore would require less funding than the big firms. Another possibility,and also worrying story could be that small firms are shut out of the bank credit market. If this is the case,then the effects of monetary policy on the small banks could be detrimental to the economy given that the majority of companies are small and medium companies[21].

[20]Bernanke and Blinder (1992) and Gertler and Gilchrist (1993) find that securities contemporaneously decrease after a tight monetary policy. More specifically, Kashyap and Stein (1995) also finds similar results for the big banks.

[21]According to Mishi and Tsegaye (2012), Small, Medium and Micro-sized Enterprises (SMMEs) formed 97.5% of all businesses in South Africa and generated 35% of the country's GDP.

Figure 11: Disaggregate response of loans categories and securities to a policy shock



4.2 Time-varying Vector Autoregressive results

In this section, we estimate the TVP-VAR models by imposing sign restrictions. Following Hristov, Hulsewig, Wollmershauser (2011) and Benati and Mumtaz (2007), the sign restrictions are imposed on the contemporaneous response of the endogenous variables. Except for consumer loans, the postulations are based on the results from the structural VARs in section 4.1., and are as follows: for the aggregate models, a contractionary monetary policy shock would contemporaneously reduce real estate loans; and increase corporate loans, inventories and credit impairment. For the disaggregate models, the discussed responses of the variables of the big banks would hold; due to their dominance in the banking sector. The imposed contemporaneous response for securities is non-negative for the big banks. For the small banks, corporate loans and securities decrease; and credit impairment increases. And following the literature, we also assume that consumer loans decrease. The results are presented in both aggregate level and disaggregate bank level for consistency.

Before we present the results, it is important to briefly discuss the convergence of the estimated results. For us to be confident in our results, the conditional posterior distributions of the retained draws from the Gibbs sampling algorithm must have converged to their marginal posterior distribution, Blake and Mumtaz (2012). A simple method to test convergence is the 20-th order autocorrelation of the retained draws. Low autocorrelation indicate convergence. The results of the 20-th sample autocorrelation indicate that both θ_t and a_t converge in all models. However, h_t still exhibit high autocorrelation, even after increasing the number of iterations to 200 000.

4.2.1 Aggregate TVP-VAR results

Results for stochastic volatility (μ_t)

Figure 12 shows the median of the time-varying distribution of the volatility, together with the 16th and 84th percentiles. The stochastic volatility for the interest rate in all models indicate one interesting feature. From about the last quarter 2009, interest rate exhibit less volatility than the first years of the remaining sample. The volatility between 2006 and third 2009 captures three events. The first one relates to the tightening cycle by the monetary policy committee between June 2006 and June 2008, which resulted in a cumulative 500 basis point increase in interest rate. In fact, we can see that from mid 2008, when interest rates were kept unchanged until December 2008, there is a decrease in volatility. According to the SARB monetary policy review reports, which gives more insight into the actions taken by the MPC committee, the SARB was aggressive in maintaining inflation under the upper bound, which was fuelled by growth in credit extension and increasing household debt amongst other variables. The second event, December 2008 to about the third quarter of 2009, coincides with the period of accommodative monetary policy. During this period, interest rates decreased by a cumulative 500 basis point decrease in the interest rate between December 2008 and August 2009 in response to the financial crisis. Nonetheless, the change in cycles from these monetary policy actions caused less volatility as compared to the last event. It is clear that even after August 2009, the volatility remains elevated than that of the 2006 to mid 2008 period. Therefore, it seems that the second period captures the initial impact of the financial crisis which becomes higher in the third period.

Figure 13 (a) present the stochastic volatility for consumer loans and real estate loans, respectively. Even though consumer loans seem to be more volatile than real estate loans, there are two notable similarities between the two. Firstly, both consumer loans and real estate loans exhibit more volatility during the first half than in the second half. Secondly, the two also peak around 2008 and between 2010 and 2011. The similarities are not surprising given that both loans are loans extended to the consumer sector and therefore reflect the volatility of consumers The stochastic volatility for corporate loans and inventories in Figure 13 (b) are unclear.

Figure 12: Stochastic volatility for the interest rates

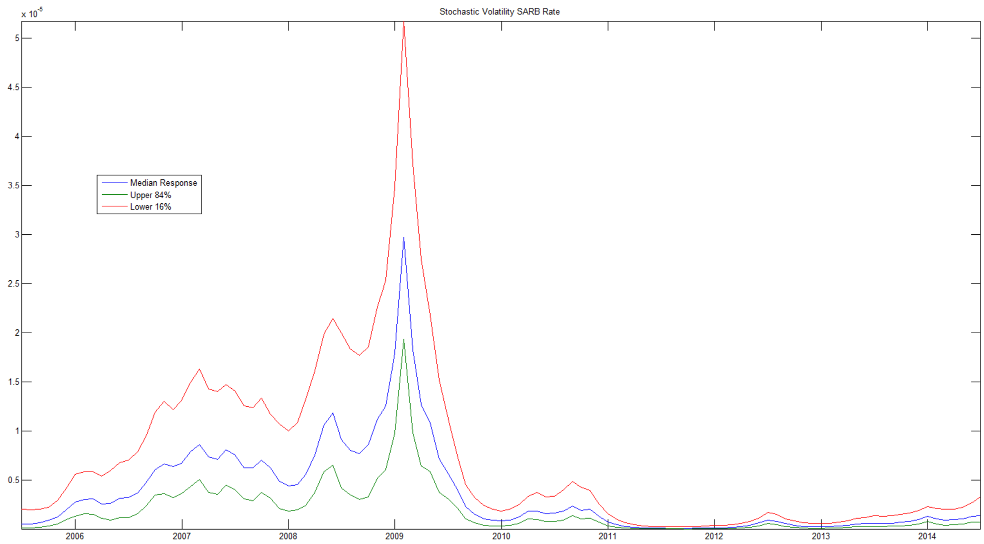
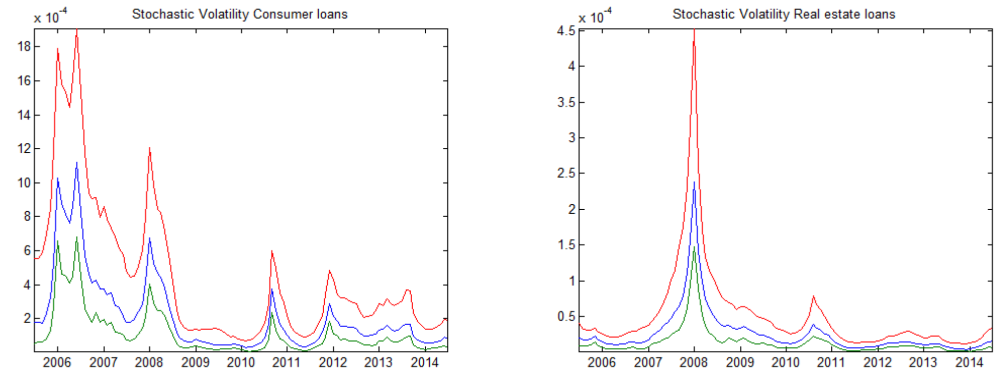
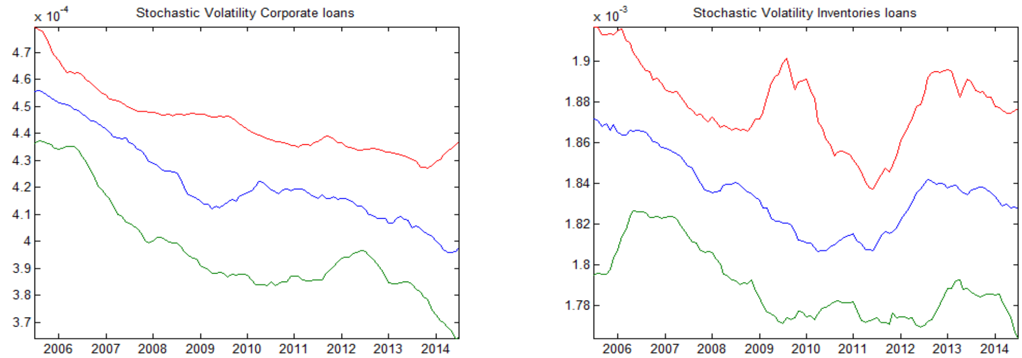


Figure 13: Stochastic volatility for the aggregate model

(a)



(b)



Results for time-varying coefficients (θ_t)

The time-varying changes in the effects of monetary policy shock are presented in Figure 14 (a) and (b). Figure 14 (a) only shows the results for consumer loans and real estate loans. Again, we can note the similarities between the responses of consumer loans and real estate loans. Both variables are more responsive around 2008 and 2012. However, consumer loans respond more to the 2012 spike, whereas real estate loans is more responsive to the 2008 spike. Therefore the results indicate that the real sector was hard-hit by the financial crisis. Or that a combination of the tight monetary cycle and the crisis fell more on real estate loans as consumers battled with falling house prices and high mortgage payments.

Figure 14: Time-varying responses for the aggregate model

(a)

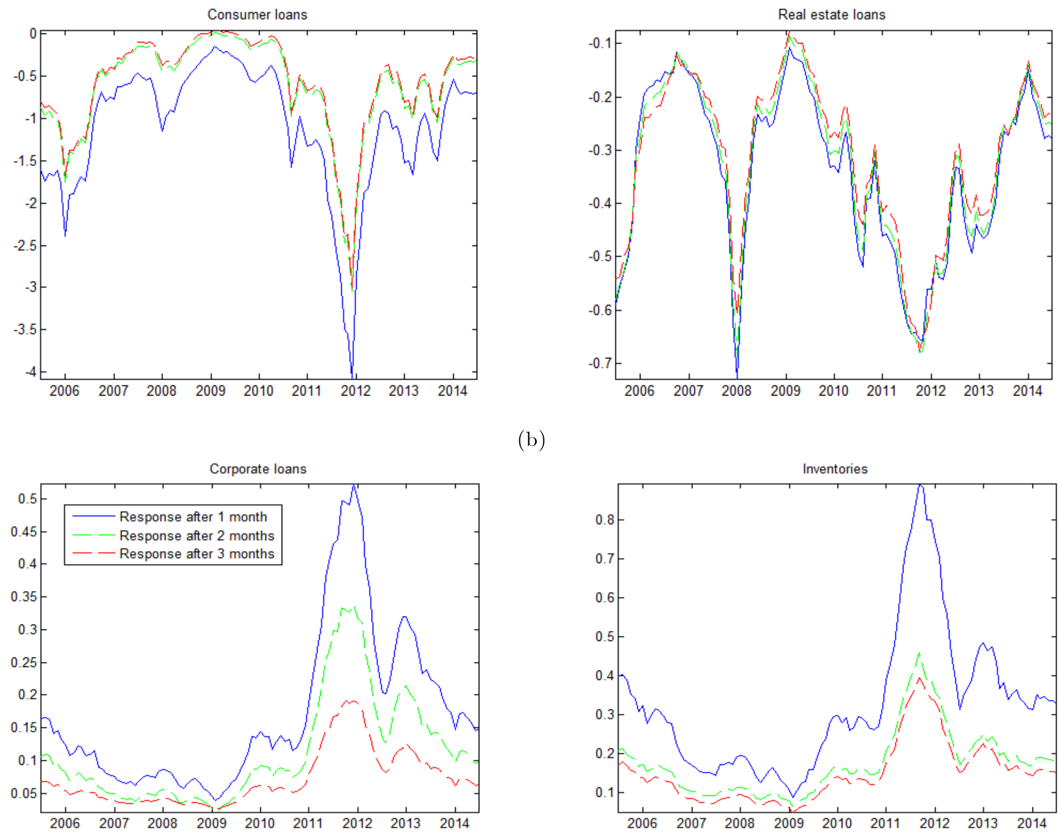


Figure 14 (b) shows the results for inventories and corporate loans. The results indicate that there is some co-movement between corporate loans and inventories. This is an interesting feature as it does validate that corporate loans are used to fund an increase in inventories during tough economic times. Another possible interpretation of these results might be that during the period of low growth, the increase in inventories is higher. And given that interest rates are also low, banks are more willing to lend to the corporate sector than they would be if interest rates were high. The response for both variables is higher during the period of low interest rates, from 2009 onwards, which is also a period of low economic growth.

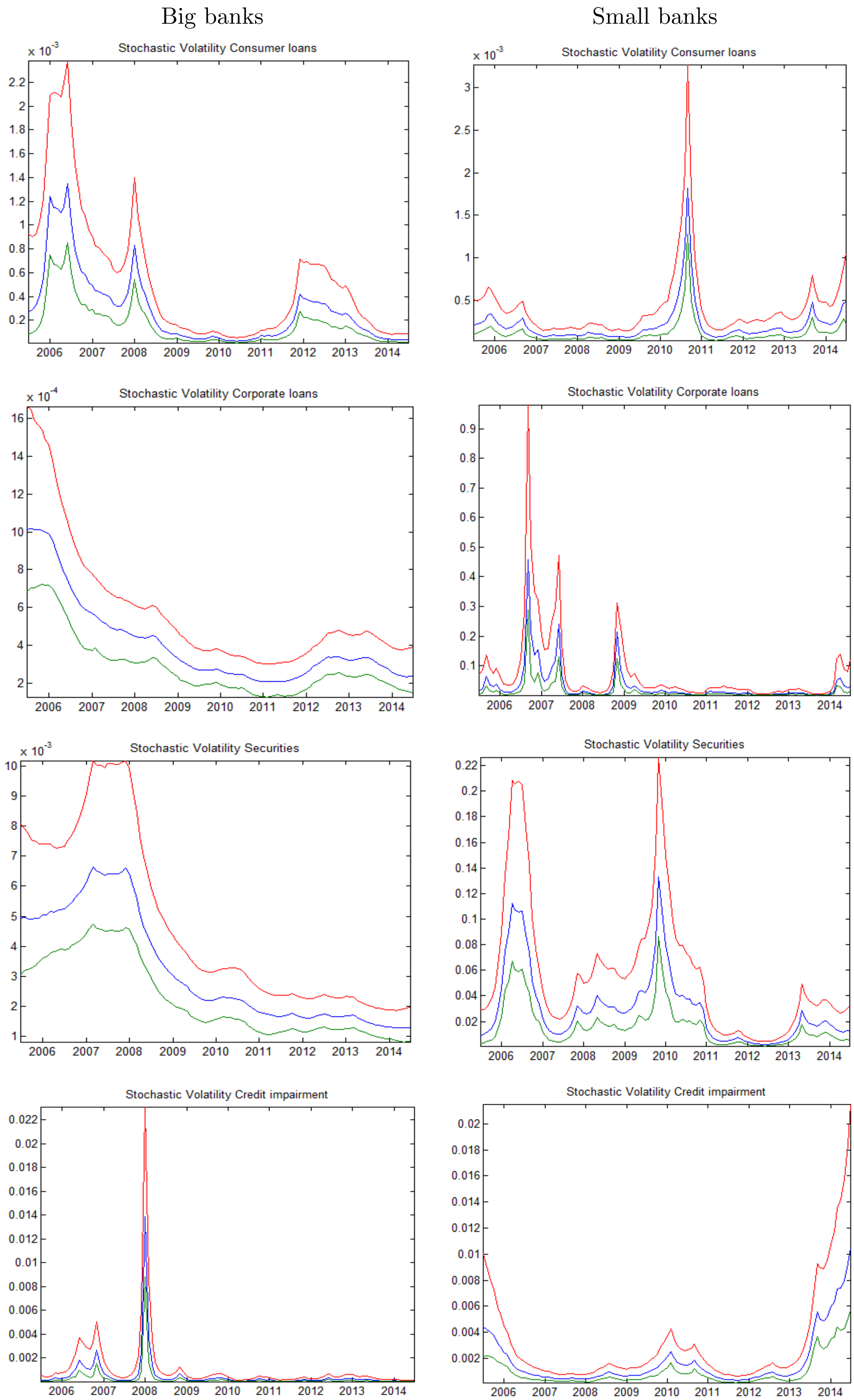
4.2.2 Disaggregate TVP-VAR results

Results for stochastic volatility (μ_t)

Figure 15 presents the stochastic volatility results by bank size. Not surprising, the results for the big banks echoes that of the aggregate model, with a few differences that can be attributed to the small banks. Starting with consumer loans, it is evident that small banks are the sole contributors of the 2010-2011 spike observed in consumer loans from the aggregate model. In fact, only consumer loans for the big banks seems to be more volatile during the monetary policy tightening cycle and the financial crisis, whereas consumer loans for the small banks exhibit very low volatility during the same period.

Turning to the results for corporate loans and securities, the volatility for both these variables for the big banks are unclear. For the small banks, the spikes are centered around the monetary policy tightening cycle. Surprisingly, the volatility decreases around the start of the financial crisis and only peaks again towards end of 2008. The results for securities indicate that after the crisis, there is a consistent and substantially higher variance for securities for the small banks. Lastly, credit impairment volatility for the big banks spikes firstly during the tightening cycle, and then around the financial crisis period. There is some evidence that the 2008 volatility in real estate loans is responsible for the majority of the 2008 spike in credit impairment. And consumer loans contributed more to the 2006 - 2007 volatility. Not surprising, there is an increase in volatility in consumer loans, securities and credit impairment for the small banks from 2013 onwards. This shows the high uncertainty associated with the small banks in the events leading to the African bank crisis.

Figure 15: Stochastic volatility for the disaggregate models



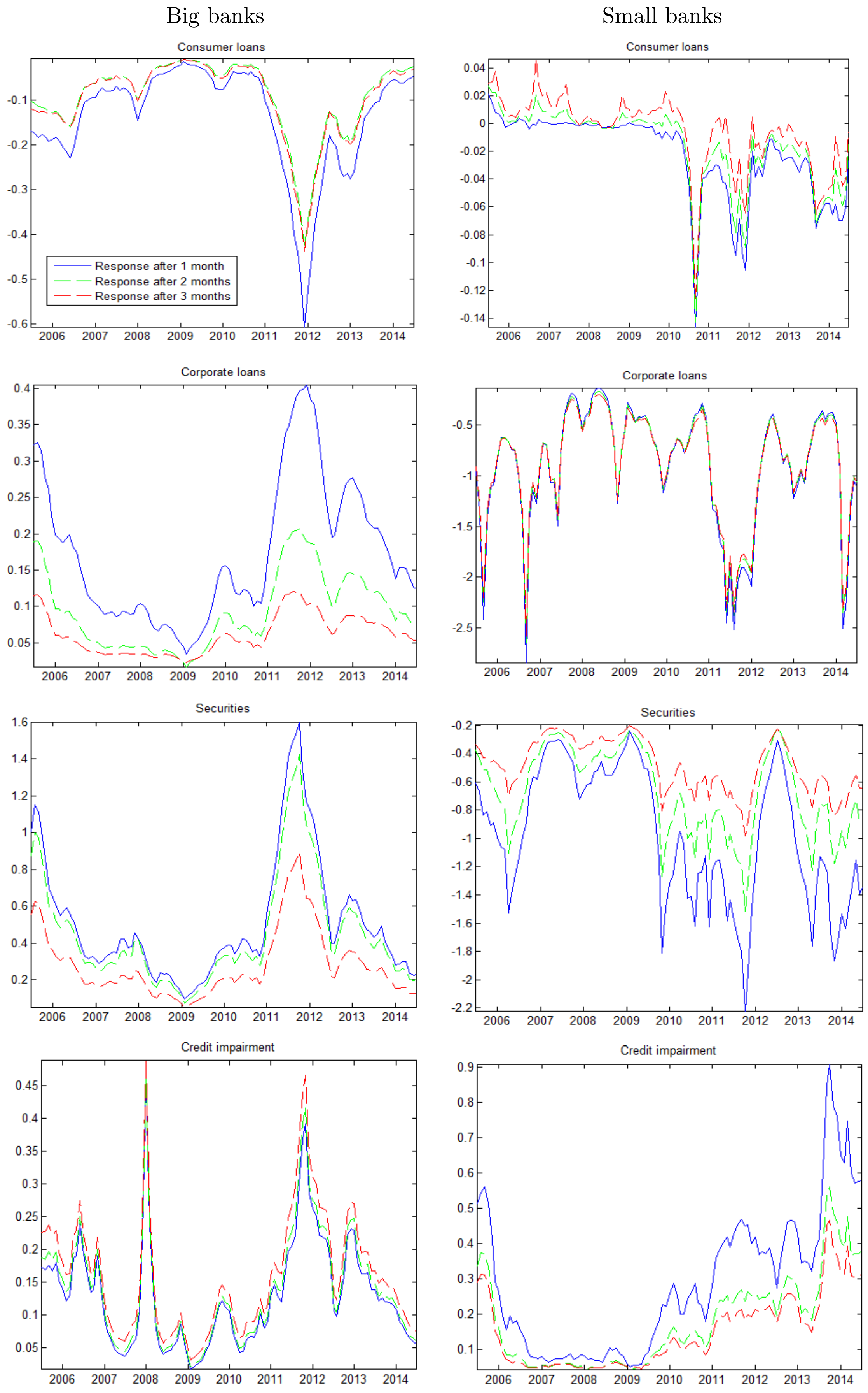
Results for time-varying coefficients (θ_t)

Figure 16 shows the results for the time-varying coefficients also by bank size. Starting with the big banks: again, the results for consumer loans and corporate loans are similar to that of the aggregate model. The results for consumer loans, securities and credit impairment indicate that after 2009, these variables became more responsive to a policy shock. The spikes in credit impairment around 2008 can be attributed to the losses from the real estate sector, which was struggling at the time. Whereas consumer loans seem to have contributed to the spike in the end of 2011. There is a co-movement between corporate loans, securities and credit impairment. And consumer loans and real estate loans seem to be negatively correlated with these three variables. The overall results for the big banks tell an interesting story about how banks balance their balance sheets to minimise losses after a policy shock. From the results, we can see that during periods when households were under financial strain and consumer loans and real estate loans were under-performing, banks increased their lending to the corporate sector to minimise credit impairment.

Moving to the small banks: similarly to teh big banks, most of the variables became more responsive from 2009. Consumer loans and securities exhibit a co-movement. The two variables are also negatively related to credit impairment. That is, when consumer loans were more responsive to a monetary policy shock, the banks sold off their security holding as a buffer against the increasing credit impairment.

Comparing the results of both the big and the small, it is clear that from 2009, both bank classes started to experience an increase in credit impairment due to consumer loans. Both bank classes were able to contain the losses, resulting in a decline in credit impairment in late 2011. Again, in end 2012 and beginning of 2013, both bank classes saw their credit impairment increase again, though less dramatic than the end 2011 spike. The big banks were able to manage their losses thereafter, as we can see by the continous decline in credit impairment. However, for the small banks, credit impairment sky-rocketed. This comparison indicate better risk-management on the side of the big banks and reckless lending behaviour by the small banks. Even though small banks are not deemed as domestic systematically important banks, more stringent regulation is required for these banks. This is especially important if the SARB is to (1) make the banking sector more competitive by lowering barriers to entry for more smaller banks to enter the market, and (2) make Postbank a retail bank.

Figure 16: Time-varying responses for the disaggregate models



4.3 Robustness checks

In addition to the benchmark specifications reported in the section 4.1, we assess the robustness of my benchmark results. We consider the case in which the recursive assumption is not imposed on the monetary policy instrument, i.e., monetary policy authorities do not respond contemporaneously respond to increase in loans. In this specification, we ordered the variables of the big banks first, followed by the variables for the small banks and then the monetary policy instrument. The intuition is that the lending actions of the big banks are not contemporaneously affected by the lending behaviour of the small banks and the central bank's actions. However, the central bank has information that gives them some indication of the current credit conditions. This is plausible if the central bank have access to forecasts on housing price index for real estate loan demand; loan application accepted can also be an indication of expected growth in credit; and other variables like inflation and oil prices forecasts that have direct effect on spending. All other model specifications remain the same. Starting with the benchmark model, the results for consumer loans is still insignificant. Real estate now contemporaneously decrease. The results for corporate and credit impairment are the same. Lastly, the initial increase in inventories is now insignificant and smaller in magnitude. In the second model, the one standard deviation to the monetary policy shock results in almost 0.3% increase in interest rate. Starting with the results for the big banks, the results indicate that unlike in Figure 10, consumer loans contemporaneously decrease and is insignificant. The results for corporate loans and credit impairment remain the same as from Figure 10. For small banks,the initial decrease in corporate loans is significant. The results for consumer loans and credit impairment remain the same. For the model with loan volume and securities, most of the results are also similar to that of Figure 11. The results for securities indicate that small banks are more sensitive to a tight monetary policy shock.

5 Conclusion

This paper re-visits the bank lending channel in South Africa to investigate first its existence at both the aggregate bank level and disaggregate bank level and also find new evidence of time-variation in the South African monetary policy. We apply both the Bayesian structural VAR and the TVP-VAR with stochastic volatility.

Overall, we do indeed find the existence of the bank lending channel, consistent with some of the current literature in South Africa. At the aggregate bank level, we find that banks distribute loans from the household sector to the non-financial corporate sector. Disaggregating this further, it become evident that only the big banks fund non-financial corporate during a contractionary monetary policy. Credit to the small non-financial corporate by the small banks decrease. Furthermore, we also find that small banks sell off their security holdings to cushion themselves during a tight monetary policy. Contrary to literature, there is a sluggish reduction in securities by the big banks.

Lastly, the results for the TVP-VAR model with stochastic volatility provide more insight into the behaviour of banks during the financial crisis, anti-inflation cycle by the SARB and regulatory changes. There results indicate that there is variation in both the coefficients and the covariance matrix. Interest rates exhibit high volatility between mid 2006 to 2009, which explain some of the volatility in consumer loans, credit impairment and securities. The results for the time-varying coefficients indicate that both the big banks and small banks were more responsive to a policy shock after 2009.

Thus, our results are overall supportive of the bank lending channel, and that bank size does matter. The results also highlight the negative impact of a contractionary monetary policy on small and medium businesses that are solely depended on small banks. Our results also indicate that banking regulation, especially for the small banks, is a concern. Even though small banks are not deemed as domestic systematically important banks, more stringent regulation is required for these banks during periods of low interest rates or financial instability. This is especially important if the SARB is to (1) make the banking sector more competitive by lowering barriers to entry for more smaller banks to enter the market, and (2) make Postbank a retail bank.

Appendix A: Data

Variables	**Definition**	**BA900 #**
Household loans	Overdrafts, loans and advances extended to the household sector	185&192
Non-financial corporate loans	Overdrafts, loans and advances extended to the non-financial corporate sector(incorporated)	183&190
Real estate loans	Residential mortgages extended to the household sector	157
Mortgages	Farm, residential, commercial and other mortgage advances	150
Credit cards	Credit card debtors	166
Overdrafts	Overdrafts,loans and advances to the private sector	180
Installments	Installment debtors,suspensive sales and leases	139
Other loans		
Credit impairments	Credit impairments in respect of loans and advances	194
Losses		
Households deposits	Deposits denominated in rand and foreign currency by the household sector	27&35
Corporates deposits	Deposits denominated in rand and foreign currency by the non-financial corporate sector	25&37
Fund managers deposits	Deposits denominated in rands by Fund managers	23
Other deposits	Deposits denominated in rand and foreign currency other than the ones discussed above	
Non-deposits	Other borrowed funds,foreign currency funding and other liabilities to the public	41,58&67
Loans (total)	Total loan	110
Liabilities	Total liabilities	1,41,58&67

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