

Essays on Monetary Policy and Banking

by
Tumisang Loate

Supervised by: Professor Nicola Viegi
South African Reserve Bank Professor of Monetary Policy

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Abstract

The size of the financial sector in South Africa has grown significantly over the past fifteen years to now almost three times the size of the economy. Parallel to that growth is the growth of the banking sector, specifically the six commercial banks that dominate the sector. This expansion has both monetary policy and financial stability implications.

The objectives of this PhD are to: (1) study the importance of internal and external variables for financial stability; (2) determine the role of the structure of the banking sector in the transmission of monetary policy and macroeconomic shocks; and (3) understand financial stability in the context of both the South African financial system structure and demographic dynamics.

We start with a cross-sectional analysis of how external and internal variables affect local financial stability. We find that local variables such as credit, stock market capitalisation and real exchange rate growth are better candidates for understanding local financial stability for both the high and the upper middle income countries.

Next we explore monetary policy and financial stability in the context of the South African banking system structure and socio-economic dynamics. An empirical analysis of the bank lending channel indicate that the effect of monetary policy is asymmetric - small banks are more affected by a contractionary monetary policy, whereas the big banks can adjust their loan portfolios to cushion the effects. However, these results (as well as the current South African literature) assume that the transmission of monetary policy and the way the exogenous shocks are generated have remained constant over time. We show that following the 2008 financial crisis, both the big banks and small banks became more responsive to a monetary policy shock.

We then develop a dynamic stochastic general equilibrium model to analyse financial stability for the South African banking sector. The main elements to capture the socio-demographic characteristics include banking and household heterogeneity. We incorporate the relative consumption motive to capture the culture of *“keeping up with the Joneses”* that has resulted in high consumption driven by debt. The heterogeneity of the banking sector is motivated by the structure of the banking sector, which has enabled the existence of the big and the small banks serving the high-income and low-income households respectively. We calibrate the model using South African data. Our model shows that liquidity injections in the presence of the relative consumption motive increase loan demand whilst adverse shocks to the banks’ balance sheets have welfare effects, especially for low-income households.

Dedication

To the Almighty and my wonderful late grandmother.

Acknowledgment

A big thank you to my family for your support throughout this journey - to my aunt, Dipuo Tlhoale, for always filling the motherly gap. And to my cousins, Mororiseng and Oratile for your sisterly support. Most importantly, a big thank you to my wonderful mother, Tamara Loate, for always being a positive force in my life. Also a great thank to my fellow PhD colleagues for your great friendship during my three years at the university. You have made the struggle less lonely. I would also like to thank the South African Reserve Bank (SARB) Chair in Monetary Economics for the funding, without which, none of this could have been possible. Lastly, I would like to thank my supervisor, Prof Nicola Viegi, for giving me the opportunity. Not only has it been a learning experience, but I have also grown as a person. This has opened my eyes to another world.

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Chapter 1

General Introduction

The objectives of this PhD are to: (1) study the importance of internal and external variables for financial stability; (2) determine the role of the structure of the banking sector in the transmission of monetary policy and macroeconomic shocks; and (3) understand financial stability in the context of both the South African financial system structure and demographic dynamics.

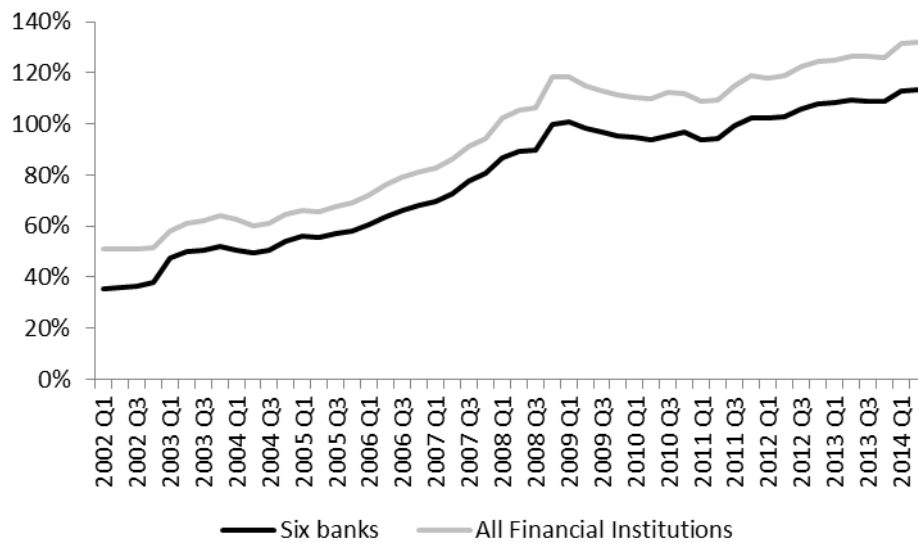
The banking sector in South Africa is central to the financial system of the country. According to the International Monetary Fund (IMF) financial system stability assessment for South Africa, IMF (2011), the financial sector is estimated to be almost three times the size of the economy. The sector can be characterised as monopolistic, highly concentrated and interconnected. Within the sector, there is domination by the six locally owned commercial banks in the retail market. The six banks consists of four big banks, namely Standard bank, Absa bank, FirstRand and Nedbank and two small banks, namely Capitec bank and African bank. The report also indicates that the four major banks had a holding of 35% of assets in life insurance and 65% of assets under management. In addition, each of the four big banks own 12-15% of Strate, which settles equity and bond trades and also serves as the central securities depository in those markets.

Figure 1.1 shows the growth of the market size of financial institutions in South Africa from 2002 to 2014, measured as the ratio of total assets to gross domestic product (GDP). During the sample period, the banking sector has more than doubled. Total assets of the financial institutions grew from 51% of GDP in 2002Q1 to 132% of GDP in 2014Q2. Looking specifically at the six banks, we see that the six banks grew from 36% to 113% of GDP during the same period. The co-movement of the two graphs shows that the growth of the banking sector is driven by the six banks.

Figure 1.2 shows the market share of the banks. The top panel shows the market

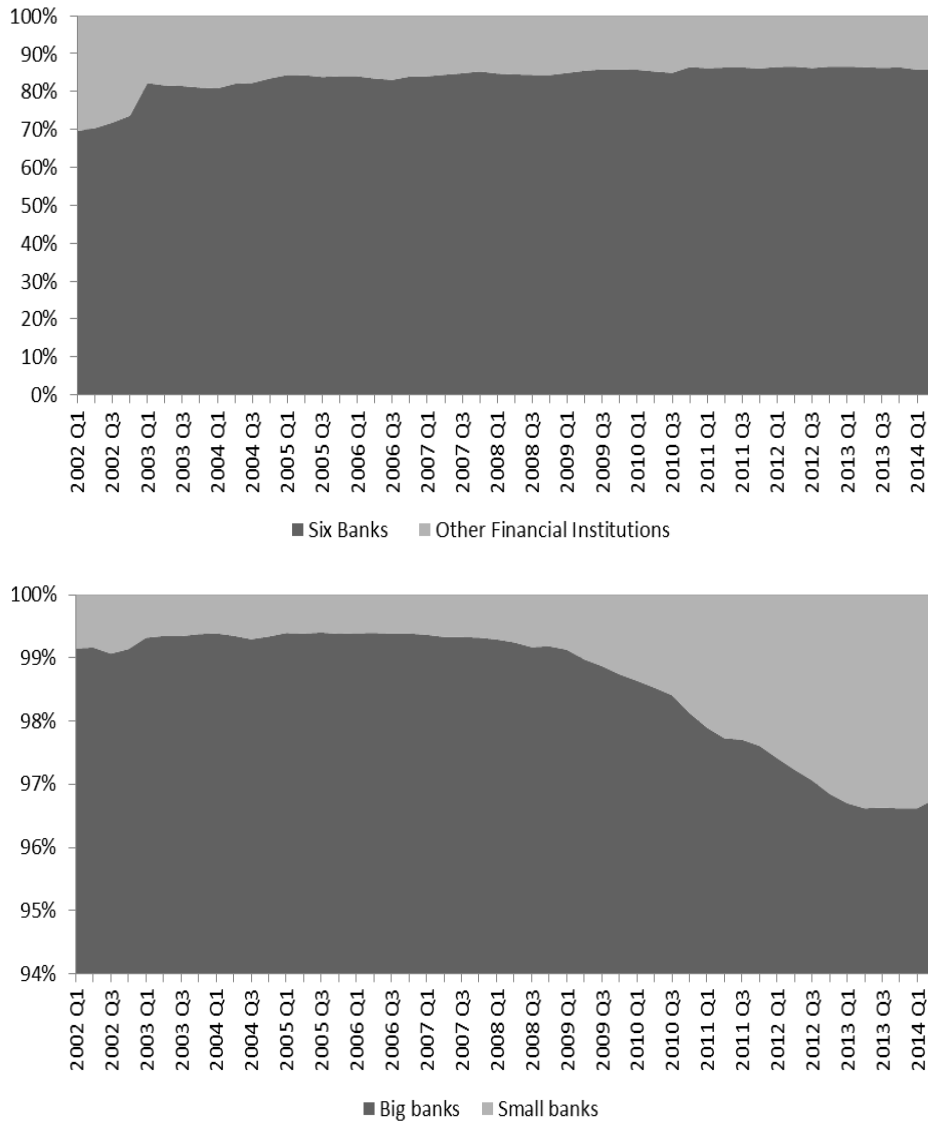
share of all the banks whereas the bottom panel shows the market share within the six banks. From the top panel, we can see that the structure of the banking sector has remained the same with the six banks maintaining a high share of the market - averaging 84% during the sample period. Within these six banks, the big banks have maintained a lion share of the market. The two small banks have a market share of less than 4% during the sample period. Given the market share of the six banks, we will refer to them as the banking sector throughout the text. Outside of South Africa, the South African banking groups have presence in 17 African countries. According to the IMF (2011) report, the banks only have significant subsidiaries in Lesotho, Namibia and Swaziland with the banking assets to the host country's GDP ranging between 27% and 47%.

Figure 1.1: The growth of the banking sector



Note: Figure 1.1 show the market size of the banks measured by their total assets to gross domestic product (GDP). The sample period is 2002M1 to 2014M07. The six banks refer to the commercial banks that dominate the South African banking sector. *Source:* SARB and Authors calculation

Figure 1.2: Market share - banks' assets



Note: Figure 1.2 show market share of the banks measured by their assets. In the top panel, market share of the six banks is the ratio of the total assets of the six banks to the total assets of the financial institutions. In the bottom panel, market share of the big banks is the ratio of the total assets of the big banks to the total assets of the six banks. The sample period is 2002M1 to 2014M7. *Source:* SARB and Authors calculation.

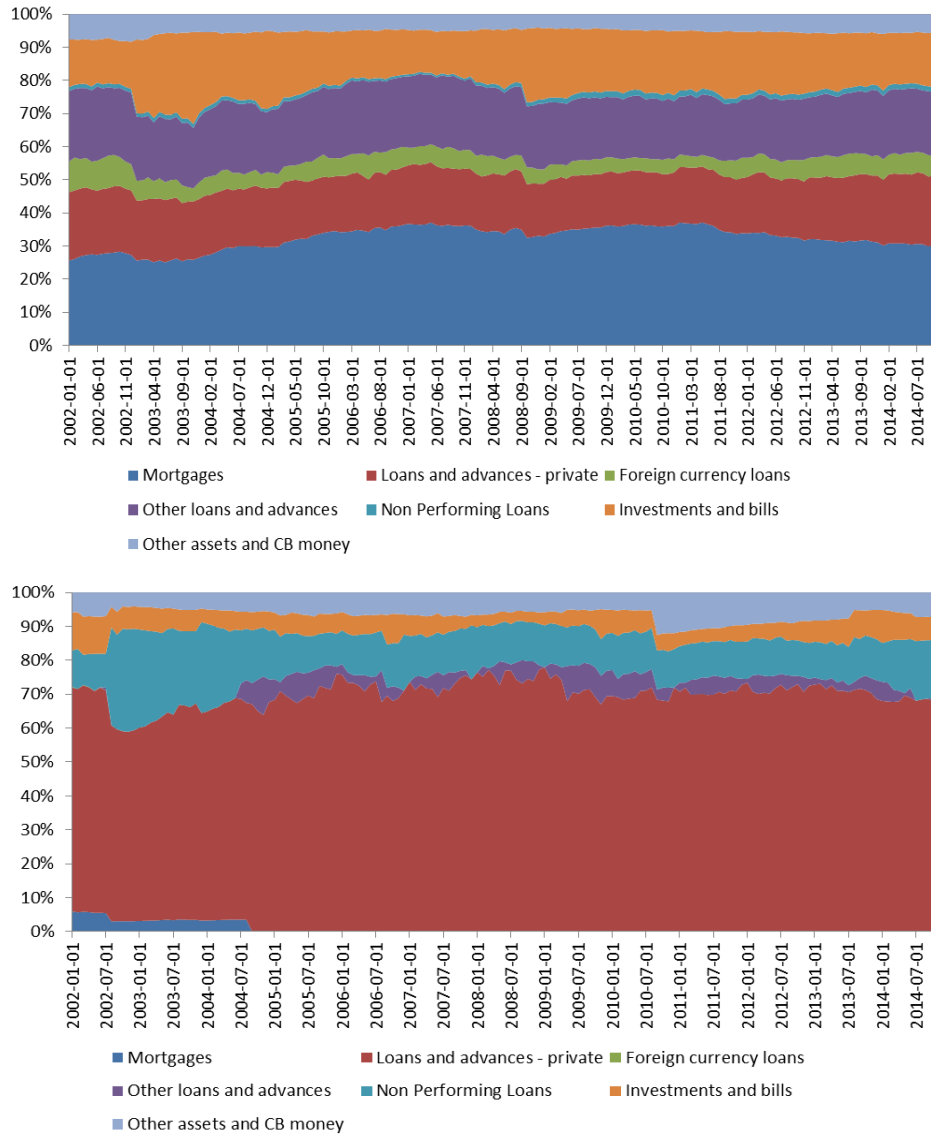
South Africa is a relatively financially small open economy. The banking sector forms part of some of the good institutions that the country is known for. This include the soundness of the banking sector which has been ranked in the top ten (and in some years in the top three) between 2009/10 and 2016/17 in the World Economic Forum Global Competitive reports, with the closest emerging market being Chile and Brazil slightly below. To date, the banking sector has remained

resilient to shocks such as the Asian and Latin American crises, the 2001 South African currency crisis and the 2008 financial crisis ¹. Reasons attributed to this resilience include high capital buffers and sound regulation and supervision (IMF (2011)), limited exposure to foreign structured finance assets during the 2008 crisis and less dependence on foreign funding (SARB (2010)).

Figures 1.3 and 1.4 show the assets and liabilities of the South African banks. We have separated the balance sheets by bank sizes to highlight the heterogeneity between the two that is often hidden by the aggregation of the data. In both figures, the top panel shows data for the big banks while the bottom panel shows the data for the small banks. Starting with the asset side on Figure 1.3, we can see that the big banks have a diversified loan portfolio compared to their counterparts. The big banks also have foreign exposure, whereas foreign loans are non-existent for the small banks. Small banks also have a high share of non-performing loans during the sample period, which averaged 17%, a far cry from the average of 1% for the big banks. The liabilities side in Figure 1.4 shows that the big banks have maintained a consistent source of deposit funding. Foreign currency funding forms part of the big banks funding mix (albeit at a more conservative level), whereas for the small banks it is non-existent. Therefore, the big banks are more susceptible to foreign exchange risk than the small banks.

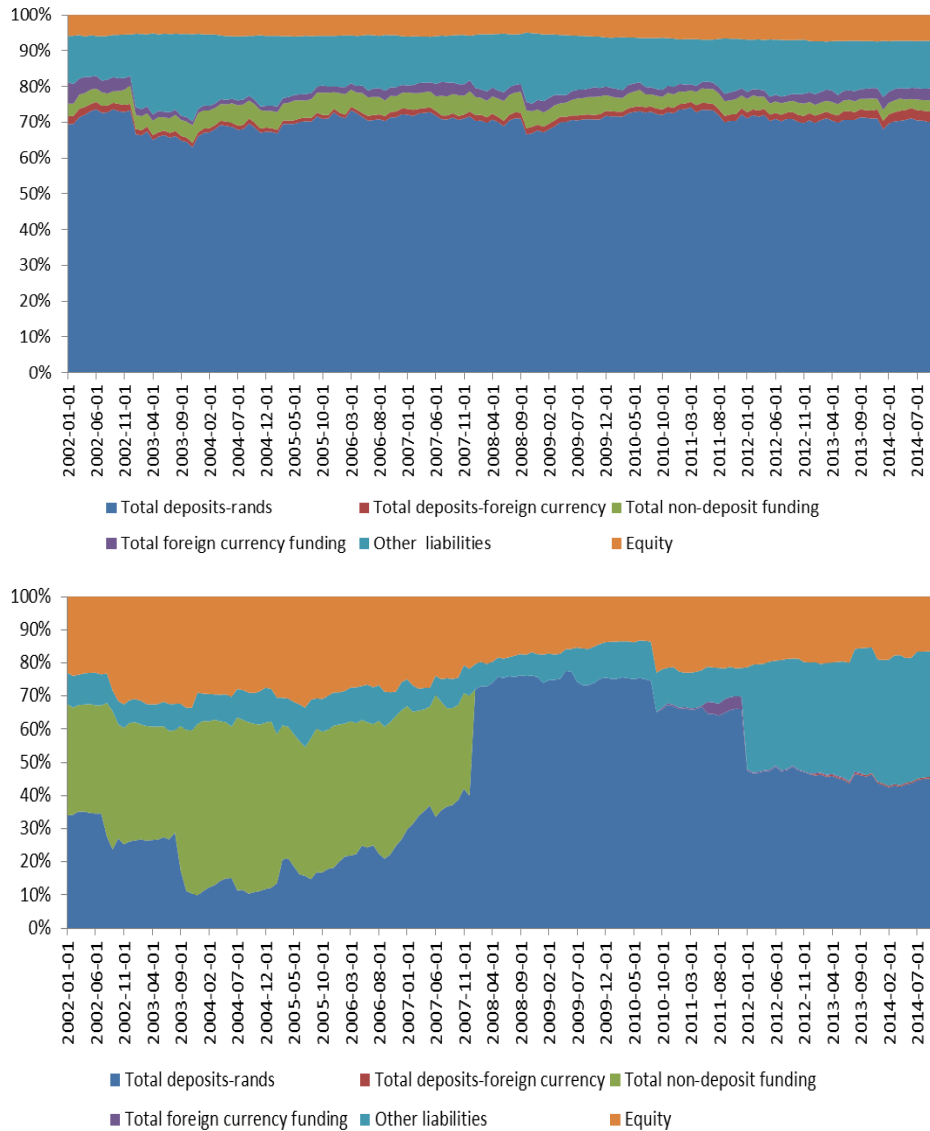
¹The effect of the 2008 financial crisis was indirectly due to economic slowdown rather than directly via the financial system, SARB (2010).

Figure 1.3: The asset side of the banks



Note: Figure 1.3 show the assets of the six banks by bank size. The sample period is 2002M1 to 2014M07. *Source:* SARB and Authors calculation.

Figure 1.4: The liabilities side of the banks



Note: Figure 1.4 show the liability of the six banks by bank size. The sample period is 2002M1 to 2014M07. *Source:* SARB and Authors calculation.

Despite its high vulnerability to global shocks, from a global perspective, the banking sector is seen as one of the best. However, such a broad stability generalisation hides the heterogeneity within the sector. This heterogeneity, as shown above in the banks' balance sheets, makes banking stability an interesting topic, at least to us. As indicated in Reinhart and Rogoff (2009), the only recorded banking crisis in South Africa is in 1985. Even though the country has not experienced a major banking crisis ever since, the banking sector has not been without local crises. Whilst the big banks have been able to increase their book size over time by acquiring some of the small banks and sustain market share and financial stability,

small to medium sized banks have repeatedly shown elements of financial instability.

After the end of the Apartheid regime in 1994, there was an influx of small to medium banks, mainly to serve low-income households or those who were previously financially excluded. This influx was reversed when these banks faced liquidity pressures, resulting in about 22 banks exiting the banking system between the last quarter of 1999 and first quarter of 2003, Mboweni (2004)². Despite the attribution of these failures to consolidation in the banking system by Mboweni (2004) and Hawkins (2003), small bank failures remain a concern to the banking system. The failure of African Bank, one of the two current small banks in our sample, has again revived the debate on small banking failures in South Africa. Following its last failure in 1995, the bank was placed under curatorship by the South African Reserve Bank Registrar of Banks and the Minister of Finance on August 2014. According to the SARB (2016) report on the investigation into the bank's failure, the concerns that were raised over the bank include liquidity issues, high loan impairments and rapid credit growth, and a rather unsustainable business model. As shown in Table 4.1 in Chapter 4, small banks have a business model that heavily depends of non-deposit funding and unsecured lending during the sample period of 2002Q1 and 2014Q3. The report states that the bank was saved as it was regarded as systemic to the South African Banking system due to its three million customers, mainly regarded as financially excluded from the big banking sector, prevention of loss of confidence from foreign investors since it was mainly funded by offshore wholesale funding, loss of 5 700 jobs by the bank and the impact to ordinary South Africans through their investment via asset management companies. Therefore, given such many failures of the small and medium banks and the stability of the big banks in South Africa, understanding these peculiarities between the two types of banks is important for the central bank and policy makers.

The banking sector can be divided into two categories - "*stable*" big banks and unstable small banks. The stability of the big banks is regarded as very important to the banking sector in the country. The four banks enjoy an implicit insurance from the South African Reserve Bank which the central bank has cemented by recognising these four banks as the "four-pillars" of the banking system, similar to the Australian banking system.

This segmentation of the banks by bank sizes does not only reflect the differences in the banks' business models, but also the socio-economic dynamics in the country. Small banks are important in South Africa as they fill a market gap left by

²Some banks were acquired by the big banks, others were left to dissolve while others did not renew their licenses and exited the market, Hawkins (2003).

the big banks through providing financial service to the low income households who have been excluded due to their low income and therefore high credit risk profile. This financial inclusion and deepening, together with the structure of the banking sector have monetary policy and financial stability implications, as we show in Chapter 3 and 4. Filardo et al. (2016) find that domestic financial deepening and inclusion boosted the interest-sensitivity of aggregate demand in the economy in emerging Asian economies, giving the central bank more leverage to influence economic activity.

The crux of this PhD is based on the literature of financial structure and economic activity, with its chronicle concisely discussed in Gertler (1988). Given the above discussion, we ask the following questions: (1) How does financial openness affect local banking stability; (2) And how does the structure of the banking sector (and the associated socio-economic demographics) play a role in both the transmission of macroeconomic shocks and monetary policy to the rest of the economy and banking system. These questions are explored in this study and briefly summarised below:

Financial Openness and Local Banking Stability

Financial fragility can stem from risk within the local financial system itself or from shocks outside the economy. In Chapter 2 we analyse the influence of financial openness and internal factors on local banking stability. We use the measure of financial openness analogous to trade openness, which is a ratio of total assets and liabilities to gross domestic products. Our focus is on financial fragility than on predicting banking crises. Financial fragility does not necessarily result into a financial crisis, and in some cases it might be a result of the financial crisis. Using the same measure of financial fragility (z-score) by the International Database on Financial Fragility (IDFF), Rewilak and Fielding (2015) find that the z-score is not a good predictor of a banking crisis. Instead, the authors find that it is the combination of a lending boom and financial instability (low z-score) that creates the conditions for a subsequent banking crisis. Our contribution to the current literature is to see if the measure of financial stability (z-score) by the IDFF would also give us empirical results consistent with the current literature. To do so, we utilise a panel analysis of high and upper middle (including South Africa) income countries. We find results consistent with some of the literature on financial crises and fragility (Demirgüç-Kunt and Detragiache (1998*a*, 2000, 1998*b*), Hardy and Pazarbaşıoğlu (1999) and Davis and Karim (2008)). The same variables that are used to predict financial crises do prove useful in understanding local financial stability conditions.

Investigating the bank lending channel using disaggregate bank loans

Chapter 3 investigates the transmission of monetary policy through the bank-lending channel in South Africa during the period 2002M1 to 2014M7. Unlike the previous South African literature, we use disaggregated bank level data. Aggregate data hides the heterogeneity in both the response of different types of loans and bank sizes. We posit that small banks in South Africa are subject to credit market imperfections using the bank lending channel (Bernanke and Gertler (1995), Kashyap and Stein (1995, 1994)), which argues that monetary policy transmission works through the banks' asset side. To distinguish this supply side effect from the demand side, we have to prove that open market operations by the central bank affect the loan supply (rather than loan demand) and this loan supply shift has real effects. Furthermore, we also need to prove that the loan supply for the small banks shifts inwards more than that of the big banks. To do this, we have to show that the loan and securities portfolios of the two types of banks respond differently to a monetary policy shock.

Our aim is to answer three related questions: does the bank lending channel exist? Is the effect symmetric across bank sizes? And has the volatility of the banks' balance sheet changed over time? The first two questions assume that the transmission of monetary policy and the way the exogenous shocks are generated have remained constant over time. This may not be true given regulatory changes in South Africa that had impact on the banking sector during the sample period. These include the local regulatory reforms with the introduction of the National Credit Act (NCA) 34 of 2005 (the Act³). The Act is created to regulate the credit industry and "promote the economic and social welfare of the South Africans", amongst other things. One of the regulations is to discourage reckless lending behaviour by credit providers (Section 20) and limiting the interest rates and fees that credit providers can charge customers (Section 101). Other regulatory changes include the implementation of Basel II, 2.5 and III in 1 January 2008, 1 January 2011, and 1 January 2013 (ongoing) respectively.

We utilise the Bayesian structural vector autoregressive (S-VAR) model to address the first two questions. For the last question, we use the time-varying parameter vector autoregressive (TVP-VAR) model which allows for both the coefficients and the variance of the shocks to vary over the time. This follows the literature on the great moderation in US economy by Primiceri (2005), Benati and Mumtaz (2007) and Koop et al. (2009). Similarly, Nakajima et al. (2011) use the TVP-VAR

³Available from <http://www.justice.gov.za/mc/vnbp/act2005-034.pdf>.

model to analyse the time-varying structure of the Japanese economy and monetary policy given changes in monetary policy and the bubble crisis in the early 1990s during their sample period. The empirical analysis of the last two questions is our main contribution to the South African literature.

Banking stability and keeping up with the riches

Lastly, in Chapter 4, we develop a dynamic stochastic general equilibrium model to analyse financial stability for the South African banking sector. The main elements to capture the socio-demographic characteristics in Chapter 3 include banking and household heterogeneity. The household sector characterises the high inequality amongst the South African population that is divided between low income and high income households. We assume limited participation in both the deposit and the loan market. Therefore high-income households only deposit their funds into the big banks whereas the low income households only borrow from the small banks, which can be assumed to be a close representation of the current market structure. We incorporate the relative consumption motive to capture the culture of *“keeping up with the Joneses”* that have resulted in high consumption driven by debt.

The heterogeneity of the banking sector is motivated by the current structure in South Africa, which has enabled the existence of the big and the small banks serving the high-income and low-income households respectively. The two types of banks have different bank loan portfolios and enjoy monopolistic power in their respective markets. The literature on the stability of the banking sector in South Africa has either focused on evaluating banking performance using financial ratios (Kumbirai and Webb (2010)) or stress testing analysis (Falkena et al. (2004) and Havrylchyk (2010)). This chapter contributes to the South African literature in understanding financial stability in the context of both the South African financial system structure and demographic dynamics. The financial stability dynamic stochastic general equilibrium (DSGE) models in the international literature do not have models that characterise the South African banking sector and economy well. We calibrate the model using South African data - the banks’ balance sheets and real economic data.

Chapter 2

Financial Openness and Local Banking Stability: A Panel Analysis

2.1 Introduction

Policies that increase the openness of the domestic market to the international world contribute to capital flows, Fernandez-Arias and Montiel (1996). And these surges in capital flows have been associated with loss of monetary autonomy, which results in domestic inflation arising from asset price bubbles, real exchange rate appreciation and the associated loss of export competitiveness. The unintended political costs (Quinn and Inlan (1997)) and macroeconomic and financial instability consequences (Fernandez-Arias and Montiel (1996) and Calvo et al. (1996)) of such policies test the tolerance of policy makers to these policies. For example, calls for capital control measures have been made for developing economies following the 2008 financial crisis and in the 1990s when most developing countries experienced an increase in capital inflows. This is to protect these economies against sudden capital flow retrievals which can trigger financial instability or crisis. Therefore, monetary policy authorities in emerging economies should take into consideration the connection between capital inflows and financial stability when making policy decisions (Brunnermeier et al. (2012) and Rey (2015)).

In this chapter, we examine the relationship between gross capital flows and financial stability between 1999 and 2011 using cross-sectional analysis. Our aim is to contribute to the current on-going literature on the impact of financial openness and internal factors on local financial stability. The main findings from our fixed effects results indicate that financial openness has a negative effect on the

financial systems of high income countries, whereas the effect on upper middle income countries are insignificant. We find that local factors play an important role in explaining local financial stability conditions, especially the real exchange rate. Lastly, we find that stock market capitalisation has a positive marginal effect on developed markets' financial stability but a negative effect for the emerging markets. Although these results hold for both the ordinary least squares and fixed and random effects models, they do not hold for most variables for the dynamic model and endogeneity specification, especially when we sub-sample the data into income levels.

The 2008 financial crisis has brought the issue of capital flows (and associated financial crisis) to the fore. Several papers have looked at the contribution of gross capital flows to the financial crises (including the 2008 crisis), global liquidity or credit booms. Mendoza and Terrones (2008) find that credit booms in emerging markets are preceded by surges in capital inflows whereas other factors such as total factor productivity and financial reforms played a secondary role. The opposite was found for developed economies, with capital inflows playing a secondary role. Broner et al. (2013) find that both gross inflows and gross outflows are positive and statistically significant before the global crises¹ and the banking crises. However, there are retrenchments for both capital flows thereafter. Calderon and Kubota (2012) find that surges in gross investment inflows (driven by gross other investment bank inflows) and gross portfolio inflows increase the probability of credit booms, whereas gross foreign direct investment (FDI) inflows reduce this probability. Furthermore, the authors find that surges in gross other investment inflows increases the likelihood of bad credit booms with these credit booms followed by systemic banking crises.

This chapter investigates the relationship between financial openness and national credit markets by using the International Database on Financial Fragility (IDFF) which gives an extended view of the evolution of national credit conditions in a large sample of emerging and developed countries in the period 1999 - 2011. We augment the dataset with data on international capital inflows and outflows, income group levels and macroeconomic conditions. We use fixed effects estimates to account for the omitted variables bias. Results for the dynamic model are also included.

In this chapter, we refrain from the strict research of the effects of capital inflows and credit on financial crisis. Instead, we take a more conservative approach and

¹Global crises in this case included the Latin American 1980 - 1984 debt crisis, the Asian and Russian 1998 - 1999crises and the 2008 financial crisis.

look at the effect of capital inflows and credit on financial stability without assuming that financial instability causes financial crisis. Therefore, we partly contribute to the broader literature. Rewilak and Fielding (2015) find that it is the combination of a lending boom and financial instability (z-score) that creates the conditions for a subsequent banking crisis. As well captured by Minsky (1974), “the fundamental instability is the way in which a period of steady growth evolves into a speculative boom”.

The remainder of the chapter is organised as follows. We briefly discuss the literature and the measurement of financial stability used in the chapter in Section 2. We then discuss the data in Section 3. We present the results in Section 4. We provide a brief discussion of the results in Section 5 before concluding in Section 6.

2.2 Financial openness and stability

The literature on financial openness and financial stability complements the finance-growth literature. The finance-growth literature posits that financial reforms contribute positively to economic growth. Whilst the past literature has found a positive effect of finance on growth, Arcand et al. (2015) find evidence that this relationship is non-linear. According to the authors, finance (measured by credit to the private sector) has a negative impact on economic growth when it reaches 100% of gross domestic product (GDP). The strength of this relationship has also come into question. Among the research, Demetriades and Rousseau (2015)’s paper find that some financial reforms have marginal positive or negative effects on growth depending on the weakness of the regulation and supervision of the banking system, instead of simply on financial development.

On the other side, there is a discussion of the role of finance on banking and financial crises. One of the arguments put forward is how monetary conditions in center countries like the US drive capital flows and leverage in financial centers of the periphery countries (Bruno and Shin (2015), Rey (2015)). Special attention has been given to countries which are at effects to the global financial cycle - the emerging markets, given the undesirable macroeconomic effects of capital inflows to these economies (Calvo et al. (1996)). For example, Hassan et al. (2015) look at how the normalisation of the global financing by the US Federal Reserve Bank affects the vulnerability of the emerging markets. The authors find that emerging economies with larger ratios of external financing requirement (which is measured as the sum of the current account and short-term external debt) to foreign exchange reserves are more vulnerable to the change in the global financial cycle.

Earlier discussions on the causes of the 2008 financial crisis were based on the excess savings view. According to this view, excess savings from emerging economies (mostly Asian countries) were channeled to the developed countries to finance their current account deficits (net capital flows), and thus fueling the housing market bubble in the recipient countries, Borio and Disyatat (2011). However, recent literature argues that gross flows should be used instead of current accounts. Two of some of the arguments put forward against the use of current account are: The first argument centers around data analysis of capital inflows and current accounts in the events leading to the crisis. A closer look at the data indicates that Asian countries only purchased safe US assets and that their holdings of these assets were a small percentage. And that European countries were the main holders of the US assets, which were securitised products that helped fund the US real estate bubble (Taylor (2012), Borio and Disyatat (2011)², Brunnermeier (2009)). The second argument (which according to the authors underpins the first argument) comes from the lack of differentiation between saving (current account surplus or net capital flows) from financing (gross capital flows), as discussed by Borio and Disyatat (2011). According to the authors, savings are only a small fraction of the global financing flows (gross capital flows) and exclude other financial assets which make up the bulk of the cross-border financing. Therefore, focusing on net capital inflows instead of gross capital flows does not adequately highlight the monetary and financial factors that underpinned the financial crisis. The authors argue that financial instability stemming from financial imbalances (unsustainable credit booms and asset prices) is due to the excess elasticity of monetary policy - inability of the monetary and financial system in preventing the build-up in these financial imbalances.

In addition to these external imbalances, internal factors are also important to the analysis of financial stability of a country. Taylor (2012) highlights the equal importance of internal variables like credit, without undermining the above discussed external variables, as key indicators of financial stress in a country. Other important internal variables include inflation, real exchange rate and gross domestic product growth. Several papers find these internal factors play a significant role in predicting financial crises³.

Bruno and Shin (2015) show both theoretically and empirically how cheap global money by major financial centers is transmitted to the banking sectors of other developed and developing countries via an increase in bank lending, whilst also

²Borio and Disyatat (2011) provide a detailed analyses on this argument.

³Kaminsky and Reinhart (1998) for Asia and Latin America crises, Kaminsky and Reinhart (1999) for both the currency and the banking crises; and Demirgüç-Kunt and Detragiache (1998*a*, 2000, 1998*b*) and Hardy and Pazarbaşıoğlu (1999) amongst others.

controlling for internal variables. One of the main findings by the authors is the importance of the exchange rate. During periods of low global risk and low interest rates in the US, local currency appreciation encourages more borrowing by local banks from global banks due to favourable balance sheets. This reinforcing cycle can lead to financial instability in the wake of a sudden increase in global risk. The authors view their results as being consistent with the empirical evidence of Lane (2003) where the real exchange rates exhibit pro-cyclical behaviour for emerging markets relative to the industrial economies.

We follow this current literature to empirically analyse the effects of the size of liabilities and assets and local factors on financial stability. Our contribution to the literature is mainly the use of a new database by the IDFF. We compare our results to the current literature. In our analysis, we control for different income groups since countries with high degree of financial openness tend to be high income countries. Our interest is on the effects on high income countries and upper middle income countries, which have been at the center of the gross flows discussions. Specifically, we want to investigate if the effects of both external and internal variables are symmetric or asymmetric across income groups.

2.2.1 Measuring financial stability

The interdependence and complex interactions of different elements of the financial system among themselves and the real economy complicates both the definition and measures of financial stability, Gadanez and Jayaram (2008). This is further exacerbated by financial openness and monetary policy divergence in major economies, all of which expose local financial systems to external imbalances. In this chapter, we use the z-score (financial stability) from the IDFF database as our measure of financial stability in each country. The database provides financial fragility (inverse of financial stability) data for 124 countries from 1998 to 2012 under different scenarios. We are only interested in the base scenario or the least restrictive rule. Under the most restrictive rule, banks that report all the financial indicators to Bankscope for at minimum two-thirds of the period are included in the composition of the aggregate financial indicators for the country, whereas, under the least restrictive rule, all available figures are used in constructing the aggregate financial indicators⁴. The banks included in the database are commercial banks, which account for two-thirds of the total assets value of the banks in the sample, with co-operative banks, Islamic banks, savings banks, investment banks and real estate

⁴For more details, see Andriano et al. (2015) and Demetriades et al. (2015)

and mortgage banks accounting for the remaining one-third of the total assets.

The z-score measures the distance of each country's banking system from insolvency, and is given by:

$$Z_{jt} = \frac{ROAA_{jt} + \frac{Equity_{jt}}{Assets_{jt}}}{\sigma_{ROAA_j}} \quad (2.1)$$

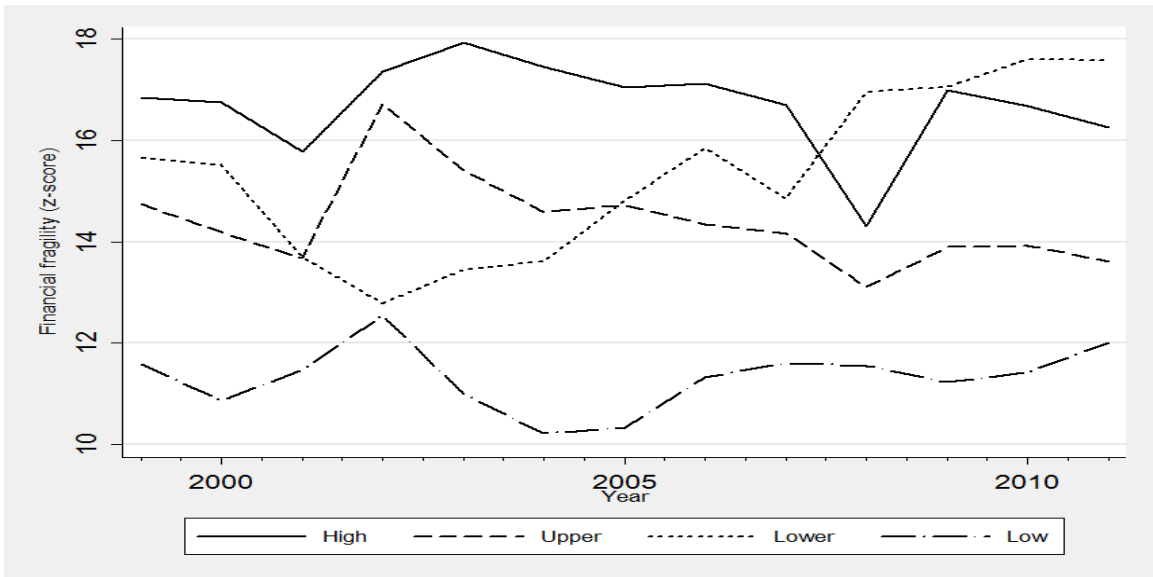
where $ROAA_{jt}$, $Equity_{jt}$ and $Assets_{jt}$ are the return on asset, equity and assets for country j at time t , respectively. Financial fragility, σ_{ROAA_j} , measures the standard deviation of the average ROAA for each country. A high z-score implies sound financial stability. The equation shows that the z-score is inversely related to financial fragility (σ_{ROAA_j}). Therefore an increase in financial fragility reduces the z-score or financial stability. Since the two measures are inversely related, we are going to use financial instability and financial fragility interchangeably. Using the IDFF data, Demetriades et al. (2015) show that low-income countries have low financial stability and poor asset quality compared to other income group countries.

Figure 2.1 shows the financial stability (z-score) by income groups for the period 1999 - 2011. Low levels of the z-score indicate high financial fragility. The figure shows that low income countries have the highest financial fragility. High and upper middle income countries exhibit two similarities. Firstly, there is deterioration in financial stability for both high and upper middle income countries from early 2000s. Secondly, both economies experienced sudden declines in financial stability during the dot-com and the 2008 financial crises. We can also see the divergence between the middle income countries - financial stability in upper middle income countries started to decline from 2003 onwards whereas at the same time lower middle income countries started to become financially stable.

Figure 2.2 shows financial openness by income groups for the period 1999 - 2011. Due to the disparity of financial openness between high income countries and other income countries, we use the left scale for the high income countries, and the right for others. From the figure, we can make the following four observations: Firstly, there is a positive co-movement of financial openness between high income and upper middle income countries from the early 2000s. Secondly, lower middle income countries were more financially open than upper middle income countries. However, in the events leading to the 2008 financial crisis, this was reversed, with upper middle income countries becoming more financially open. Thirdly, financial openness declined in low income countries from early 2003 until the 2008 financial crisis. However, following the crisis, the countries saw an increase in financial openness, as in other income group countries. Lastly, the negative impact of the 2008 financial crisis is evident across all income groups, except for low income

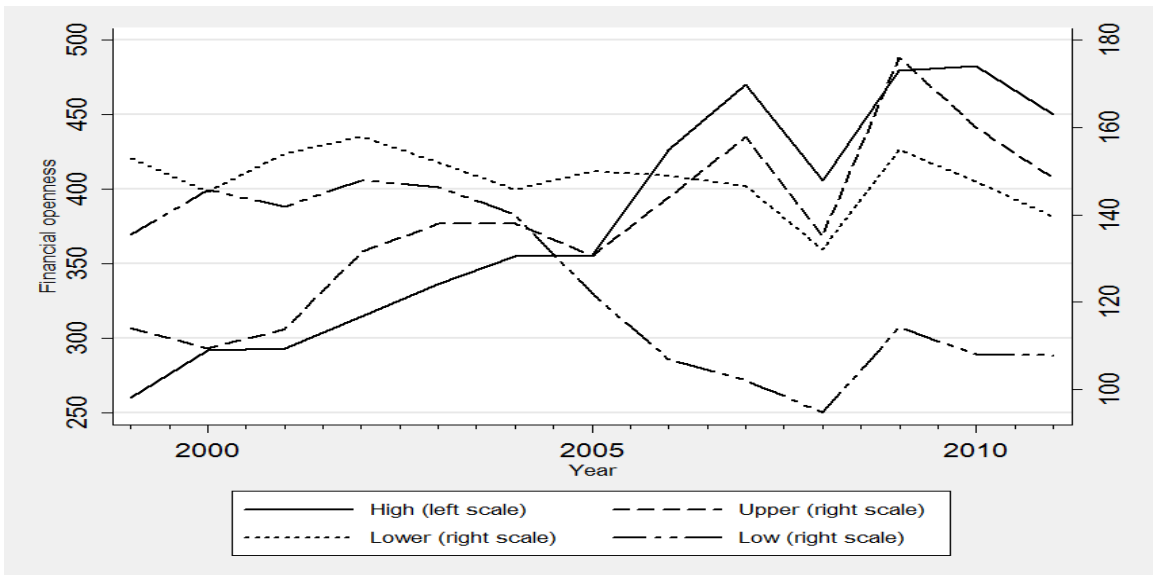
countries.

Figure 2.1: Financial fragility (z-score) by income groups



Note: This figure shows the financial fragility (z-score) classified according to the four categories of income groups: High-income (High), Upper middle-income (Upper), Lower-income (Lower) and Low-income (Low). *Source:* IDFF and authors calculation

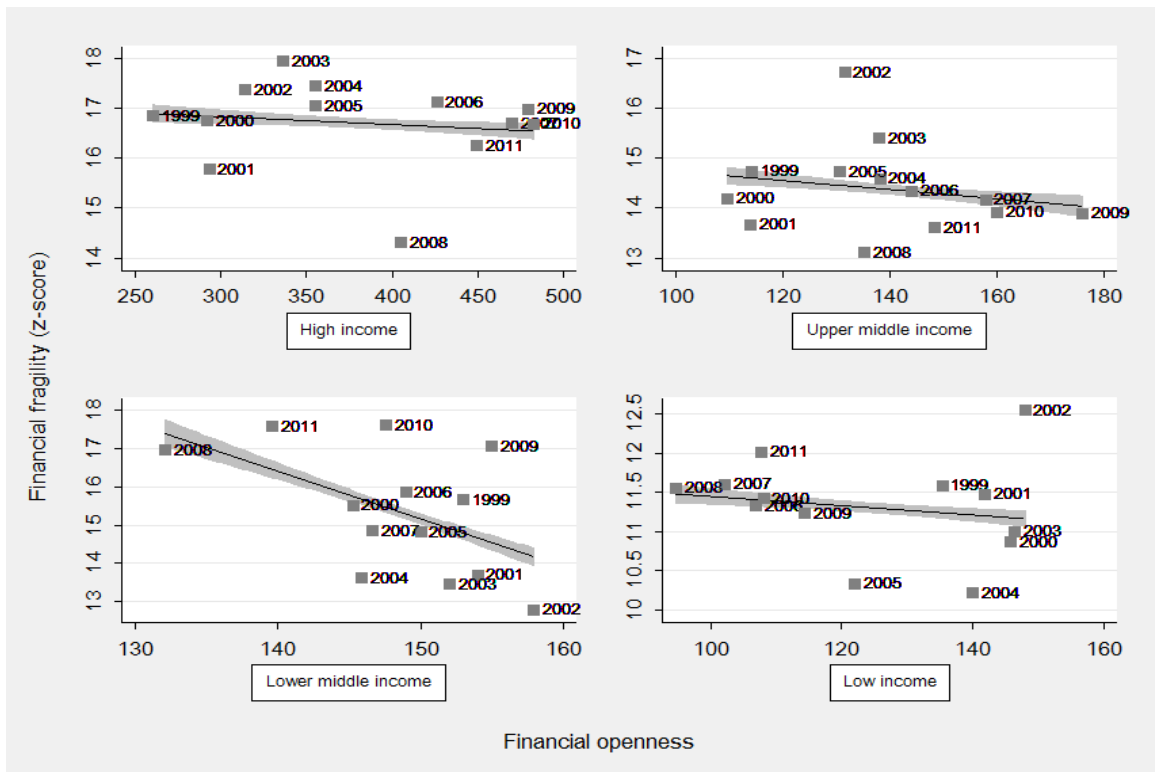
Figure 2.2: Financial openness by income groups



Note: This figure shows the financial openness classified according to the four categories of income groups: High income (High), Upper middle income (Upper), Lower upper income (Lower) and Low income (Low). Financial openness is measured as total assets and liabilities as a percentage of gross domestic products. We excluded the following outliers: Mauritius, Singapore, Liberia and Ireland. *Source:* IDFF and authors calculation

Lastly, we look at the relationship between financial openness and financial fragility. For each income group, we firstly look at the time dynamics of this relationship and then we look at which countries within each income group fair better or worse than their peers. Figure 2.3 shows the relationship between financial fragility and financial openness during the period 1999 - 2011, by income groups. The figure shows the averages per year across countries in each income group. From the figure, we can see the negative effect of the 2001 dot-com and the 2008 financial crises on both the financial stability and openness of both the high and upper middle income countries. There is a divergence between the two groups post the 2008 financial crisis. While both groups became more financially open post the crisis, financial stability improved more in high income countries than in upper middle income countries. Perhaps this captures the positive effects of the banking system reforms in high income countries following the 2008 crisis. Overall, the figure indicates that there is strong negative relationship between financial stability and openness for the lower middle income countries. The relationship is weak for other income groups.

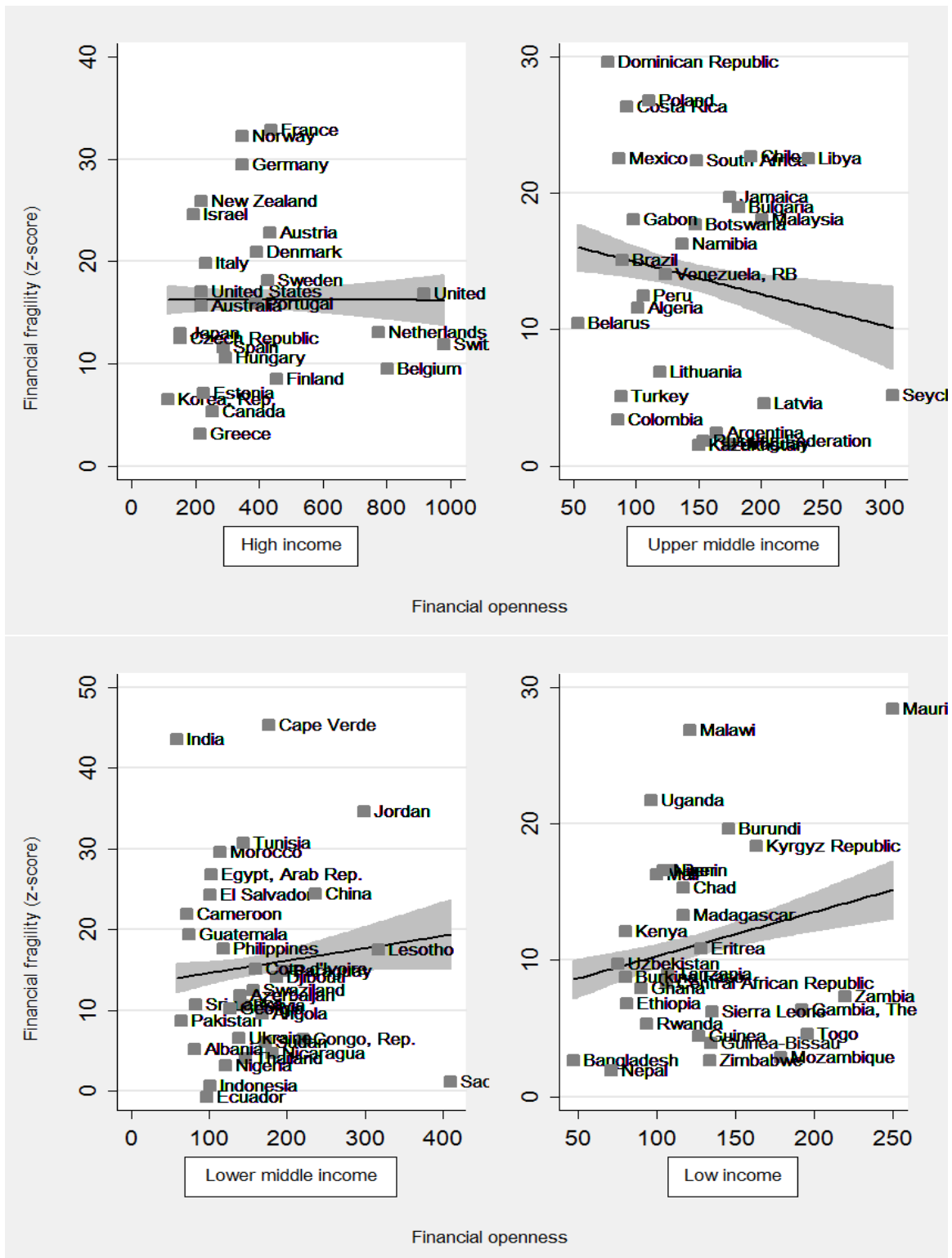
Figure 2.3: Financial fragility vs. Financial openness - by years



Note: Figure 2.3 shows the relationship between financial fragility (z-score) and financial openness by years and classified according to the four categories of income groups: High-income (High) - Top left panel, Upper middle-income (Upper) - Top right panel, Lower-income (Lower) - Bottom left panel and Low-income (Low) - Bottom right panel. We excluded the following outliers: Mauritius, Singapore, Liberia and Ireland. The grey area is the 95% confidence intervals. *Source:* IDFF and authors calculation

Figure 2.4 shows the average relationship between financial openness and financial stability by countries, grouped by their income groups. Starting with the high income countries on the left-hand top panel, we can see that the US and the UK have the same average level of financial stability. However, the UK seems to be almost four times more open than the US. The right-hand top panel shows the results for the upper middle income groups. From the figure, we can see that Russia, Argentina and Uruguay have the lowest level of financial stability, whereas South Africa, with a similar level of financial openness to the three, has a higher level of financial stability. And from the right-hand bottom panel, we can see that low income countries are clustered at lower levels of financial stability.

Figure 2.4: Financial stability vs. Financial openness - by countries



Note: Figure 2.4 shows the relationship between financial fragility (z-score) and financial openness classified according to the four categories of income groups: High-income (High) - Top left panel, Upper middle-income (Upper) - Top right panel, Lower-income (Lower) - Bottom left panel and Low-income (Low) - Bottom right panel. We excluded the following outliers: Mauritius, Singapore, Liberia and Ireland. The grey area is the 95% confidence intervals. Source: IDFF and authors calculation

2.3 Data and Methodology

2.3.1 Data

Our dependent variable is financial stability. We use the *z-score* (*z-score*) from the International Database on Financial Fragility (IDFF) from the University of Leicester as our proxy for financial fragility. The *z-score* measures the distance of each country's banking system from insolvency, with a high level implying sound financial stability and is inversely related to financial fragility⁵.

The choice for the list of explanatory variables follows the empirical and theoretical literature on banking and financial crises and financial openness or liberalisation (Hardy and Pazarbaşıoğlu (1999), Kaminsky and Reinhart (1999, 1998) and Demirgüç-Kunt and Detragiache (1998*a*, 2000, 1998*b*)). According to Hardy and Pazarbaşıoğlu (1999), these variables can be grouped into three groups. The first group consists of *real sector* variables, which include gross domestic product growth, investment and private consumption. The second group consists of *banking sector* variables, which include the ratio of credit to the private sector to GDP and the ratio of foreign liabilities of the banking sector to GDP. The last group consists of shocks that may directly or indirectly (through the real sector) affect the health of the banking sector. This includes inflation, real exchange rate and growth of imports or terms of trade.

For our analysis, we control for the health of the financial sector with a measure of credit. Credit is proxied by total credit to the private sector by deposit banks and other financial institutions (*Credit*). Total credit to the private sector by deposit banks and other financial institutions is also used in the finance-growth literature as a measure of financial depth. Arcand et al. (2015) argue that it is a best measure of finance than bank credit as it includes the shadow banking system.

Lastly, we control for other variables, internal or external, that can either directly or indirectly affect the health of the financial sector. Our main variable of interest is the measure of financial openness. Clark et al. (2012) provide a discussion on the interrelationship between financial openness, integration, and interdependence and capital mobility and flows. The authors indicate that analogous to trade openness, there are two ways to measure financial openness. The first is a broad measure of capital flows while the second measure is of government constraints on taxes and capital controls. In this study, we use the first measure of capital flows. For this, we use the ratio of total assets and liabilities to GDP as a proxy for financial openness

⁵In the banking competition and financial stability literature, Beck et al. (2013) and Leroy and Lucotte (2017) also use the *z-score* as a measure of bank soundness.

(*Financial*). We also disaggregate financial openness into total assets to GDP (*Assets*) and total liabilities to GDP (*Liabilities*). The database we use is the External Wealth of Nations Mark II by Lane and Milesi-Ferretti, an updated and extended version of the 1970-2004 database. The latest database covers the period 1970-2011 and includes 188 countries. Total assets include the assets' side of equity portfolio, debt portfolio, foreign direct investment (FDI), financial derivatives, and foreign reserves minus gold, whereas total liabilities include the liabilities' side of equity portfolio, debt portfolio, foreign direct investment (FDI) and financial derivatives. Gross domestic product is measured in US dollars.

Other remaining variables include local variables such as inflation, real exchange rate growth and the ratio of stock market capitalisation to GDP. Inflation (*Inflation*) is proxied by year-on-year growth of consumer prices index (CPI). Real exchange rate growth (*RER growth*) is the change in real exchange rate. The data for inflation and RER growth is obtained from the International Macroeconomic dataset - USDA Historical data which is available from the Graduate Institute of International and Development Studies.

The inclusion of the stock market capitalisation (*Stock*) is to determine if stock markets also play a role in the overall financial stability of a country. The effect of stock market capitalisation on financial stability can be explained theoretically by three explanations of the link between stock market and the economy, as discussed in Duca (2007). The first explanation is the Tobin Q theory. The theory states that increases in asset prices increases firms' market value relative to their replacement cost of capital. Therefore firms can increase their investment expenditure and thereby increase output. The second explanation is the Permanent Income Hypothesis (PIH) by Modigliani (1981). The Permanent Income Hypothesis postulates that increase in stock prices increases the wealth of the individual. This then increases income. The last explanation is the financial accelerator. According to the financial accelerator theory by Bernanke et al. (1999), increase in asset prices improves the firms' balance sheets. This results into increase in collateral which allow the firms to borrow more against their collateral to finance investment projects, and therefore increase output. This increase in economic activity allows both households and firms to meet their financial obligations, and therefore has a positive effect in financial stability. However, according to Duca (2007), the effect of stock market on economic growth depends on the country. The author finds that countries with small capital markets to GDP do not exhibit any causal relationship from the stock market to output.

Empirical studies of the effects of financial markets on economic growth can be

divided into four categories: the bank-based theory, the market-based theory, the financial-services theory and the law and finance theory. The bank-based theory argues that banks can finance development more effectively than stock markets in the early development stages of a country. On the contrary, the market-based theory highlight the problems of bank-based financial systems such as inefficient monopoly power and excessive conservative approach, and argue that big (measured by stock market capitalisation), liquid and efficient (measured by market liquidity) stock markets foster growth and profit incentives, enhance corporate governance and facilitate risk management amongst other things, Luintel et al. (2008).

Lastly, the financial-services theory and the law and finance theory focus on how to create better financial services (both banks and markets) and the role of law, respectively, in promoting the financial sector that supports growth. Therefore, according to these two theories, the structure of the financial sector is irrelevant. Papers by Luintel et al. (2008) and Ergungor (2008) do find that structure does matter. Contrary, Levine (2002) and Beck and Levine (2004) simultaneously analyse the role of banks and stock markets and find an overall support for financial development. Including both private credit and a measure of stock market development in our analysis mean that we control for the financial structure of the economy, Fufa and Kim (2017).

Caution is required when using stock market capitalisation to control for stock market development. As discussed in Levine and Zervos (1998), the forward-looking nature of the stock market makes both value traded and stock market capitalisation subject to price effects. Price effects arise from future expectations of market investors. Expectations of high profits in the future will drive asset prices up. Therefore, any relationship between the current stock market capitalisation or value traded and current or future economic growth might be driven by prices. To circumvent this, the authors propose either using stock market turnover ratio or both stock market capitalisation and value traded together. We run our regressions with stock market capitalisation and then perform robustness checks with value traded.

After merging different datasets, we remain with a sample of 77 countries, which include high and upper middle income countries. The classification of countries is from the World Bank. Table 2.1 provides a list of countries included in our sample.

Table 2.1: Countries by income groups

	High	Upper middle	
Equatorial Guinea	China (Hong Kong)	Argentina	Chile
Australia	Belgium	Costa Rica	Dominican Republic
Denmark	France	Peru	Uruguay
Germany	Italy	Venezuela	Jamaica
Netherlands	Finland	Malaysia	Algeria
Hellenic	Ireland	Botswana	Gabon
Portugal	Spain	Mauritius	Seychelles
Czech Republic	Estonia	Namibia	Belarus
USA	UK and Northern Ireland	Kazakhstan	Bulgaria
Norway	Sweden	Russia	Latvia
Canada	Japan	Lithuania	Turkey
Austria	New Zealand	South Africa	Brazil
Israel	Korea	Colombia	Mexico
Singapore	Hungary		

2.3.2 Methodology

As already discussed, the variables included in our econometric model follow that in the financial or banking crises and financial openness literature. These variables encompass measures of financial stability, financial openness and macroeconomic conditions. Local financial factors are proxied by credit to the private sector as a percentage of GDP at both the stock level (*Credit*) and the first difference (*D.Credit*) and stock market capitalisation as a percentage of GDP (*Stock market*). The aggregated measure of financial openness (*Financial*) is proxied by the ratio of total assets and liabilities to GDP. The disaggregated measures of financial openness are proxied by ratios of total assets (*Assets*) and total liabilities (*Liabilities*) to GDP. Macroeconomic conditions include inflation (*Inflation*) and real exchange rate growth (*RER growth*). We estimate the following model:

$$FF_{c,t} = \beta_c + \gamma * FinOp_{c,t-s} + \lambda * TradeOp_{c,t-s} + \delta_i * LocalFac_{c,t-s,i} + \varepsilon_{c,t} \quad (2.2)$$

$$\varepsilon_{c,t} = \mu_c + \eta_{c,t} \quad (2.3)$$

where β_c , is the constant term for each country and $FF_{c,t}$ is the financial fragility (instability) of country c at time t in levels and is proxied by the z-score. Financial openness and trade openness are represented by $\gamma * FinOp_{c,t-s}$ and $\lambda * TradeOp_{c,t-s}$, respectively, for country $c = 1, 2, \dots, N$ with lags of s . $\delta_i * LocalFac_{c,t-s,i}$ represent all

the local variables i , which include credit (in level and first difference), stock market capitalisation, inflation and real exchange rate growth. Lastly, the disturbance term $\varepsilon_{c,t}$ consists of the fixed effects μ_c which captures the heterogeneity between countries, and the idiosyncratic shocks, $\eta_{c,t}$. And the two should be independent from each other, that is:

$$E(\mu_c) = E(\eta_{c,t}) = E(\mu_c \eta_{c,t}) = 0 \quad (2.4)$$

Lastly, we include two interaction terms. The first interaction term is between financial openness and the real exchange rate growth. Financial openness makes countries vulnerable to currency movements, especially emerging markets. Therefore a negative and significant coefficient of this interaction term would imply that financial openness has more negative effect on countries which experience high local currency depreciation. The second interaction term is between the stock of credit and inflation, which captures the additional effect of credit on countries with high inflation.

We also include time fixed effects to capture changes in financial stability due to unobservable variables during the years such as regulatory changes. We standardised the variables to allow for easy comparison between different income groups.

2.4 Panel Analysis: Results

2.4.1 Pooled OLS estimates

We start our empirical analysis with a simple pooled ordinary least square (OLS) regression. We look at the impact of financial openness and also its components, total assets and total liabilities, on financial stability. The results are presented in Table 2.2.

Firstly, we start with a simple model specification of financial openness and trade openness as determinants of financial stability in column (1) to (3). Then we extend our model specifications with other control variables from column (4) to (12). Due to the high correlation between total assets and total liabilities, we run the estimations of the two separately. From column (1), the results for both financial and trade openness are significant. The results indicate that financial openness reduces financial stability, whereas trade openness improves financial stability. These results only remain robust when we add credit and the change in credit in column (4), though credit and the change in credit are insignificant. The model specifications in column (7) and (10) indicate that the level of credit, inflation and

real exchange rate growth have negative effect on financial stability, whereas stock market capitalisation improves financial stability.

When we look at the two components of financial openness, the results for the simple model specification in column (2) and (3) indicate that both total assets and total liabilities have a negative effect on financial stability. Similarly to financial openness, the individual components lose their significance level as we add more controls, with total liabilities only being significant in column (5) and total assets only being significant in (12). Again, stock market capitalisation, inflation and real exchange rate growth are robust across all model specifications.

Lastly, we check if the results for stock market capitalisation are driven by price effects. We re-estimate the regressions and include value traded together with stock market capitalisation to see if stock market capitalisation remains significant. The results are provided in Table 2.6 in the Appendix section 2.6.1. Stock market capitalisation still remains positive and significant across all model specification even after controlling for prices effects. Overall, the results indicate that local macroeconomic conditions play a significant role in explaining local financial stability. A positive exchange rate growth implies a depreciation of the local currency. Therefore, the results indicate that a depreciation of the local currency increases financial instability in the system. The overall significance of the variables is very low as indicated by small r-square values.

2.4.2 Income groups

Next we look at the results when we control for income groups. The results for our fixed effects models are presented in Table 2.3. We also include the results for random effects for completeness. The results for fixed effects are presented in columns (1) to (6) with one-way fixed effects in column (1), (3) and (5) and two-way fixed effects in column (2), (4) and (6). Column (1) and (2) show the results for the whole sample, (3) and (4) for the high income countries whereas (5) and (6) show the results for the upper middle income countries.

Starting with the results for fixed effects for the whole sample in columns (1) and (2), we can see that financial openness is only significant at a 5% level when we control for time effects. Therefore, financial openness has a negative marginal effect on financial stability when we control for the business cycle. Similarly, trade openness and the level of credit are well estimated with the two-way fixed effects specification. The other remaining variables are mostly similar to Table 2.2. When we control for income group levels in Columns (3) to (6), we observe the similarities and the differences between the two income groups. Firstly, the results show that

Table 2.2: Pooled regression for Financial stability (Z-score)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Financial	-0.096** (0.045)			-0.088* (0.046)			-0.045 (0.058)			-0.080 (0.057)		
Trade	0.069* (0.038)	0.061 (0.039)	0.082** (0.038)	0.075* (0.041)	0.073* (0.041)	0.078* (0.041)	0.026 (0.049)	0.024 (0.049)	0.028 (0.049)	0.083 (0.052)	0.077 (0.051)	0.091* (0.051)
Liabilities		-0.096** (0.046)			-0.101** (0.047)			-0.043 (0.060)			-0.067 (0.059)	
Assets			-0.110** (0.044)			-0.065 (0.045)			-0.048 (0.056)			-0.100* (0.054)
Credit				-0.038 (0.049)	-0.037 (0.049)	-0.037 (0.050)	-0.142** (0.058)	-0.142** (0.059)	-0.144** (0.058)	-0.144** (0.059)	-0.146** (0.059)	-0.144** (0.057)
D.Credit				-0.036 (0.058)	-0.041 (0.058)	-0.026 (0.058)	-0.030 (0.076)	-0.032 (0.076)	-0.028 (0.077)	-0.010 (0.072)	-0.011 (0.073)	-0.006 (0.073)
Stock market							0.153*** (0.051)	0.152*** (0.051)	0.159*** (0.051)	0.132** (0.050)	0.130** (0.050)	0.144*** (0.050)
Inflation										-0.138*** (0.046)	-0.135*** (0.046)	-0.143*** (0.046)
RER growth										-0.163*** (0.047)	-0.160*** (0.047)	-0.169*** (0.047)
Constant	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)	-0.013 (0.016)	-0.015 (0.016)	-0.011 (0.016)	-0.004 (0.020)	-0.004 (0.021)	-0.003 (0.020)	-0.026 (0.021)	-0.027 (0.021)	-0.024 (0.020)
N	1462	1462	1462	1214	1214	1214	849	849	849	819	819	819
N (group)	117	117	117	115	115	115	79	79	79	76	76	76
R ² (<i>adjusted</i>)	0.010	0.010	0.012	0.011	0.013	0.007	0.039	0.039	0.039	0.073	0.072	0.076
F stat	3.637	3.229	5.173	2.514	2.718	2.129	5.180	5.045	5.535	6.675	6.539	7.249
F stat (p-value)	0.029	0.043	0.007	0.045	0.033	0.082	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports pooled ordinary least square regressions for financial fragility (z-score). The dependent variable is z-score from the IDFF. All variables are scaled by gross domestic product, excluding exchange rates and inflation. All variables are yearly data and in levels. Significance levels are: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in brackets.

financial openness has a negative effect (only significant in the two-way fixed effects model specification) on financial stability for high income countries while there is no significant effect for upper middle income countries. Secondly, though the effect of trade openness is positive for both income groups, it is only significant for the upper middle income group. An increase in trade openness can either come from increase in export or imports, which would improve economic growth through investment or consumption. Thus, the results indicate that financial stability for upper middle income countries is pro-cyclical, improving during periods of either high consumption or investment. Thirdly, for high income countries, the level of credit in the financial system reduces financial stability, with the change in credit being insignificant.

Contrary, for upper middle income countries, even though too much credit in the financial system causes financial instability, the change in credit has a positive effect on financial stability. This indicates that credit growth is not a bad thing for these economies, it is only credit booms that are the culprits. In these countries, credit expansion might be necessary to fuel consumption spending or investment, as long as lending standards (no inflationary pressures) are maintained. Fourthly, stock market capitalisation is associated with financial instability in upper middle income countries. Lastly, the effects of inflation and real exchange rate depreciation are negative for both income groups, though more pronounced for the upper middle income countries. The results for random effects in column (7) to (9) are similar to that of the fixed effects. The results for stock market capitalisation remain significant, positive and negative for high income and upper middle income countries, respectively across all model specifications after controlling for price effects with value traded. The results are presented in Table 2.7 in the Appendix section 2.6.1.

Results with interaction terms

Next we look at the results for fixed effects by income groups using different model specifications, presented in Table 2.4. In columns (1), we augment our base model with an interaction term between financial openness and real exchange rate growth. In columns (2), the base model is extended with the interaction term between credit and inflation. Columns (3) and (5) separate financial openness into its total assets and total liabilities components. Lastly, columns (4) and (6) include the interaction term between each component with real exchange rate growth. We control for time effects in all the model specifications. Starting with high income countries, the results show that financial openness has a negative effect on financial stability, from

Table 2.3: Fixed and Random effects regression for Financial stability (Z-score)

	Fixed Effects						Random effects		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Financial	-0.069 (0.058)	-0.128** (0.062)	-0.023 (0.096)	-0.398** (0.161)	0.135 (0.079)	0.077 (0.069)	-0.080 (0.057)	-0.064 (0.094)	0.116 (0.082)
Trade	0.091* (0.051)	0.128** (0.060)	0.026 (0.086)	0.113 (0.091)	0.125** (0.051)	0.209** (0.074)	0.083 (0.051)	0.030 (0.085)	0.109** (0.049)
Credit	-0.149** (0.059)	-0.230*** (0.065)	-0.237** (0.106)	-0.270*** (0.084)	-0.173 (0.104)	-0.185* (0.102)	-0.144** (0.058)	-0.211** (0.105)	-0.194* (0.104)
D.Credit	-0.007 (0.078)	0.059 (0.079)	-0.259 (0.184)	-0.218 (0.173)	0.253* (0.127)	0.340** (0.131)	-0.010 (0.072)	-0.192 (0.180)	0.213* (0.109)
Stock market	0.127** (0.050)	0.124** (0.057)	0.157* (0.081)	0.265** (0.115)	-0.266*** (0.073)	-0.286*** (0.064)	0.132*** (0.050)	0.174** (0.079)	-0.230*** (0.078)
Inflation	-0.145*** (0.047)	-0.065 (0.053)	-0.184** (0.085)	0.020 (0.110)	-0.223*** (0.076)	-0.179* (0.094)	-0.138*** (0.046)	-0.195** (0.084)	-0.206*** (0.078)
RER growth	-0.164*** (0.048)	-0.202*** (0.061)	-0.146** (0.070)	-0.180** (0.081)	-0.221*** (0.070)	-0.268** (0.101)	-0.163*** (0.047)	-0.151** (0.069)	-0.226*** (0.068)
Constant	-0.027** (0.010)	-0.107 (0.148)	0.062* (0.030)	-0.559 (0.344)	-0.035 (0.024)	0.162 (0.276)	-0.026 (0.020)	0.053 (0.045)	-0.031 (0.040)
Time effects	N	Y	N	Y	N	Y	N	N	N
F stat	6.619	7.140	4.218	21.414	11.835	17.056			
N	819	819	273	273	223	223	819	273	223
N (group)	77	77	25	25	22	22	77	25	22
χ^2							47.020	30.848	74.401
P-values (F stat and χ^2)	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000
R ² (overall)	0.081	0.143	0.137	0.225	0.202	0.250	0.081	0.139	0.204

Note: This table reports the fixed effects and the random effects results for financial fragility. The dependent variable is z-score from the IDFF. All variables are yearly data and in levels. Significance levels are: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in brackets.

both total assets and total liabilities. Real exchange rate growth does not have any significant effect on the impact of financial openness on financial stability, or any of its components. Similarly, the interaction term between credit and inflation is insignificant. The results indicate that the level of credit, stock market capitalisation and real exchange rate growth are robust in all model specifications.

For the upper middle income countries, neither financial openness, nor its components, have any significant effect on financial stability. Only the interaction terms between financial openness or total liabilities and real exchange rate growth are significant and indicate that financial openness or total liabilities have a negative effect on financial stability when the real exchange rate depreciates. Similarly, inflation intensifies the negative effect of credit on financial stability. As in Table 2.3, the effects of trade openness, stock market capitalisation and the change in credit are robust to all model specifications. Again, the results show that too much credit in the financial system causes financial instability, whereas the change in credit has a positive effect on financial stability. The results for stock market capitalisation remain robust for upper middle income countries to controlling for price effects with value traded. For high income countries, stock market capitalisation loses its significance in model specifications in column (5) and (6). These results are presented in Table 2.8 in the Appendix section 2.6.1.

2.4.3 Dynamic panel analysis

We complete our analysis by considering the issue of endogeneity of some regressors and also controlling for the dynamic nature of financial fragility. For example, countries with stable (and normally large) financial systems may attract capital inflows from foreign investors. Alternatively, local investors in countries with unstable financial systems may invest in foreign countries with better financial systems. Financial fragility may also affect the level of trade openness through a reduction in trade finance and investment for firm borrowers who are dependent on loans. The issue of endogeneity may also arise from the interrelationship between banking crises, equity or house price bubbles, exchange rate crashes and inflation crises, Reinhart and Rogoff (2009). We employ the dynamic panel generalised method of moments (GMM) and restrict the lag length from 2 to 4 lags, given the short sub-samples when we split the whole sample by income groups. Table 2.9 shows the results for the dynamic two-step system GMM for the whole sample and also by income group levels. We augment the discussed models by including the first lag of the dependent variable as an additional regressor. The coefficient of the lagged dependent variable indicates the persistence level of the variable with a positive value indicating that

Table 2.4: Fixed effects regression for Financial stability (Z-score)

	High income						Upper middle income					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Financial	-0.396** (0.162)	-0.396** (0.160)					0.075 (0.070)	0.107 (0.067)				
Trade	0.113 (0.090)	0.112 (0.090)	0.091 (0.089)	0.087 (0.088)	0.119 (0.094)	0.119 (0.095)	0.191** (0.080)	0.228*** (0.079)	0.209** (0.111)	0.198** (0.113)	0.226*** (0.097)	0.217** (0.080)
Credit	-0.268*** (0.084)	-0.275*** (0.084)	-0.272*** (0.083)	-0.270*** (0.082)	-0.258*** (0.086)	-0.258*** (0.088)	-0.191* (0.103)	-0.166* (0.096)	-0.215* (0.111)	-0.226* (0.113)	-0.172* (0.097)	-0.172* (0.099)
D.Credit	-0.215 (0.172)	-0.218 (0.175)	-0.191 (0.174)	-0.187 (0.174)	-0.266 (0.178)	-0.265 (0.177)	0.336** (0.133)	0.365*** (0.123)	0.338** (0.132)	0.315** (0.143)	0.344** (0.134)	0.348** (0.130)
Stock market	0.263** (0.115)	0.264** (0.115)	0.269** (0.114)	0.269** (0.114)	0.228* (0.121)	0.228* (0.121)	-0.277*** (0.069)	-0.314*** (0.065)	-0.279*** (0.063)	-0.259*** (0.069)	-0.276*** (0.065)	-0.277*** (0.067)
Inflation	0.022 (0.111)	0.017 (0.112)	0.029 (0.111)	0.032 (0.112)	0.012 (0.112)	0.012 (0.115)	-0.168* (0.088)	-0.173* (0.086)	-0.178* (0.097)	-0.163* (0.092)	-0.163 (0.095)	-0.159* (0.090)
RER growth	-0.181** (0.080)	-0.177** (0.080)	-0.181** (0.083)	-0.182** (0.082)	-0.192** (0.083)	-0.192** (0.082)	-0.242** (0.086)	-0.293*** (0.097)	-0.269** (0.101)	-0.244*** (0.086)	-0.260** (0.100)	-0.249** (0.091)
Financial*RER	-0.051 (0.092)						-0.105* (0.055)					
Credit*Inflation		0.022 (0.069)						-0.247*** (0.065)				
Liabilities			-0.320* (0.162)	-0.310* (0.162)					0.093 (0.087)	0.086 (0.093)		
Liabilities*RER				-0.066 (0.097)						-0.114* (0.061)		
Assets					-0.329*** (0.114)	-0.329*** (0.114)					-0.019 (0.065)	-0.017 (0.064)
Assets*RER						-0.002 (0.084)						-0.046 (0.068)
Constant	-0.631 (0.374)	-0.551 (0.350)	-0.463 (0.356)	-0.545 (0.380)	-0.404 (0.288)	-0.407 (0.323)	0.097 (0.270)	0.085 (0.283)	0.151 (0.274)	0.085 (0.266)	0.100 (0.292)	0.080 (0.293)
F	19.451	20.338	24.130	22.798	21.340	30.255	21.857	17.059	18.384	15.927	25.370	29.930
F stat p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	273	273	273	273	273	273	223	223	223	223	223	223
N (group)	25	25	25	25	25	25	22	22	22	22	22	22
R ² (overall)	0.226	0.225	0.218	0.219	0.224	0.224	0.260	0.281	0.254	0.263	0.249	0.252

Note: This table reports the fixed effects results for financial fragility. The dependent variable is z-score from the IDFF. All variables are scaled by gross domestic product, excluding exchange rates and inflation. All variables are yearly data and in levels. Significance levels are: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in brackets.

periods of high financial stability tends to be followed by financial stability. We also use liabilities (inflows) and assets (outflows) as a measure of financial openness. The Arellano-Bond AR (2) test indicates that there is no second order serial correlation. The Hansen test of over-identification does not reject the null hypothesis that our instruments are valid. We also fail to reject the null hypothesis of the exogeneity of the instruments used. All the models include time dummies. We also use the forward orthogonal deviation to maximise our sample size. The standard errors are Windmeijer-corrected.

The results for the whole sample are presented from column (1) to (6). The results indicate that there is persistence of financial (in)stability, with the coefficient of the lagged Z score being statistically significant at the 1% level across all model specifications. The coefficients of the lagged dependent variable also indicate dynamic stability. All measures of financial openness are insignificant in all but one specification. Trade openness has a positive effect (and significant in 4 of the 6 model specifications) on financial fragility whereas credit has a negative effect (in 3 of the 6 model specifications). The results for stock market capitalisation and real exchange rate growth are robust and indicate a positive and a negative effect on financial fragility, respectively. Columns (7) to (9) and (10) to (12) show the results for high-income and upper middle-income countries, respectively. Disentangling the results enables us to identify the differences between these two income groups. From the table, we can see that the lag of financial fragility is positive but only significant for high-income countries. The results for trade openness are only significant for the upper middle-income countries. Stock market capitalisation and macroeconomic variables lose their significance levels at the income country levels.

Taken together, the results for the ordinary least squares, fixed and random effects and dynamic model indicate that local variables (credit, inflation, real exchange rate growth and stock market capitalisation) are fundamental in explaining some of the financial instability. These results are consistent with literature on banking crises. We do find a negative and significant effect of financial openness on local banking stability in some ordinary least squares and fixed and random effects results for the whole sample and high-income countries using both the aggregate and disaggregate measure of financial openness. Using the ratio of M2 to foreign reserves as a measure of external vulnerability of the banking sector to capital outflows (for countries with exchange rate pegs), Demirgüç-Kunt and Detragiache (1998*a*) find that an increase in this variable increases the probability of a banking crisis in most specifications. Caballero (2014) finds empirical evidence that financial integration (using foreign liabilities) increases the likelihood of a banking crisis using panel

Table 2.5: System GMM for Financial stability (Z-score)

	Whole sample					High income			Upper middle income			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L.Z-score	0.528*** (0.041)	0.541*** (0.057)	0.540*** (0.039)	0.544*** (0.058)	0.504*** (0.043)	0.520*** (0.059)	0.541*** (0.098)	0.558*** (0.088)	0.520*** (0.145)	0.446 (0.554)	0.254 (0.238)	-0.172 (0.286)
Financial	-0.072 (0.045)	-0.068 (0.046)					-0.136 (0.367)			-0.778 (0.817)		
Trade	0.166** (0.068)	0.137 (0.084)	0.153** (0.066)	0.133 (0.084)	0.206*** (0.074)	0.151* (0.083)	-0.067 (0.170)	-0.069 (0.177)	0.021 (0.237)	0.618 (0.374)	0.650** (0.285)	0.953*** (0.279)
Credit	-0.112* (0.057)	-0.077 (0.093)	-0.098* (0.052)	-0.076 (0.094)	-0.146** (0.063)	-0.085 (0.087)	-0.153 (0.119)	-0.128 (0.128)	-0.174 (0.153)	-0.229 (0.953)	0.167 (0.523)	0.894** (0.427)
D.Credit	-0.107 (0.072)	-0.158** (0.065)	-0.115 (0.073)	-0.160** (0.066)	-0.086 (0.066)	-0.152** (0.066)	-0.339* (0.170)	-0.331* (0.180)	-0.192 (0.131)	0.243 (0.656)	0.529 (0.316)	0.906** (0.364)
Stock market	0.092** (0.042)	0.094** (0.041)	0.084** (0.042)	0.094** (0.042)	0.121** (0.046)	0.105** (0.041)	0.271 (0.213)	0.248 (0.245)	0.129 (0.121)	-0.028 (1.629)	-0.534 (0.503)	-1.553** (0.721)
Inflation	-0.068 (0.059)	-0.051 (0.085)	-0.062 (0.057)	-0.051 (0.085)	-0.072 (0.059)	-0.045 (0.087)	0.192 (0.244)	0.183 (0.287)	0.075 (0.184)	0.488 (0.899)	-0.020 (0.743)	-0.375*** (0.120)
RER growth	-0.179** (0.089)	-0.144** (0.061)	-0.166** (0.082)	-0.141** (0.061)	-0.161** (0.074)	-0.146** (0.060)	-0.160 (0.156)	-0.161 (0.158)	-0.151 (0.213)	-0.570 (1.414)	-0.273 (0.597)	0.406 (0.394)
Financial*RER	0.232 (0.277)						0.366 (0.798)			0.633 (0.783)		
Credit*Inflation		-0.066 (0.356)		-0.058 (0.360)		-0.082 (0.344)						
Liabilities			-0.062 (0.040)	-0.057 (0.041)				-0.096 (0.363)			-0.383 (0.599)	
Liabilities*RER			0.158 (0.223)					0.218 (0.980)			0.614 (0.521)	
Assets					-0.165 (0.107)	-0.188* (0.105)			-0.055 (0.552)			-0.399* (0.222)
Assets*RER					0.362 (0.300)				0.193 (0.469)			0.318 (0.308)
Constant	-0.014 (0.160)	-0.031 (0.130)	0.007 (0.155)	-0.528** (0.235)	0.211 (0.345)	0.589* (0.298)	1.903 (1.248)	1.909 (1.349)	0.379 (0.987)	0.587 (6.068)	-2.629 (5.023)	-6.740* (3.266)
F stats	41.397	41.323	40.547	41.015	40.239	39.250	30.483	31.075	90.364	4.796	13.609	9.544
F stat p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	819.000	819.000	819.000	819.000	819.000	819.000	273.000	273.000	273.000	223.000	223.000	223.000
N (group)	77.000	77.000	77.000	77.000	77.000	77.000	25.000	25.000	25.000	22.000	22.000	22.000
AR (2)	0.867	0.658	0.801	0.688	0.536	0.587	-0.522	-0.478	-0.019	0.020	-0.434	-1.618
AR (2) p-value	0.386	0.510	0.423	0.492	0.592	0.557	0.602	0.632	0.985	0.984	0.664	0.106
Hansen	5.866	6.077	6.420	6.271	3.861	5.215	1.796	2.044	0.824	0.261	0.041	0.267
Hansen p-value	0.438	0.415	0.378	0.394	0.696	0.517	0.937	0.916	0.991	1.000	1.000	1.000

Notes: This table reports system GMM results for financial stability with one-way and two-way fixed effects. The dependent variable is financial stability as given by the Z-score. Included instruments are D.Credit, Inflation, Financial openness (or Liabilities and Assets), Stock market capitalisation and RER growth. Excluded instruments are Credit and Trade openness. The significance levels are given by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at a country level and are reported in brackets.

data. Hardy and Pazarbaşıoğlu (1999) find similar results using change in foreign liabilities by banks to GDP as a measure of vulnerability of the banking sector to private capital inflows. However, our results are not robust to the dynamic model specification. This indicates that further estimations need to take into account the endogeneity issues. Furthermore, a search for a better model specification is also important.

Contrary to financial openness, we find that *trade openness* increases financial stability especially for the upper middle income countries. Demirgüç-Kunt and Detragiache (1998b) find that GDP growth and change in the terms of trade were some of the robust indicators for financial crises, with GDP growth being highly significant than the terms of trade.

The results for inflation, credit growth and real effective exchange rate indicate that these variables have a negative effect on banking distress. This is consistent with Caballero (2014), Davis and Karim (2008) and Hardy and Pazarbaşıoğlu (1999) amongst others⁶. Beck et al. (2013) use different measures of bank-soundness, including the z-score. They find that growth in loans have a negative effect on bank-soundness for 79 sample of developed and developing countries between 1994 and 2009 in their competition-stability analysis. DeLean and Joseph (2014) do not find any significant effect of inflation on the output loss during financial crises. However, whilst credit growth is mostly insignificant for high income countries, the results for upper middle income countries indicate that the expansion of credit is good for the stability of the financial system.

Lastly, we find that the effect of stock market capitalisation on financial stability is different between high income countries and upper middle income countries with the effect being negative for upper middle income countries. Contrary to our results, DeLean and Joseph (2014) find that stock market development, whether capitalisation, liquidity, or turnover, reduces output loss during financial crises for both high and low income countries. In their analysis of the equity and house prices cycles and the banking crises, Reinhart and Rogoff (2009) show that the behaviour of housing prices and equity prices around financial crises is different. Whereas equity prices exhibit a quick V-shaped recovery (within a year) in both developed and emerging markets, the downturn and recovery of house prices is prolonged. Following this thinking, our results might indicate that at an annual data level, even if asset prices

⁶Davis and Karim (2008) also find that real GDP growth and the terms of trade are robust indicators for predicting financial crises. Similarly, Hardy and Pazarbaşıoğlu (1999) find that private capital inflows (measured by change in foreign liabilities by banks to GDP), inflation, credit growth and real effective exchange rate have negative coefficients on banking distress in the crisis and pre-crisis year.

have a negative effect on the financial stability of high income countries, the effect is short-lived. This might indicate the differences in the soundness of the financial systems or the difference in the type of companies listed on the stock markets of the two countries (the stability and the investors motives in investing in long-term growth big capitalised companies versus the high-risk high-return medium to small capitalised companies), and merits further attention.

2.5 Conclusion

In this chapter, we investigate the effects of financial openness and internal variables on the local financial stability using panel data for the period 1999 to 2011. We separate our sample between high income countries and upper middle income countries. The results for the whole sample indicate that financial openness has a negative effect on financial stability. The results still hold even when we look at total assets and total liabilities separately. The results should be treated with caution as they are not significant across all model specifications. Credit, real exchange rate depreciation and inflation negatively affect financial stability. Stock market capitalisation has a positive effect on the financial stability, even after controlling for price effects.

When we control for country income groups, we find both similarities and differences. The similarities include the negative effect of the stock of credit, inflation and real exchange rate growth on financial stability. The differences are: Firstly, financial openness has a negative and mostly significant impact on financial stability for high income groups. The results for the upper middle income group are insignificant. Only the interaction terms between financial openness or total liabilities and real exchange rate growth are significant for upper middle income countries and indicate that financial openness or total liabilities have a negative effect on financial stability through the real exchange rate depreciation. Secondly, even though trade openness has a positive effect on financial stability, the results are only significant for the upper middle income group. Lastly, we also find that even though too much credit in the financial system causes financial instability, the change in credit has a positive effect on financial stability for upper middle income groups.

Overall, our results indicate that weak macroeconomic conditions (credit growth, inflation, real exchange rate depreciation and stock market capitalisation) are fundamental in explaining some of the financial instability. Our results are consistent with some of the literature on financial crises and fragility. The same variables that are used to predict financial crises do prove useful in understanding local financial

conditions. However, as highlighted in Demirgüç-Kunt and Detragiache (2000), sometimes strong macroeconomic fundamentals can prove to be elusive, as was the case in 1997 Asian crises.

However, these results are not robust to the dynamic model specification. Most variables lose their significance when we control for income groups. This indicates that further estimations need to take into account the endogeneity issues. Furthermore, a search for a better model specification that control for bank-specific variables and institutional factors is also important.

2.6 Appendix

2.6.1 Additional results

Table 2.6: Pooled regression for Financial stability (Z-score)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Financial	-0.096** (0.045)			-0.088* (0.046)			-0.054 (0.058)			-0.086 (0.057)		
Trade	0.069* (0.038)	0.061 (0.039)	0.082** (0.038)	0.075* (0.041)	0.073* (0.041)	0.078* (0.041)	0.028 (0.050)	0.026 (0.050)	0.031 (0.050)	0.082 (0.052)	0.075 (0.052)	0.089* (0.052)
Liabilities		-0.096** (0.046)			-0.101** (0.047)			-0.050 (0.060)			-0.073 (0.059)	
Assets			-0.110** (0.044)			-0.065 (0.045)			-0.061 (0.056)			-0.107* (0.054)
Credit				-0.038 (0.049)	-0.037 (0.049)	-0.037 (0.050)	-0.165*** (0.059)	-0.165*** (0.060)	-0.167*** (0.058)	-0.157** (0.061)	-0.158** (0.062)	-0.158*** (0.059)
D.Credit				-0.036 (0.058)	-0.041 (0.058)	-0.026 (0.058)	-0.009 (0.077)	-0.011 (0.077)	-0.005 (0.078)	-0.006 (0.073)	-0.008 (0.073)	0.001 (0.074)
Stock market							0.184*** (0.057)	0.182*** (0.057)	0.192*** (0.056)	0.145** (0.058)	0.141** (0.059)	0.159*** (0.058)
Value traded							-0.068 (0.060)	-0.066 (0.060)	-0.071 (0.060)	-0.012 (0.064)	-0.010 (0.064)	-0.017 (0.064)
Inflation										-0.138*** (0.046)	-0.136*** (0.047)	-0.143*** (0.046)
RER growth										-0.158*** (0.050)	-0.156*** (0.049)	-0.162*** (0.050)
Constant	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)	-0.013 (0.016)	-0.015 (0.016)	-0.011 (0.016)	-0.007 (0.021)	-0.008 (0.021)	-0.006 (0.021)	-0.027 (0.021)	-0.028 (0.021)	-0.025 (0.021)
N	1462	1462	1462	1214	1214	1214	835	835	835	805	805	805
N (group)	117	117	117	115	115	115	79	79	79	76	76	76
P-value	0.029	0.043	0.007	0.045	0.033	0.082	0.000	0.000	0.000	0.000	0.000	0.000
R ² (overall)	0.010	0.010	0.012	0.011	0.013	0.007	0.046	0.046	0.047	0.077	0.075	0.080

Note: This table reports pooled ordinary least square regressions for financial fragility (z-score). The dependent variable is z-score from the IDFF. All variables are yearly data and in levels. Significance levels are: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in brackets.

Table 2.7: Fixed and Random effects regression for Financial stability (Z-score)

	Fixed Effects						Random effects		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Financial	-0.073 (0.058)	-0.132** (0.062)	-0.025 (0.088)	-0.433** (0.156)	0.139 (0.084)	0.061 (0.074)	-0.086 (0.056)	-0.068 (0.098)	0.115 (0.087)
Trade	0.091* (0.052)	0.128** (0.061)	0.027 (0.075)	0.091 (0.085)	0.142** (0.053)	0.236*** (0.079)	0.082 (0.051)	0.032 (0.085)	0.119** (0.051)
Credit	-0.167*** (0.062)	-0.241*** (0.066)	-0.245*** (0.082)	-0.233** (0.086)	-0.198* (0.112)	-0.233** (0.105)	-0.157** (0.061)	-0.224** (0.106)	-0.216* (0.112)
Stock market	0.143** (0.059)	0.125* (0.065)	0.164** (0.067)	0.230* (0.120)	-0.256** (0.101)	-0.269** (0.098)	0.145** (0.058)	0.185** (0.091)	-0.220** (0.105)
Value traded	-0.019 (0.065)	0.028 (0.069)	-0.023 (0.087)	0.185 (0.147)	-0.020 (0.103)	-0.018 (0.114)	-0.012 (0.063)	-0.038 (0.124)	-0.003 (0.102)
Inflation	-0.145*** (0.048)	-0.071 (0.054)	-0.180** (0.073)	0.003 (0.111)	-0.217*** (0.075)	-0.174* (0.098)	-0.138*** (0.046)	-0.189** (0.083)	-0.201*** (0.076)
RER growth	-0.158*** (0.051)	-0.211*** (0.062)	-0.137* (0.070)	-0.221** (0.094)	-0.222*** (0.059)	-0.271** (0.100)	-0.158*** (0.050)	-0.138* (0.076)	-0.225*** (0.060)
Time effects	N	Y	N	Y	N	Y	N	N	N
F	6.574	6.627	5.240	19.885	13.034	160.423			
N	805	805	273	273	215	215	805.	273	215
N (group)	77	77	25	25	22	22	77	25	22
χ^2							53.475	31.564	95.902
P-values (F-stat and χ^2)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R ² (overall)	0.086	0.151	0.138	0.232	0.203	0.261	0.086	0.140	0.206

Note: This table reports the fixed effects and the random effects results for financial fragility. The dependent variable is z-score from the IDFF. All variables are scaled by gross domestic product, excluding exchange rates and inflation. All variables are yearly data and in levels. Significance levels are: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in brackets.

Table 2.8: Fixed effects regression for Financial stability (Z-score)

	High income						Upper middle income					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Financial	-0.431** (0.157)	-0.431** (0.155)					0.061 (0.075)	0.095 (0.074)				
Openness	0.090 (0.084)	0.089 (0.085)	0.067 (0.084)	0.064 (0.083)	0.097 (0.089)	0.097 (0.089)	0.219** (0.084)	0.254*** (0.083)	0.235*** (0.080)	0.224** (0.083)	0.252*** (0.082)	0.245*** (0.086)
Credit	-0.231** (0.086)	-0.239** (0.088)	-0.236** (0.085)	-0.235** (0.084)	-0.219** (0.088)	-0.219** (0.090)	-0.238** (0.107)	-0.208* (0.103)	-0.264** (0.118)	-0.276** (0.120)	-0.231** (0.098)	-0.230** (0.101)
Stock market	0.228* (0.120)	0.228* (0.119)	0.237* (0.119)	0.236* (0.119)	0.190 (0.124)	0.189 (0.125)	-0.259** (0.105)	-0.300*** (0.101)	-0.264** (0.094)	-0.240** (0.105)	-0.249** (0.098)	-0.249** (0.100)
Value traded	0.185 (0.146)	0.187 (0.146)	0.177 (0.148)	0.176 (0.147)	0.186 (0.148)	0.186 (0.148)	-0.020 (0.115)	-0.026 (0.109)	-0.022 (0.114)	-0.021 (0.114)	-0.019 (0.114)	-0.021 (0.116)
Inflation	0.006 (0.112)	-0.001 (0.112)	0.014 (0.112)	0.017 (0.113)	-0.005 (0.113)	-0.005 (0.115)	-0.163* (0.091)	-0.171* (0.089)	-0.174* (0.100)	-0.159 (0.095)	-0.155 (0.099)	-0.152 (0.095)
RER growth	-0.222** (0.094)	-0.218** (0.093)	-0.221** (0.096)	-0.221** (0.095)	-0.235** (0.098)	-0.235** (0.097)	-0.248*** (0.084)	-0.294*** (0.096)	-0.273** (0.099)	-0.250*** (0.084)	-0.263** (0.099)	-0.254** (0.090)
Financial*RER	-0.049 (0.089)						-0.099* (0.057)					
Credit*Inflation		0.030 (0.068)						-0.236*** (0.072)				
Liabilities			-0.349** (0.155)	-0.339** (0.156)					0.086 (0.092)	0.080 (0.097)		
Liabilities*RER				-0.061 (0.093)						-0.112* (0.063)		
Assets					-0.360*** (0.108)	-0.361*** (0.107)					-0.041 (0.066)	-0.038 (0.064)
Assets*RER						-0.003 (0.085)						-0.037 (0.069)
F	18.031	18.774	20.068	26.450	18.845	20.752	463.444	419.714	113.124	106.477	258.116	139.030
N	273	273	273	273	273	273	215	215	215	21	215	215
N (group)	25.000	25.000	25.000	25.000	25.000	25.000	22.000	22.000	22.000	22.000	22.000	22.000
χ^2												
F stat p-values	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R ² (overall)	0.232	0.231	0.224	0.225	0.231	0.231	0.272	0.292	0.265	0.275	0.263	0.266

Note: This table reports the fixed effects results for financial fragility. The dependent variable is z-score from the IDFF. All variables are yearly data and in levels. Significance levels are: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in brackets.

Table 2.9: System GMM for Financial stability (Z-score)

	Whole sample						High income			Upper middle income		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L.Z-score	0.552*** (0.071)	0.541*** (0.070)	0.564*** (0.067)	0.551*** (0.068)	0.549*** (0.085)	0.529*** (0.092)	0.529 (0.372)	0.567*** (0.142)	0.490 (0.326)	0.485 (0.339)	0.354 (0.337)	0.509 (0.502)
Financial	-0.062 (0.178)	-0.094 (0.150)					-0.006 (1.402)					-0.158 (0.549)
Trade	0.162** (0.078)	0.151* (0.089)	0.154** (0.073)	0.146* (0.084)	0.174** (0.083)	0.133 (0.080)	0.079 (0.359)	-0.020 (0.318)	0.008 (0.315)	0.341 (0.394)	0.435 (0.357)	0.227 (0.438)
Credit	-0.099 (0.076)	-0.074 (0.073)	-0.095 (0.069)	-0.074 (0.077)	-0.130* (0.071)	-0.097 (0.063)	-0.072 (0.179)	-0.137 (0.196)	-0.169 (0.146)	0.005 (0.523)	0.236 (0.475)	1.940 (4.296)
D.Credit	-0.139 (0.086)	-0.164** (0.067)	-0.130 (0.088)	-0.163** (0.069)	-0.112 (0.087)	-0.149** (0.072)	-0.213 (0.147)	-0.207 (0.128)	-0.346 (0.388)	0.143 (0.505)	0.259 (0.537)	-0.063 (0.666)
Stock market	0.104* (0.055)	0.098* (0.051)	0.101* (0.055)	0.101** (0.050)	0.120** (0.054)	0.102** (0.050)	0.017 (0.447)	-0.011 (0.124)	0.249 (0.260)	-0.550 (0.511)	-0.637 (0.452)	-2.576 (4.784)
Value traded	-0.006 (0.051)	-0.010 (0.050)	-0.012 (0.050)	-0.017 (0.047)	0.011 (0.060)	-0.002 (0.057)	0.078 (0.231)	0.012 (0.239)	0.102 (0.286)	0.159 (0.253)	0.101 (0.220)	0.329 (0.490)
Inflation	-0.073 (0.058)	-0.064 (0.064)	-0.065 (0.058)	-0.059 (0.067)	-0.078 (0.066)	-0.057 (0.064)	0.005 (0.327)	-0.044 (0.123)	-0.079 (0.340)	0.020 (0.190)	-0.141 (0.134)	-0.669 (1.361)
RER growth	-0.175* (0.093)	-0.143** (0.059)	-0.172* (0.089)	-0.142** (0.061)	-0.160** (0.077)	-0.141** (0.057)	-0.314 (0.285)	-0.398 (0.291)	-0.090 (0.116)	-0.007 (0.275)	0.037 (0.274)	0.331 (0.809)
Financial*RER	0.145 (0.288)						0.238 (0.620)			0.068 (0.408)		
Credit*Inflation		0.011 (0.254)		-0.006 (0.262)		0.017 (0.274)						
Liabilities			-0.052 (0.167)	-0.084 (0.149)				0.145 (0.838)			-0.234 (0.315)	
Liabilities*RER			0.128 (0.233)					0.181 (0.509)			0.095 (0.429)	
Assets					-0.033 (0.258)	-0.121 (0.236)			-0.264 (1.303)			1.384 (3.877)
Assets*RER					0.271 (0.358)				0.533 (0.581)			-0.247 (0.550)
Constant	0.483** (0.211)	0.292* (0.171)	0.280** (0.127)	-0.003 (0.162)	0.398 (0.375)	-0.111 (0.243)	0.767 (2.538)	-0.385 (0.826)	0.954 (1.255)	-0.431 (2.765)	-1.362 (2.237)	-11.286 (24.362)
F stat	15.355	15.499	14.553	14.488	17.518	16.081	22.777	24.383	20.548	27.195	91.139	75.478
F p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	805	805	805	805	805	805	273	273	273	215	215	215
N (group)	77	77	77	77	77	77	25	25	25	22	22	22
AR (2)	0.709	0.618	0.684	0.627	0.624	0.564	-0.026	0.271	-0.141	0.501	-0.158	-0.520
AR (2) p-value	0.478	0.536	0.494	0.530	0.532	0.573	0.979	0.787	0.888	0.617	0.875	0.603
Hansen	6.252	6.261	6.514	6.453	5.700	6.429	1.114	0.790	2.143	0.000	0.000	0.000
Hansen p-value	0.282	0.282	0.259	0.265	0.337	0.267	0.953	0.978	0.829	1.000	1.000	1.000

Notes: This table reports system GMM results for financial stability with one-way and two-way fixed effects. The dependent variable is financial stability as given by the Z-score. Included instruments are D.Credit, Inflation, Financial openness (or Liabilities and Assets), Stock market capitalisation and RER growth. Excluded instruments are Credit and Trade openness. The significance levels are given by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at a country level and are reported in brackets.

Chapter 3

Investigating the bank lending channel using disaggregate bank loans

3.1 Introduction

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 interest in the lending channel. Even though the South African central bank did not employ 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 products¹. Within the banking industry, there is both high concentration and interconnectedness, with the four major banks holding 35% of assets in life insurance and 65% of assets under management. Therefore, high credit impairments to the banks' balance sheets have the potential to trigger a systemic risk to the economy.

In this chapter, we re-explore the lending channel in South Africa in a quest to answer a chain of three related questions. Firstly, we want to test if the lending channel exists in South Africa, with specific interest to its impact on selected loan categories. Secondly, we want to investigate if 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

¹IMF Financial system stability assessment for South Africa, IMF (2011)), and SARB Banking Supervision Annual Report of 2013.

chapter presents some new supporting empirical evidence, specifically on the last two questions.

According to Gumata et al. (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 effect 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 chapter, 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 suggest 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 reflects the response for the small banks, given the market share of the big banks. That is, even though the paper addresses the first question, it does not address the second question.

As highlighted in Sichei (2005) and subsequently, Mishi and Tsegaye (2012), bank characteristics does matter in the South African lending channel ². Both papers find evidence that small banks are more sensitive to a tight monetary policy shock than the big banks. However, similarly to Gumata et al. (2013), the papers also suffer from a different type of aggregation effect. In this case, the aggregation of loans hides the heterogeneity of loans highlighted by Gertler and Gilchrist (1993a) and Den Haan et al. (2007). These two papers find that a contractionary monetary policy shock increases non-financial corporate loans while consumer and real estate loans decrease. Therefore, in this case, the Sichei (2005) and Mishi and Tsegaye (2012) papers do address question two of our empirical approach, and fail to give further insights into the first question. It is this divergence of results that we are attempting to address in the first two questions.

Lastly, the chapter 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 monetary policy shock over time. That is, did the financial crisis or the regulatory changes in the banking and financial sector as a whole have any effect on how banks adjust their loan portfolios following a monetary policy

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

shock?

We utilise both the Bayesian structural vector autoregression (VAR) to answer the first two empirical questions and the Time-Varying VAR with stochastic volatility to answer the last empirical question. Unlike the current South African literature, we use monthly data. This not only increases the frequency of our data, but it also 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, as discussed in Bernanke and Gertler (1995). In the Bayesian structural VAR, we specifically test for the credit channel at both the aggregated and the disaggregated bank levels.

This empirical approach of using both aggregated and disaggregated levels follows that of the credit market imperfections for small firms by Gertler and Gilchrist (1993a). However, here we adopt the work of 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. We see this approach relevant to our analysis. Similarly to Kashyap and Stein (1995), the main assumption underpinning our empirical questions is that small banks in South Africa face credit market imperfections relative to the big banks. During the sample period, small banks heavily depend on non-deposit funding 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. The TVP-VAR with stochastic volatility methodology used in this chapter is the same as that used in the United States (US) by Primiceri (2005) and Benati and Mumtaz (2007) amongst others in extending the analyses of the effects of monetary policy actions during the periods of Burns and Volcker-Greenspan.

At the aggregate bank level, we find that the lending channel does exist in South Africa, supporting the findings of 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 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 disaggregated bank level, *i.e.* by bank sizes, provide some support that the lending channel is transmitted differently across the two types of banks. Furthermore, the results indicate that small banks incur an increase in credit impairment sooner than the big banks. Contrary to the international literature (amongst others Bernanke and Blinder (1992), Gertler and

Gilchrist (1993*a*), 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 the variables are more responsive during periods of high uncertainty like the 2008 financial crisis. In summary, the results for the Bayesian structural VAR at the disaggregated 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 chapter is organised as follows. Sub-section 3.1.1 presents the evolution of the South African banking industry. In section 3.2, we discuss the literature review. Section 3 provides the methodology used in the chapter. Section 3.3 documents the results. The last section concludes.

3.1.1 Basic characteristics of the banking sector

This section provides a non-theoretical background on selected financial variables of the banking sector between 2002Q1 and 2014Q3. The chapter covers the six local commercial banks³ that dominate the local retail market. The categorisation of the banks by bank size is taken from 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. The ratio of total loans to total assets for the big and small banks averaged 76% and 85% respectively during the sample period. As of the writing, the big four banks have market share of 83.3% of the banking sector⁴.

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 2014⁵, continuing increase in household debt and credit impairment has put the banking sector under

³The local banks are the South African banks which are required to have deposits with the South African Reserve Bank (SARB). The big banks include Standard Bank, Nedbank, FirstRand and ABSA bank while the small banks include African Bank and Capitec. Small banks do not offer mortgage loans and have low corporate loans in their loan books.

⁴South Africa: Financial system stability assessment, IMF (2011).

⁵Following its last failure in 1995, the bank was placed under curatorship by the South African Reserve Bank Registrar of Banks and the Minister of Finance on August 2014. According to the SARB (2016), the concerns that were raised over the bank include liquidity issues, high loan impairments and rapid credit growth, and a rather unsustainable business model.

great scrutiny by the rating agencies.

Figures 3.1 to 3.4 present selected basic characteristics of the six banks in real terms. Figure 3.1 (a) shows the year-on-year growth of liabilities and loans for 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 the period between 2003 and the second quarter of 2011. The impact of the global financial crisis is also evident, with negative growth for both loans and liabilities during the period. Figure 3.2 (a) 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.

Similarly, Figures 3.1 (b) and 3.2 (b) show the growth of liabilities and loans and components of the loans for the small banks respectively. The growth in liabilities for the small banks exceeds the growth in loans during November 2004 to June 2009. Surprisingly, unlike the big banks, there is positive growth in loans during the crisis. In Figure 3.2 (b), we can see that the loan portfolio of the small banks is undiversified, with unsecured lending, especially overdrafts, loans and advances to the private sector, accounting for at least 70% of the loan portfolio⁶.

Figures 3.3 show the funding liabilities of the banks. In Figure 3.3 (a), 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 3.3 (b) indicates that the banks have relied on non-deposits funding between 2002 and 2007. Furthermore, funding from fund managers declined from over 60% to less than 20% in 2014. Deposits denominated in foreign currency average 0.1% of the total deposits over the sample period.

Lastly, Figures 3.4 presents 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, consistent with the 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 requirements⁷.

⁶The undiversified loan portfolio of the small banks makes them more vulnerable to increasing household debt and other internal negative macroeconomic factors. However, Laeven et al. (2014) argue that small banks pose little 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.

⁷The 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). 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,

Figure 3.1: Assets and Liabilities by bank size

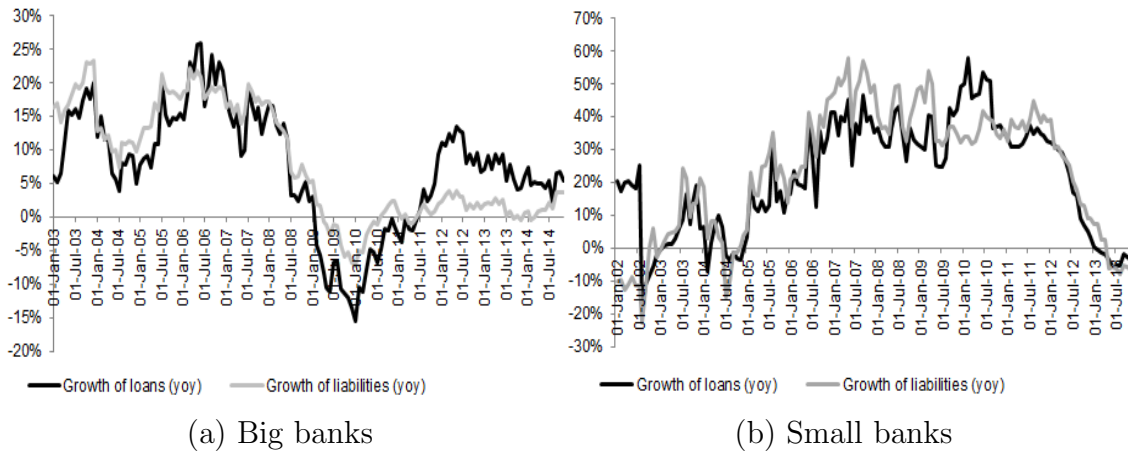


Figure 3.2: Composition of loans by bank size

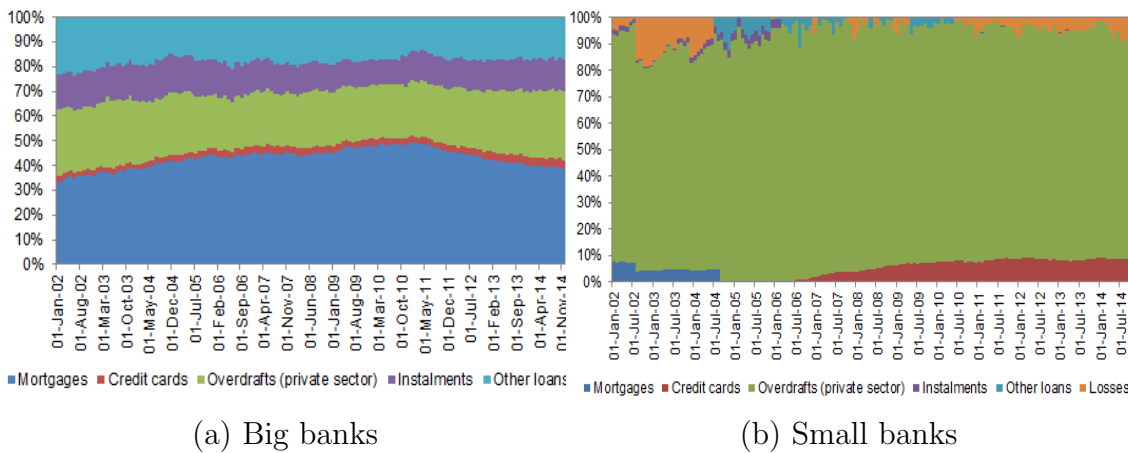
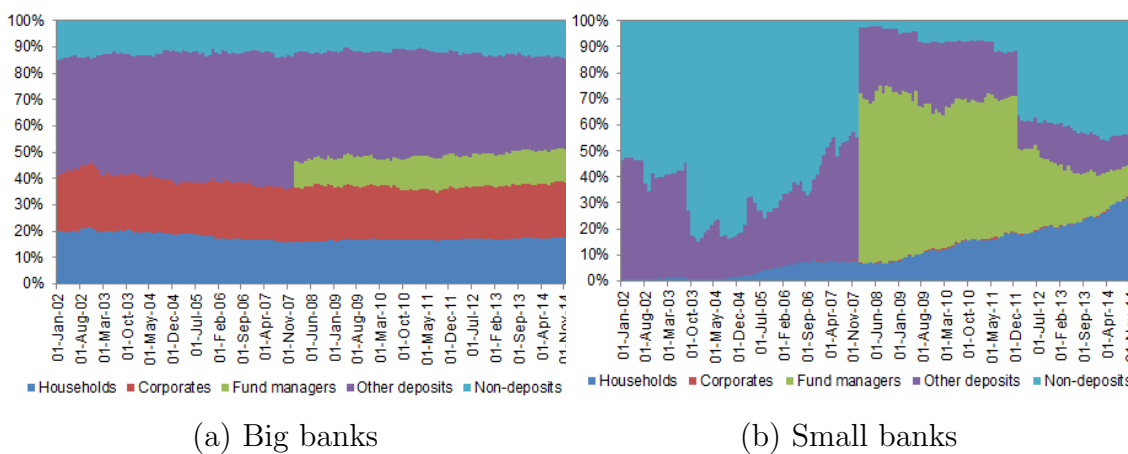
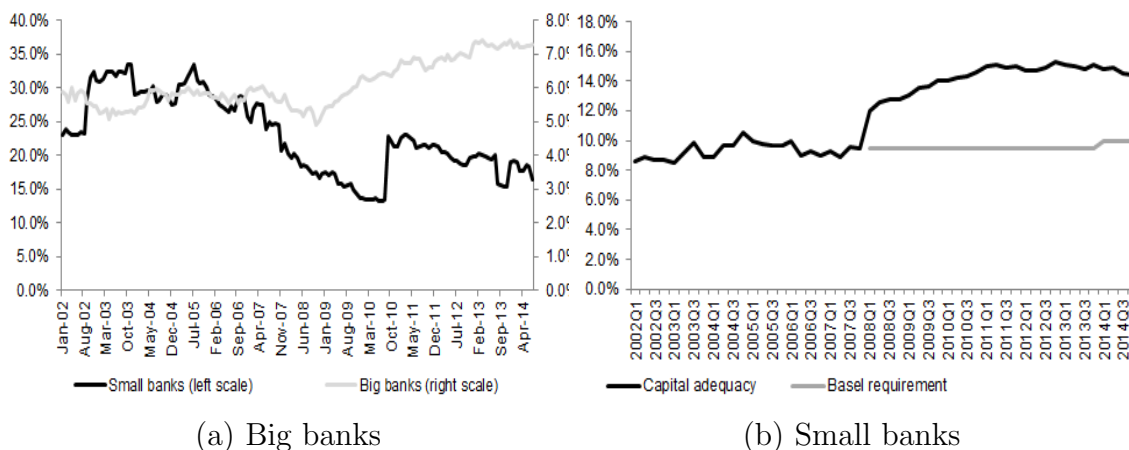


Figure 3.3: Composition of liabilities by bank size



the report suggests that the banks would be able to absorb the credit losses due to their high capital buffers.

Figure 3.4: Non-weighted asset-to-capital ratio



3.2 Theory

The credit channel theory⁸ states that information asymmetry between bank lenders and borrowers create a wedge between the cost a borrower incurs in raising external or 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 help to explain some of the puzzling results that are unexplained by the traditional interest rate channel⁹. 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 et al. (1990) in reference to Bernanke and Blinder (1988), the existence of the lending channel depends on two conditions. The first condition requires perfect substitutability between banks liabilities (transaction deposits and certificates of deposits) and securities issued outside the banking system, like commercial papers. The second condition requires equal reserve requirements on transaction deposits and certificates of deposits. If the second condition does not

⁸Gertler and Gilchrist (1993*b*), Bernanke and Gertler (1995, 1989).

⁹One 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, Bernanke and Gertler (1995).

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.

Both Gertler and Gilchrist (1993*a*) and later Kashyap and Stein (1995) provide empirical evidence for credit market imperfections from the borrowers and the lenders' perspective, respectively. Using data for small and big manufacturers, Gertler and Gilchrist (1993*a*) show that small borrowers are more sensitive to credit market imperfections than large borrowers due to their less diversified balance sheets and smaller collateralised net worth relative to the big borrowers. This then makes it harder for these borrowers to raise non-bank funding. Therefore they either 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 banks. According to the authors, credit market imperfections create cross-sectional differences across different bank sizes after a tight monetary policy shock. 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 arise from the adverse selection problem, advertising or high return to attract investors.

Proving the lending-channel-induced cross-section difference across banks can be summarised as a two-stage process. The first stage of the test is to prove the lending channel. The second stage of the test is to prove that the effects of the lending channel are heterogeneous among 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 must be 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). Alternatively, the net effects at the new loan market equilibrium must result from the loan supply effects, i.e. the loan supply curve must shift inward more than the loan demand curve. These are the arguments of Bernanke and Blinder (1988)'s paper.

For the second stage, there must be evidence that the effects of the lending channel depend on the size 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 consists of loans and securities and the liability side of deposit and non-deposit external funding. Equilibrium in the model is deter-

mined either by assuming a homogeneous loan demand market or a heterogeneous loan demand market ¹⁰. 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 holdings 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 holdings 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: (a) loan demand shocks should not differ across bank sizes; and (b) 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 hold in the heterogeneous equilibrium model.

Lastly, 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 and capital tend to be less responsive to a contractionary monetary policy shock. We will not be looking at these characteristics in this chapter.

3.2.1 Evidence to the theory

The main loan categories used in the literature¹¹ 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 represent two different 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 their risk-return behaviour.

The results for bank loan portfolios by Gertler and Gilchrist (1993*b*) indicate that a rise in the Fed funds rate reduces total bank loans. Closer analysis of the

¹⁰The main difference between the two is that in the heterogeneous market, each bank has its own monopoly power with its customers.

¹¹Amongst others Gertler and Gilchrist (1993*b*) and Den Haan et al. (2007).

disaggregated bank credit indicate that consumer and real estate loans decrease for about eight quarters after the shock while the results for business loans are insignificant. Therefore, they attribute the decline in total loans to consumer and real estate loans. Further analysis of the compositional or cross-section effects indicate that business loans to large firms increase while business loans to the small firms decrease after a contractionary monetary policy shock. They concluded that tight monetary policy fall more on small firms. Den Haan et al. (2007) find similar results for the aggregate loan categories. However, they find that corporate loans increase and are significant within the first year until about the fourth year.

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. The results for securities however provide a weak support for their credit market imperfections story for the small banks. Hosono (2006) finds that total loans for regional (small) banks decline more than of major (big) banks for Japan, thereby concluding that monetary policy fall more on small banks.

With regards 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 the lending channel on bank characteristics between 2000 and 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 more¹². Mishu and Tsegaye (2012) extend Sichei (2005)'s 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 as in Sichei (2005). Similar to Sichei (2005), they also find that the bank specific characteristic (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 find evidence of heterogeneity across different bank sizes, the empirical studies results have some shortcomings. As discussed by Kashyap and Stein (1995), the results for total loans may be driven by the 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

¹²Loan 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.

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 disaggregated quarterly bank loan data for the whole banking sector. The sample period is from the first quarter of 2001 to the 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 monetary 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 are 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 heterogeneity among bank sizes.

3.2.2 Why should bank size matter?

This chapter follows that of Gertler and Gilchrist (1993a) and Kashyap and Stein (1995) in two ways. At the aggregate bank level, we want to test the heterogeneity of loan categories in response 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 disaggregated 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 disaggregated 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 to that of 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, big banks in South Africa hold a slightly less percentage of loans relative to the small

banks. In addition, big banks hold twice (17%) as much securities as the small banks. Therefore, not only are the small banks reliant on one type of loan portfolio, they also do not have a large buffer of stock of liquid assets to sell following a contractionary monetary policy shock. 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 the fact that small banks do not borrow much from the Fed market, the authors argue that this supports their model assumption that small banks find it hard to raise external funding. As already discussed in subsection 3.1.1, the opposite hold in South Africa with the big banks relying more on deposit funding.

Beside these differences in the structure of the banks, 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 depend more 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 in raising external finance either by spending more on advertising 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 investors¹³.

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. The alternative is for the small banks to increase their risk taking in order to increase the loan volume.

Though the chapter does not look at the balance sheet channel, we can deduce some implications about the household sector from the results¹⁴. 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

¹³This assumption can be supported by comparing the behaviour of the deposits by fund managers between the small and the big banks in Figure 3.3. 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.

¹⁴Sichei (2005) also suggest that the condition that there are bank-dependent customers in South Africa generally hold given the structure of the economy.

consumption¹⁵, whereas the middle to high income earners have a wider access to credit options and investments they can utilise during tough economic periods. If consumer loans for the small banks decrease more relative to the big banks, it means that monetary policy fall more on low income earners and small businesses. The second implication follows from the first implication. With limited credit options, we expect small banks to experience credit impairment either sooner or higher than that of the big banks. If this does not hold, it will mean that either 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 low income households. The first reason is not plausible since it implies that low income earners are insensitive to tough economic periods.

3.3 Empirical methodology

3.3.1 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 from 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 study¹⁶. 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, respectively. 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 frequency of the data is monthly. All the data except for the interest rate is in real terms and detrended using the

¹⁵This view ignores other popular sources of credit that are popular amongst low income earners in South Africa, like traditional social clubs known as "stokvels".

¹⁶One bank is excluded from the study as it does not have bank loan in its balance sheet.

Hodrick-Prescott (HP) filter with the smoothing parameter lambda set to 14 400, which is the conventional smoothing parameter for monthly data. As shown in Figure 1.1 in Chapter 1, the growth of the banking sector follows a linear trend. This indicates a change in the mean for the banks' balance sheets during the sample period. Therefore, we remove the trend to make the data stationery. Removing the trend also help us to analyse the effect of monetary policy on the fluctuations of the variables, consistent with the business cycle analysis in chapter 4. The sample period starts from January 2002 and ends in July 2014.

3.3.2 Model estimation

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

$$S_t = f(-t) + \Phi_s \xi_t^s \quad (3.1)$$

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 findings in the literature that banks extend credit to the non-financial corporates 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 chapter 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) meeting¹⁷.

Structural Vector Autoregressive model

The first two empirical questions are estimated using three Bayesian structural VARs models with 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

¹⁷See Christiano et al.(1998).

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 at a disaggregated bank level¹⁸. 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 (3.2) presents the VAR (2) model¹⁹,

$$Y_t = c + B_1 Y_{t-1} + B_2 Y_{t-2} + \nu_t \quad (3.2)$$

where Y_t is a vector of endogenous variables, c is the vector of the intercept terms, matrices B_1 and B_2 contain coefficients for the first and second lags of Y_t and ν_t is the vector of the error terms. The covariance-variance matrix of ν_t is given by equation (3.3) with zero covariances in equation (3.4):

$$E(\nu_t' \nu_s) = \Sigma \text{ for } t = s \quad (3.3)$$

$$E(\nu_t' \nu_s) = 0 \text{ for } t \neq s \quad (3.4)$$

$$E(\nu_t) = 0 \quad (3.5)$$

which can be written in a compact form:

$$Y_t = B X_t + \nu_t \quad (3.6)$$

with $X_t = \{c_i, Y_{it-1}, Y_{it-2}\}$. Equation (3.6) can further be re-written as

$$y = (I_N \otimes X) b + V \quad (3.7)$$

where $y = \text{vec}(Y_t)$, $b = \text{vec}(B)$, and $V = \text{vec}(\nu_t)$. 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

¹⁸Only 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.

¹⁹Please consult chapter 2 in Blake and Mumtaz (2012) and Robertson and Tallman (1999) for extensive explanation of the model, code; and priors.

the VAR covariance matrix (Σ) are given by equation (3.8) and (3.9) respectively,

$$p(b) \sim N(\tilde{b}_0, H) \quad (3.8)$$

$$p(\Sigma) \sim IW(\tilde{S}, \alpha) \quad (3.9)$$

where \tilde{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 \tilde{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 (3.10), where σ_i are the variances of the residuals and λ_0 measures the overall tightness of the prior on the covariance matrix

$$\frac{\sigma_i}{\lambda_0} \quad (3.10)$$

The covariance of the prior (H) is determined using equation (3.11),

$$H = \tilde{S} \otimes \tilde{H} \quad (3.11)$$

with \tilde{H} given by equation (3.12) for the coefficients on lambdas and (3.13) for the constant term.

$$\left(\frac{\lambda_0 \lambda_1}{l^{\lambda_3} \sigma_i}\right)^2 \quad (3.12)$$

$$(\lambda_0 \lambda_4)^2 \quad (3.13)$$

Starting with equation (3.12), 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 (3.11). The parameter λ_1 is the standard deviation of the prior for the ii -th element of the B_1 matrix in equation (3.2). 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 (3.2) are shrunk to zero. Lastly, from equation (3.13), 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. (2007) and others in the literature by assuming that the benchmark specification is that the interest rate does not respond

to other variables contemporaneously. To achieve this, the models are estimated with interest rate ordered first. The structural shocks are recovered by using the Cholesky decomposition of innovations Σ :

$$\Sigma = A_0' A_0 \quad (3.14)$$

where A_0 is a lower triangular matrix. 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 increases 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 $\lambda_4 = 1$.

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 3.2 and 3.3 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-variable 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 (3.2) can be re-written as

$$Y_t = B_{0,t} + B_{1,t}Y_{t-1} + B_{2,t}Y_{t-2} + \nu_t; \text{Var}(\nu_t) = \mu_t \quad (3.15)$$

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 $\text{Var}(\varepsilon_t) = H_t$. The time-varying covariance matrix is factorised as:

$$\mu_t = A_t^{-1}H_t(A_t^{-1})' \quad (3.16)$$

with H_t and A_t defined as:

$$H_t = \begin{bmatrix} h_{1,t} & 0 & 0 \\ 0 & h_{2,t} & 0 \\ 0 & 0 & h_{3,t} \end{bmatrix} \text{ and } A_t = \begin{bmatrix} 1 & 0 & 0 \\ a_{21,t} & 1 & 0 \\ a_{31,t} & a_{32,t} & 1 \end{bmatrix} \quad (3.17)$$

Following Primiceri (2005) and Benati and Mumtaz (2007), let $\beta_t = [B_{0,t}, B_{1,t}, B_{2,t}]$ and $\theta_t = \text{vec}(\beta_t')$. 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:

$$\theta_t = \theta_{t-1} + \omega_t; \text{Var}(\omega_t) = Q \quad (3.18)$$

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

$$\ln h_t = \ln h_{t-1} + \xi_t; \text{Var}(\xi_t) = Z_i \text{ for } i = 1 \dots 3 \quad (3.19)$$

and

$$a_t = a_{t-1} + \eta_t; \text{Var}(\eta_t) = D \quad (3.20)$$

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

$$V = \text{var} \begin{pmatrix} \mu_t \\ \omega_t \\ \eta_t \\ \xi_t \end{pmatrix} \sim N(0, V) \quad (3.21)$$

$$V = \begin{bmatrix} I_3 & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & D & 0 \\ 0 & 0 & 0 & Z \end{bmatrix} \text{ and } Z = \begin{bmatrix} \sigma_1^2 & 0 & 0 \\ 0 & \sigma_2^2 & 0 \\ 0 & 0 & \sigma_3^2 \end{bmatrix} \quad (3.22)$$

The structure of D also follows a block-structure:

$$D = \begin{bmatrix} D_1 & 0_{1 \times 2} \\ 0_{2 \times 1} & D_2 \end{bmatrix} \quad (3.23)$$

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 are $\theta_{0|0} = vec(\theta_0)'$ 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

$$p(Q) \sim IW(Q_0, T_0) \quad (3.24)$$

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 prior for D_1 is an inverse gamma

$$p(D_1) \sim IG(D_{10}, T_0) \quad (3.25)$$

and for D_2 is an inverse Wishart

$$p(D_2) \sim IW(D_{20}, T_0) \quad (3.26)$$

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

$$p(Z) \sim IG(Z_0, \nu_0) \quad (3.27)$$

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 $\tilde{A}_{0,t} = P_t C_t^{1/2}$. Then draw an $N \times N$ matrix K from a $N(0, 1)$ distribution, and take a QR decomposition of K , such that $K = Q \times R$. This leads to a structural impact matrix of $A_{0,t} = \tilde{A}_{0,t} Q'$. 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 draws²⁰. 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 $\ln h_{i,t}$ ²¹.

3.4 Results

3.4.1 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 10 basis points.

Re-visiting the lending channel

Figure 3.5 presents the estimated impulse response functions of the VAR system including interest rate, consumer loans, non-financial corporate loans, real estate loans, inventories and credit impairment to a positive one standard deviation shock to the policy rate. The results are for the aggregated data and therefore serve as benchmark results for the disaggregated bank level results. A one standard deviation in monetary policy results in a contemporaneous 0.25% or 25 basis point increase in interest rate.

The results for consumer loans are insignificant. Real estate loans decline as we would expect. The decline only starts after about 4 months and reaches its peak at -0.25% after 10 months before returning to their original value. Consistent with the literature, corporate loans increase to as high as 0.6% 8 months after the shock.

²⁰The procedure for the simulation of the posterior distribution follows that of Blake and Mumtaz (2012) handbook.

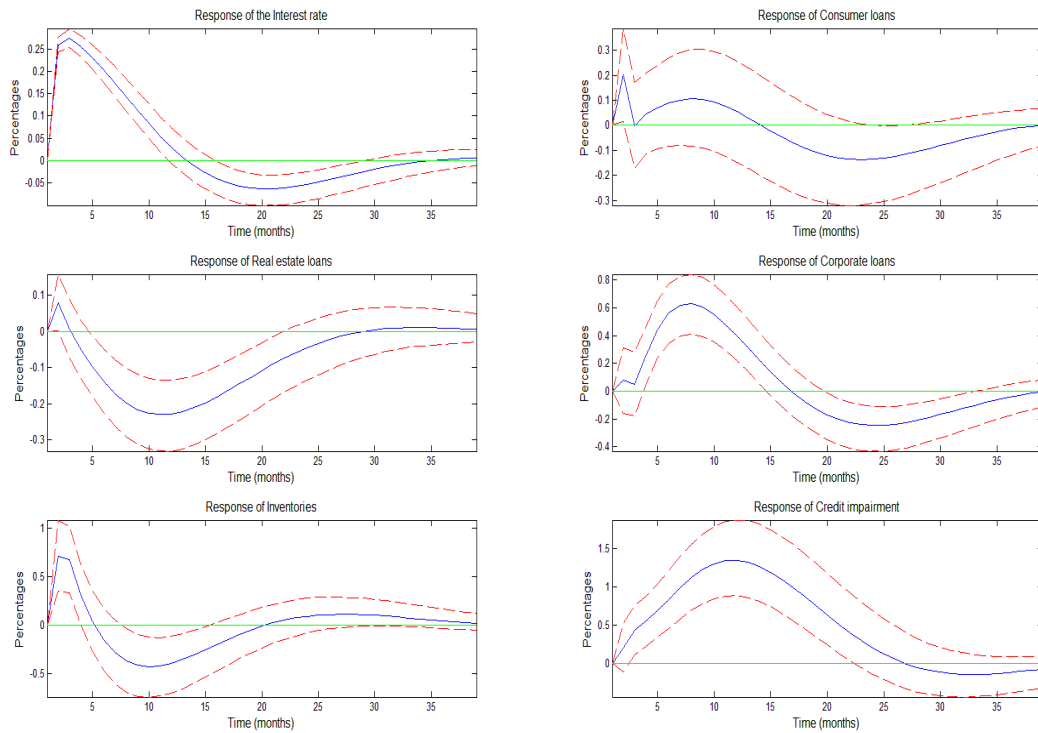
²¹The results failed to converge even after 200 000 iterations.

To contextualise the increase in corporate loans to the developments in the real economy, we also present the results for inventories. The results indicate that the effect of a tight monetary policy on inventories is as expected. Inventories increase in the first 3 months, after which they decrease before returning to their original value. Similar results have been obtained by Bernanke and Gertler (1995). The general view in the literature is that banks extend credit to the business sector to help them fund the increase in inventories due to reduction in demand during high interest rates periods, showing the negative relationship between inventory investment and interest rate. Though the results for corporate loans and inventories are consistent with the literature, the magnitude of the increase in corporate loans indicate that inventories are only part (and not the full reason) of the story²². A possible explanation is that some of the sectors to which credit is extended do not carry inventories. And therefore, during tight money, the corporate loans are used to pay for operational costs.

Lastly, from the bottom right panel, we can see that credit impairment increases and peaks at about 1.5% 12 months after the shock. If we look at the increase in credit impairment taking into consideration the results of the different loan categories, the decrease in real estate loans alone is not 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 loans) following a monetary policy shock. And that banks adjust credit from low risk and long-term assets to short-term assets. The effects seem to be mainly transitory, lasting for less than 20 months for most variables.

²²We looked at the composition of the bank credit to the non-financial corporate sector in 2011Q2-4. The averages of the top 5 sectors to which non-financial corporate credit is extended to are: real estate (6.40%); community, social and personal services (5.48%); manufacturing (4.21%); wholesale and retail trade, hotels and restaurants (3.86%); and mining and quarrying (3.6%) - KPMG report. The majority of these sectors do not carry inventories.

Figure 3.5: Aggregate response of loan categories to a monetary policy shock

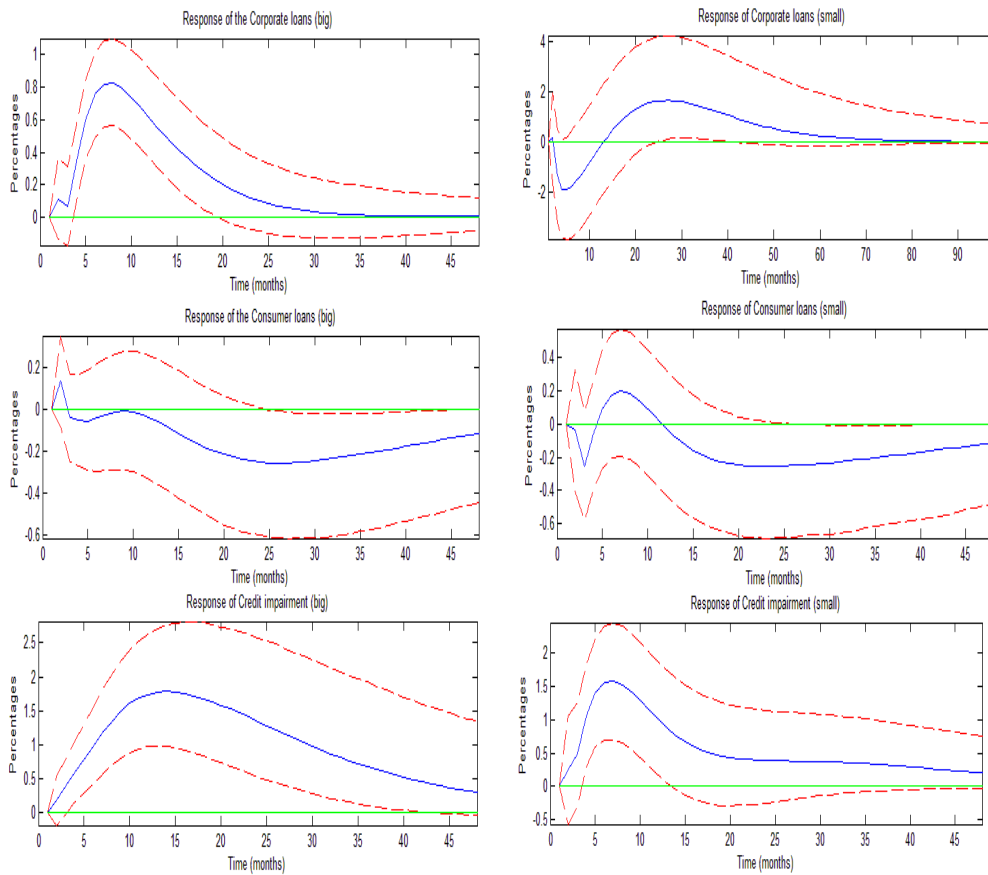


Does bank size matter?

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 (1993b), Den Haan et al. (2007) and Gumata et al. (2013). Now we are interested in determining how the results for 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 disaggregated models. The results are presented in Figure 3.6. 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 effects across bank sizes. The results for big banks are the same as that of the benchmark model. For the small banks, the results for corporate loans are insignificant. For consumer loans, the results are insignificant across all bank sizes. Lastly, credit impairment for both the big and the small banks increase to 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 maximum for the big banks. This indicates that low income earners default quicker

than the middle to high income earners. This can happen if these low income earners are more recession sensitive. The other possible explanation can be that small banks rely heavily on unsecured loans. If most of them are bad loans, then a small monetary policy shock would induce a quicker default. Overall, the results do indicate that analysing monetary policy transmission with disaggregated loan data provide more insight into the behaviour of bank loans after a shock.

Figure 3.6: Disaggregate response of loan categories to a Monetary 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 hypothesis that monetary policy impacts the small banks more than the big banks holds, 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 3.7. 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 and decrease to a little over 3% after 5 months. The results for the big banks remain the same. The results for consumer

loans still remain insignificant across all bank sizes.

Contrary to the literature²³, the results for securities for the big banks show that they firstly increase in the first 2 months, periodically decrease before increasing again and returning to the zero line thereafter. However, the decrease 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 (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.

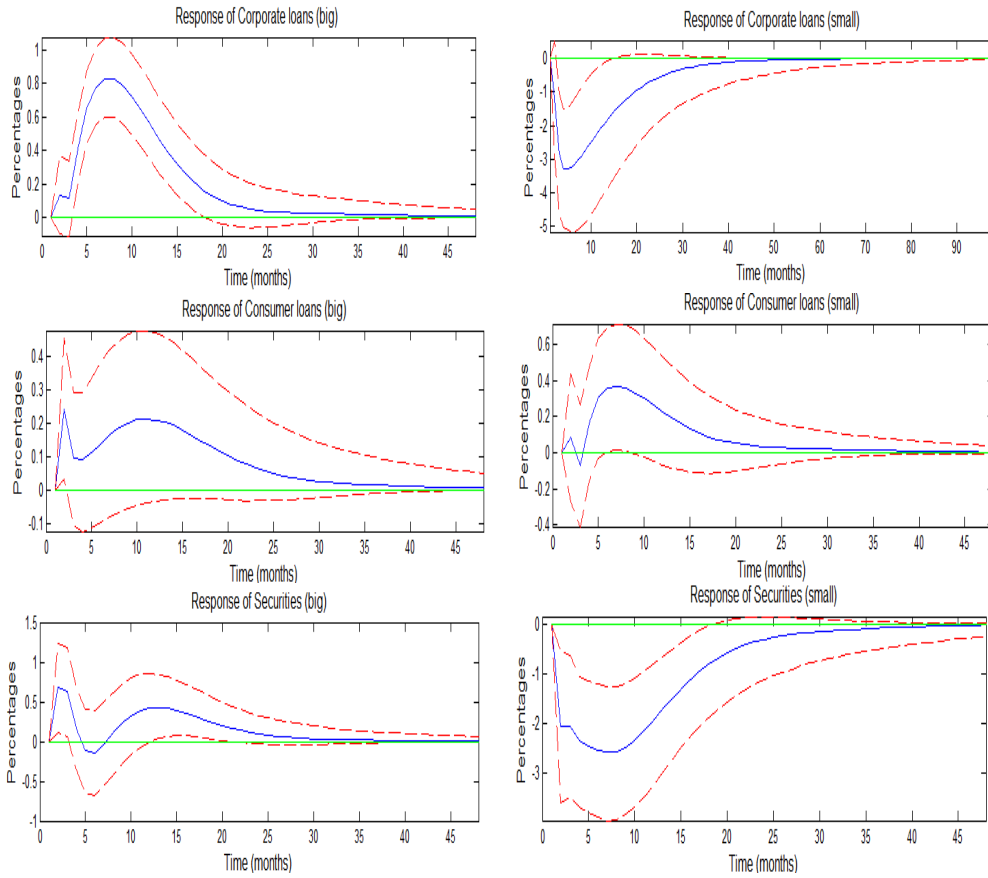
Even though the results for corporate loans for the small banks are sensitive to the model specification, there is some evidence that a tight monetary policy affect the small banks more than the big banks.

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 could indicate that small firms do not carry much inventories and therefore would require less funding than the big firms, Gertler and Gilchrist (1993*a*). 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 companies²⁴.

²³Bernanke and Blinder (1992) and Gertler and Gilchrist (1993*b*) find that securities contemporaneously decrease after a tight monetary policy. More specifically, Kashyap and Stein (1995) also finds similar results for the big banks.

²⁴According 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 3.7: Disaggregate response of loans categories and securities to a Monetary policy shock



3.4.2 Time-varying Vector Autoregressive results

In this section, we estimate the TVP-VAR models by imposing sign restrictions. Following Hristov et al. (2012) 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 3.4.1. Starting with the aggregate models, a contractionary monetary policy shock would contemporaneously reduce real estate loans and increase corporate loans, inventories and credit impairment. For the disaggregated models, the discussed responses of the variables would hold for the big banks given their dominance in the banking sector. In addition, the imposed contemporaneous response for securities is non-negative for the big banks. However, 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 disaggregated 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.

Aggregate TVP-VAR results

Results for stochastic volatility (μ_t)

Figure 3.8 show 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 indicates one interesting feature. From about the last quarter of 2009, interest rate exhibit less volatility than the first years of the remaining sample. The volatility between 2006 and third quarter of 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 6% upper bound of the 3% - 6% target, which was fueled 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 points 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, which is the global financial crisis. It is clear that from the beginning of 2008, the volatility remains elevated, reaching the peak in the start of 2009.

The top panel for Figure 3.8 presents 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 during 2010. However, consumer loans continue to be more volatile between

2012 and 2013, albeit at a smaller level. The similarities are not surprising given that both loans are loans extended to the consumer sector and therefore reflect the volatility of consumers. Surprisingly, real estate loans do not exhibit any volatility post the crisis. The stochastic volatility for corporate loans and inventories in the bottom panel of Figure 3.8 are unclear.

Figure 3.8: Stochastic volatility for the interest rates

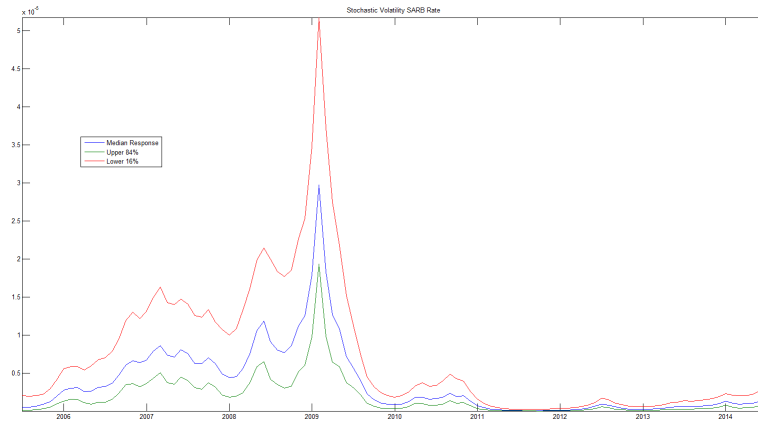
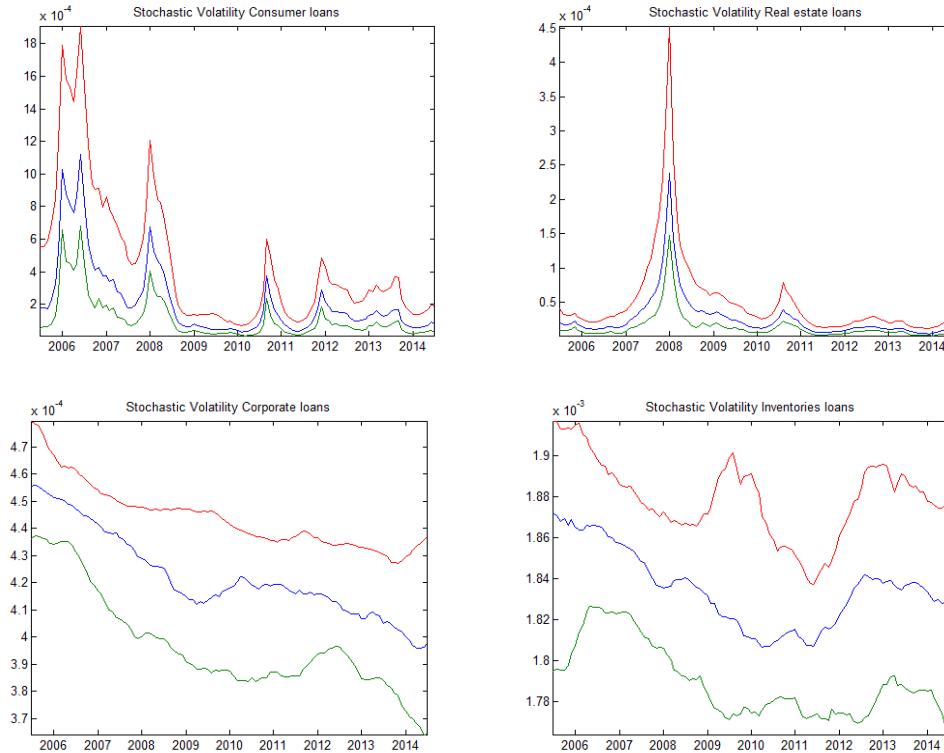


Figure 3.9: Stochastic volatility for the aggregate model

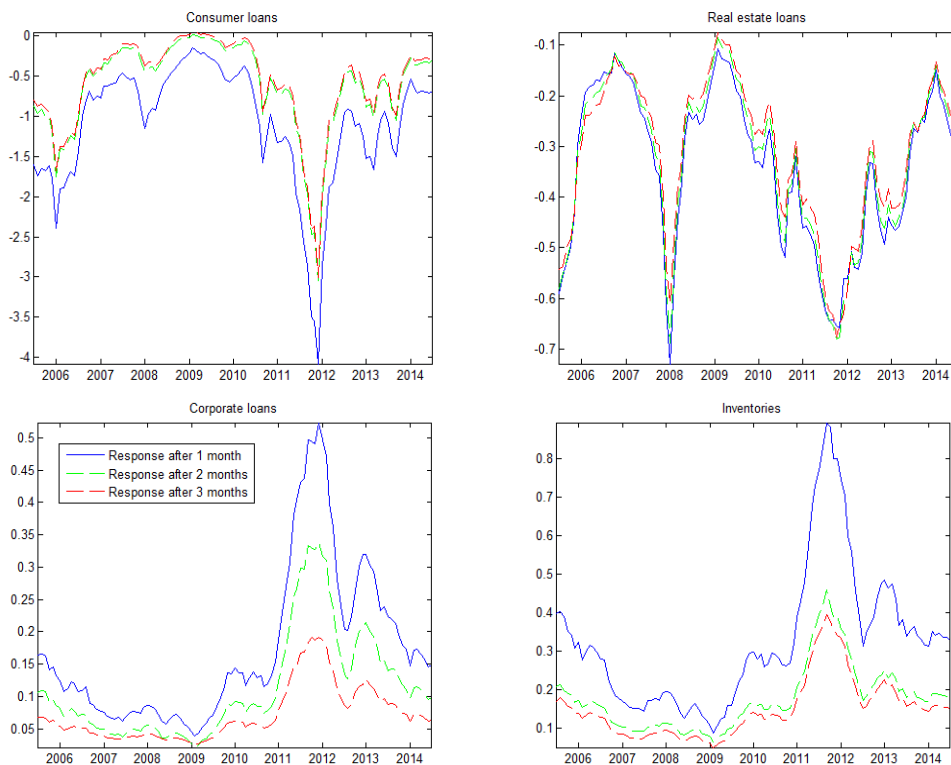


Results for time-varying coefficients (θ_t)

The time-varying changes in the effects of monetary policy shock are presented in

Figure 3.10. The top panel of Figure 3.10 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 2011 spike, whereas real estate loans are more responsive to the 2008 spike. Therefore the results indicate that the real sector was hard-hit by the financial crisis.

Figure 3.10: Time-varying responses for the aggregate model



The bottom panel of Figure 3.10 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. Taken together, it seems that after the crisis, consumer loans became more responsive to tight money which is reflected in an increase in inventories. Banks responded by also increasing lending to help corporates fund their inventories. Therefore the transmission mechanism seems to have become stronger after the crisis.

Disaggregated TVP-VAR results

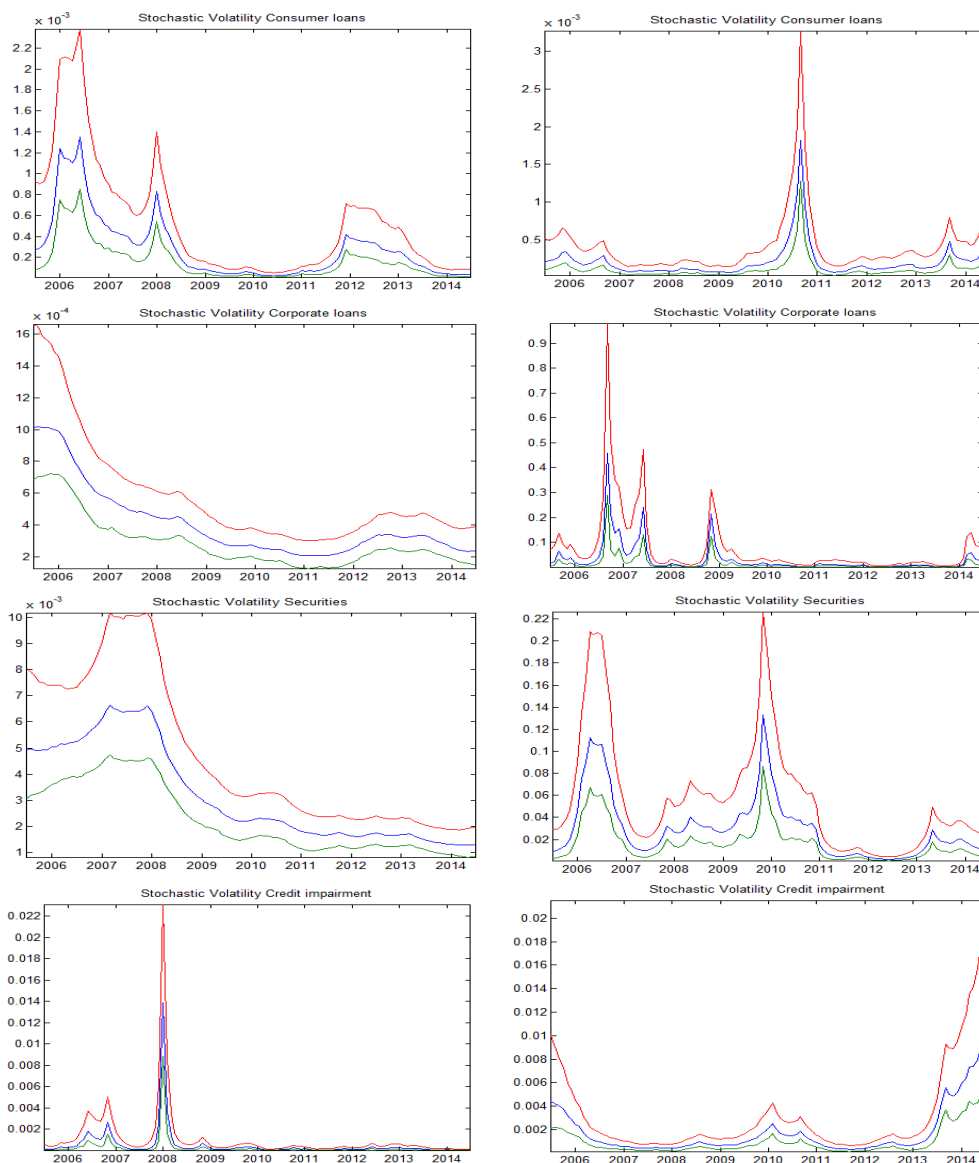
Results for stochastic volatility (μ_t)

Figure 3.11 presents the stochastic volatility results by bank size. Not surprising,

the results for the big banks echoes that of the aggregate model. 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 on the monetary policy tightening cycle. Surprisingly, the volatility for consumer loans for the small banks decreases around the start of the financial crisis and only peaks again towards the 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 3.11: Stochastic volatility for the disaggregate models



Results for time-varying coefficients (θ_t)

Figure 3.12 shows the results for the time-varying coefficients by bank size. Starting with the big banks, 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 spike in credit impairment around 2008 coincide with the big decline in real estate loans from Figure 3.10 as consumer loans were less responsive around the same period. This indicates that the responsiveness of credit impairment can mainly be attributed to real estate loans. This is not surprising since real estate loans averaged 33% of the big banks loan portfolio as indicated in Table 4.1 in Chapter 4. Similarly, between 2009 and 2010, both the real estate loans

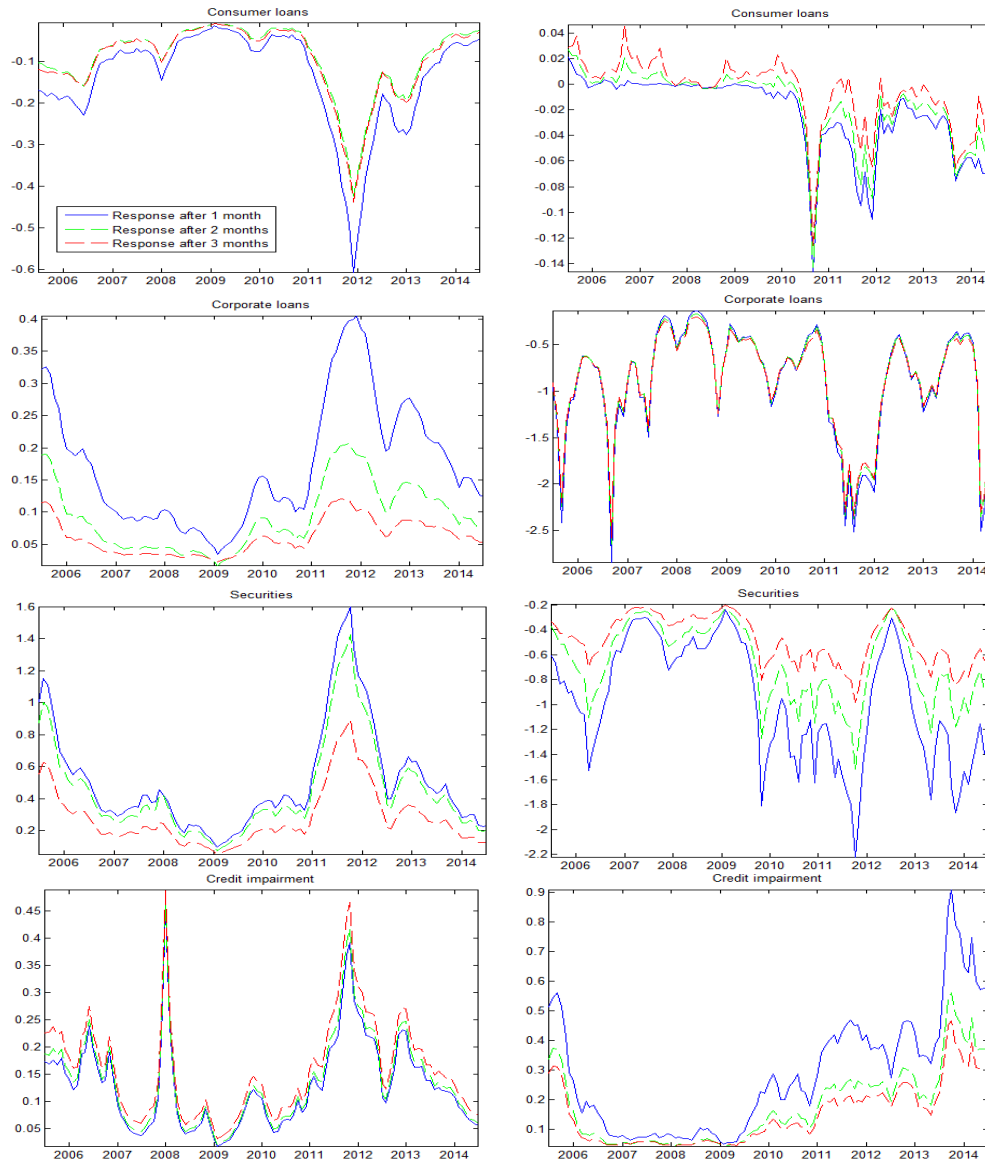
and credit impairment are less responsive before becoming more responsive again thereafter. This highlights the contribution of real estate loans to credit impairment. However, after 2010, consumer loans also become very responsive. Therefore the responsiveness of credit impairment after 2010 can be attributed to both credit and real estate loans, amongst other loan assets that might not be included in our model. The overall results for the big banks tell an interesting story on how banks balance their balance sheets to minimise losses. From the results, we can see that during periods when consumer and real estate loans were underperforming, banks increased their lending to the corporate sector to minimise credit impairment. The results for small banks show that the response of consumer loans is mostly muted until 2010 whilst corporate loans and securities are responsive through most of the period. Overall, the results indicate that the responsiveness of the three variables coincides with the increase in credit impairment from 2009 until the start of 2014.

Contrary to the big banks, the results indicate that when consumer loans were more responsive to a monetary policy shock, the small banks sold off their security holding as a buffer against the increasing credit impairment.

Comparing the results of both the big and the small banks, it is clear that from 2009, both started to experience an increase in credit impairment. However, it appears that while the big banks were able to contain the impairments from 2013, things only got worse for the small banks with credit impairment sky-rocketing between 2013 and 2014. This comparison might indicate better risk-management and benefits of a diversified loan portfolio on the side of the big banks and the opposite for the small banks²⁵.

²⁵Some of the reasons cited in the report on the investigation of the collapse of African bank, one of the small banks in our sample, include aggressive loan growth with reliance on one product, mismatch of loans and funding, and increased reliance on wholesale local and foreign funding, amongst other several reasons.

Figure 3.12: Time-varying responses for the disaggregate models



3.4.3 Robustness checks

In addition to the benchmark specifications reported in the section 3.4.1, we assess the robustness of the benchmark results. We consider the case in which the recursive assumption is not imposed on the monetary policy instrument, i.e., monetary policy authorities respond contemporaneously 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 condi-

tions. This is plausible if the central bank have access to forecasts on housing price index for real estate loan demand; loan application accepted which can also be an indication of expected growth in credit; and other variables like inflation and oil price forecasts that have 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 loans 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 are 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.

3.5 Conclusion

This chapter re-visits the bank lending channel in South Africa to investigate its existence at both the aggregate bank level and disaggregated 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 corporates 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. The 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. They highlight the negative impact of a contractionary monetary policy on small and medium businesses that are solely depended on small banks. They 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.

At the same time, we recognise the limitations of our results. The insignificant of consumer loans across all models and the weakness of corporate loans for small banks limit our analysis of the monetary policy transmission on consumers. Perhaps other model specifications need to be explored. For the TVP-VAR, the non-convergence of the stochastic volatility indicate that either a larger number of iterations are required or that there are some technical data issues that we are currently not aware of.

3.6 Appendix

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
Credit impairments	Credit impairments in respect of loans and advances	194
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 loans	110
Liabilities	Total liabilities	1,41,58&67

Chapter 4

Banking stability and keeping up with the riches

4.1 Introduction

We develop a DSGE model to capture the relationship between a heterogeneous banking sector and a heterogeneous household sector, which we consider a fair representation of the South African financial sector. In particular, we want to capture the peculiarity of the banking sector in South Africa which after the end of the Apartheid regime in 1994 saw an influx of small to medium banks, mainly to serve low-income households or those who were previously financially excluded. These small to medium sized banks have been financed through the interbank market and have repeatedly shown elements of financial instability.

The South African banking sector is characterised by a few big banks and small banks. Whilst most of the big banks have been able to increase their book size over time by acquiring some of the small banks and sustain market share and financial stability, the same cannot be said about the small banks. The influx of small banks between 1994 and 2004 was reversed when these banks faced liquidity pressures, resulting in about 22 banks exiting the banking system between the last quarter of 1999 and first quarter of 2003, Mboweni (2004). Despite the attribution of these failures to the consolidation in the banking system than failure of the small and medium banks (Mboweni (2004) and Hawkins (2003)), small bank failures remain a concern to the financial system¹. This is evident from the recent bank failure by one of the small banks in 2014². Therefore, given such many failures of the small and

¹Some banks were acquired by the big banks, others were left to dissolve while others did not renew their licenses and exited the market, Hawkins (2003).

²Following its last failure in 1995, the bank was placed under curatorship by the South African

medium banks and the stability of the big banks in South Africa, understanding these peculiarities between the two types of banks is important for the central bank and policy makers.

Financial instability is defined by Tsomocos (2003) as a combination of an increase in defaults by households and banks and a decrease in the profitability of the banks. The elements essential for the analysis of financial stability are liquidity, endogenous default and agent heterogeneity, Goodhart et al. (2009). A model of an active heterogeneous banking sector with different loan portfolios is needed for the existence of the interbank market and a contagious financial crisis, whereas endogenous default and incomplete financial markets are required for the possibility of a financial crisis, Goodhart et al. (2004). A supervisory authority is also required to restore financial stability in the model by imposing penalties to defaulters, De Walque et al. (2010).

Using these elements, several papers have developed DSGE models to analyse financial stability. Starting with Goodhart et al. (2006), the authors develop a partial-microfounded general equilibrium model. The model includes a heterogeneous banking (net borrowers and a net lender in the interbank market) and household (borrowers and a depositor) sectors, a central bank and a regulator with endogenous default. Tabak et al. (2013) and Saade et al. (2007) simulate Goodhart et al. (2006)'s model for Brazil and Colombia respectively. In their papers, banking heterogeneity is based on ownership (private, public or foreign) in Tabak et al. (2013), whereas in Saade et al. (2007), the banking sector is divided into mortgage banks, domestic banks and foreign banks.

De Walque et al. (2010) develop a DSGE model with a heterogeneous banking sector consisting of a deposit bank and a merchant bank, a firm, a household who owns the firm and the banks, a banking supervisor and a central bank with endogenous default, liquidity and bank regulation. The authors find that a positive productivity shock in the presence of endogenous default increases the repayment rate of both the firm and the borrowing bank, and amplifies the effects of the shock. However, one of the main limitations of the model discussed by the authors is treating liquidity injections as a commodity and ignoring the issue of inflation. Furthermore, the authors suggest the New-Keynesian approach to address this limitation. Lastly, Goodhart et al. (2009) develop a New-Keynesian DSGE model which includes liquidity, endogenous default and agent heterogeneity. This model addresses the liquidity limitation raised by De Walque et al. (2010). The model consists of

Reserve Bank Registrar of Banks and the Minister of Finance on August 2014. According to the SARB (2016), the concerns that were raised over the bank include liquidity issues, high loan impairments and rapid credit growth, and a rather unsustainable business model.

two heterogeneous households and two heterogeneous commercial banks. However, one of the households is treated as a farmer, collapsing the household sector to a firm (a simplified production sector) and a household. Furthermore, the model does not include the role of the supervisory authority to restore financial stability. Contrary to De Walque et al. (2010), the authors find that endogenous defaults in the financial system create short to medium-run adverse effect on the banks' profitability and firm's repayment rate following a positive productivity shock.

Although the above mentioned DSGE models incorporate the elements required for financial stability analysis, they do not have a heterogeneous household sector required in our model. Household heterogeneity is important in analysing the welfare effects of exogenous shocks as shocks might have asymmetric effects depending on which part of the economy gets affected by the shock, Goodhart et al. (2009). Other DSGE models, such as those of Soler and Estrada (2010) and Gerali et al. (2010) do have heterogeneous household sectors. However, they lack the heterogeneous banking sector. Klein and Krause (2014) develop a DSGE model with household heterogeneity and a firm to analyse the relation between consumer credit and real economic activity during the great moderation. The workers demand credit for their consumption, which they measure relative to that of the investors' consumption level. The authors incorporation of the relative consumption motive, which they term as *"keeping up with the riches"*, allow their model to produce positive correlation between consumption, labour and credit, and a negative correlation between wages and credit. However, their model does not include a financial system, and therefore there is no analysis on banking (in) stability.

All of the above mentioned papers do not have models that characterise the South African banking sector and economy well and to help us achieve our research objective. Therefore, we see the opportunity to develop such a model. To do so, we follow the model by De Walque et al. (2010). Our aim is to develop a DSGE model of financial stability with a heterogeneous banking sector and a heterogeneous household sector. In our model, the heterogeneity of the banking sector is motivated by the structure of the banking sector in South Africa, which has enabled the existence of the big and the small banks serving the high-income and low-income households respectively. The two types of banks have different bank loan portfolios and enjoy monopolistic power in their respective markets. We depart from the De Walque et al. (2010) model by assuming household heterogeneity. In this regard, we follow Klein and Krause (2014)'s household structure which characterise the high inequality amongst the South African population that is divided between the have-nots (low-income) and the haves (high-income). Lastly, as in Goodhart et al. (2004),

we assume limited participation in both the deposit and the loan market. Therefore, high-income households only deposit their funds into the big banks whereas the low-income households only borrow from the small banks.

The literature on the stability of the banking sector in South Africa has either focused on evaluating bank performance using financial ratios (Kumbirai and Webb (2010)) or stress testing analysis (Falkena et al. (2004) and Havrylchyk (2010)). This chapter contributes to the South African literature in understanding financial stability in the context of both the South African financial system structure and demographic dynamics. We calibrate the model using South African data - the banks' balance sheets and real economic data.

Notwithstanding its ability to reproduce some of the real business cycle moments, this model provides a starting point for modeling a DSGE model suitable for analysing financial stability dynamics in the South African banking sector. Firstly, we look at the effects of introducing endogenous defaults in the model. Overall, the results indicate that endogenous default rates for both the small banks and the low-income households cause some financial instability by increasing the overall risk (non-performing loans) in the financial system. These results highlight the findings by Goodhart et al. (2009). The authors also find that in the presence of endogenous defaults for both banks and households, a positive technology shock has a negative effect on financial stability in the short run. Secondly, we look at the effects of liquidity injection in the absence and the presence of the relative consumption motive. We find that the inclusion of the relative consumption motive does not affect any of the variables, except the loan demand by the low-income households. Lastly, we investigate the effects of a negative market book shock on both the small and the big banks. We find that the effects of small banking crises on macroeconomic variables and low-income households' welfare are only short-lived, whereas the big banks seem to have a longer impact. Therefore, central bank intervention is important to prevent any bank crisis, big or small. However, it is very important to ensure the financial stability of the domestically important banks as they pose higher risk to the economy and the banking sector.

The rest of the chapter is as follows: Sub-section 4.1.1 provides an overview of the South African banking sector. Section 4.2 describes the characteristic of the DSGE model, in section 4.4 and 4.5 we discuss the simulations and calibration results while section 4.6 concludes.

4.1.1 Why banking heterogeneity?

The banking sector in South Africa can be divided into small banks and big banks. This bank size is based on the market share of the locally controlled South African banks. There is also high concentration in the banking sector, which has been prevalent for years. The big four banks have enjoyed a market share of 83.8%, 87.4% and 84.1% of total banking assets during 1994, 2006 and 2011 respectively. The heterogeneity of the banks is based on the difference in the composition of the balance sheets between the small and the big banks.

Table 4.1 shows the averages of selected balance sheet variables during the period 2002Q1 and 2014Q3. On the liability side, the table indicates that the big banks have a higher reliance on deposits for funding than the small banks, averaging 88% over the period for the big banks and 58% for the small banks. This is different to the US (Japan) where small banks (regional banks) have similar percentages of deposits to total liabilities as that of the South African big banks. We can also see that small banks rely more on fund managers than the big banks, whereas corporates prefer to put their deposits in the big banks. The asset side shows that small banks rely heavily on the loans and advances, which averaged 90% of total assets. Overdrafts, loans and advances averaged 82% of the total loans, indicating a non-diversified loan portfolio. For the big banks, loans and advances averaged 76% of total assets, and the balance sheet indicates a well-diversified loan portfolio.

Table 4.1: Summary of the banks' balance sheets

	Small banks	Big banks
Number of banks	2	4
Mean of assets (R millions)	R403	R25 253
Median of assets (R millions)	R232	R28 822
Total loans (% of total assets)	90%	76%
Real estate loans	0%	33%
Overdrafts	82%	18%
Instalments	1%	10%
Other credit	5%	16%
Other assets (% of total assets)	10%	24%
Total deposits (% of total liabilities)	58%	88%
Households	10%	18%
Corporates	0%	21%
Fund managers	23%	6%
Other deposits	25%	43%
Other liabilities (% of total liabilities)	42%	12%

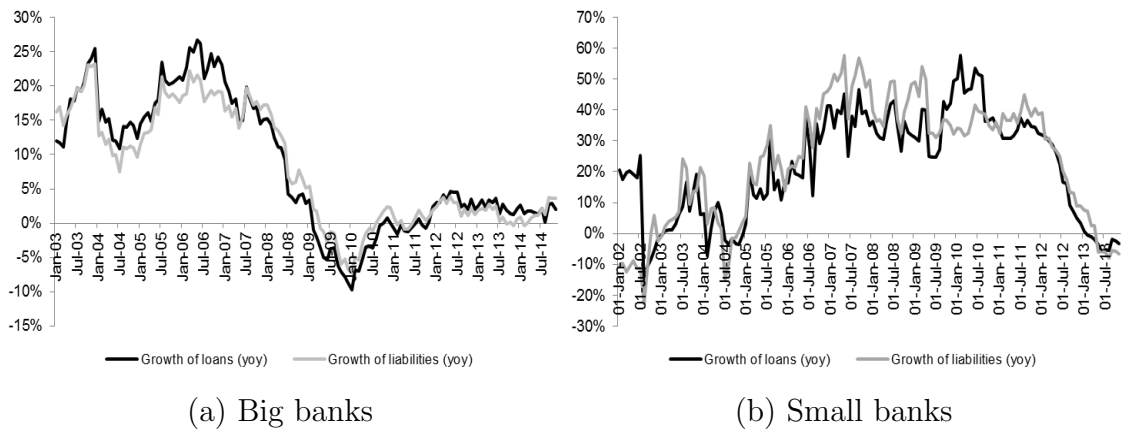
Notes: This table shows selected elements of the banks' balance sheet. All the data is in real terms and detrended.

Figure 4.1 presents the year-on-year growth of assets and liabilities between 2002Q1 and 2014Q3 by bank sizes. From Figure 4.1 (a), we can see that there is a positive co-movement between the liabilities and loans and advances. The effect of the 2008 financial crisis is also evident, with a sharp decrease in both loans and advances and liabilities. We can see that between mid-2008 and mid-2011, the growth rate of liabilities is greater than that of loans. And the figure also shows that the growth rates post the crisis have been lower than the pre-crisis levels. Contrary to the big banks, Figure 4.1 (b) shows that from 2004, there was an upward trend in both liabilities and loans and advances, even during the financial crisis. However, from mid-2011 (around the same time as the recovery by the big banks), there was a negative trend in both liabilities and loans and advances, which eventually led to a collapse of one of the small banks in South Africa.

Figure 4.2 (a) shows the profitability of the banks between 2002Q1 and 2014Q3. We can see that the profitability of the banks decreased after June 2008 to June 2011, highlighting the effects of the 2008 financial crisis on the banking sector. Figure 4.1 (b) shows the delinquency ratio, which is calculated as the ratio of loan impairments to total loans and advances by bank size. The darker-shaded area indicates the time around the 2008 financial crisis whereas the light-shaded area indicates the time around the local banking "crises". The darker-shaded area shows

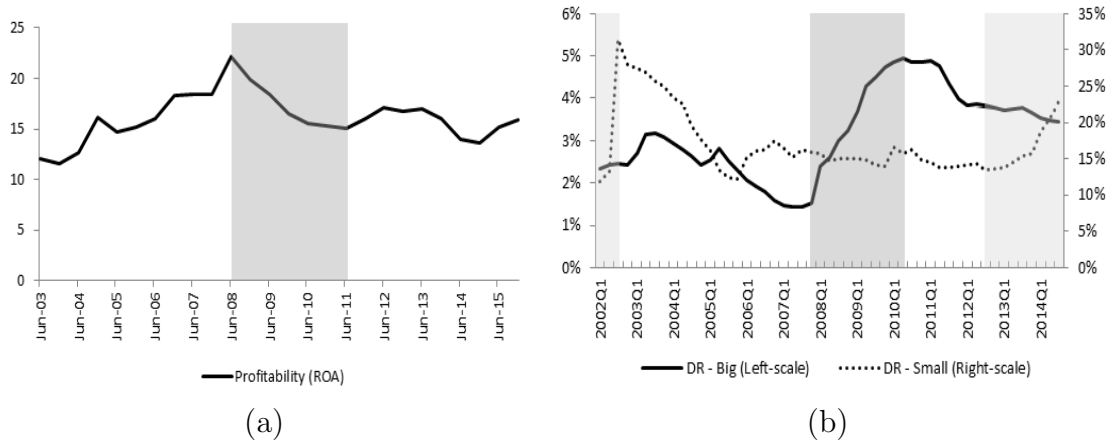
that non-performing loans started to increase from late 2007, reaching its peak during the first half of 2010 before stabilising and then declining for the big banks. The effect of the crisis on the small banks' non-performing loans is muted, with only a slight increase during the last quarter of 2009. Contrary, we can see a sharp increase in non-performing loans for the small banks during both cases of the local banking “*crises*”. This indicates that big banks do not seem to be much affected by local “*crises*”, whereas small banks are more susceptible to it. This is no surprise since these crises emanated from the small to medium size banking sector. The dynamics of the two types of banks raise important questions for both researchers and regulatory authorities.

Figure 4.1: Assets and Liabilities (year-on-year growth)



Note: Figure 4.1 (a) show the year-on-year growth of liabilities and assets for the big banks. Figure 4.1 (b) show the year-on-year growth of liabilities and assets for the small banks.

Figure 4.2: Profitability and Non-performing loans



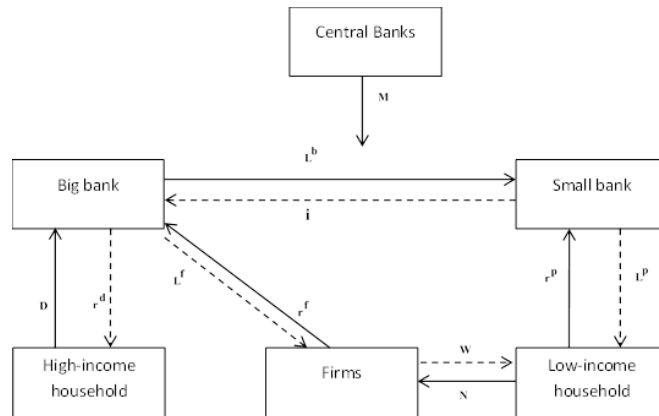
Note: Figure 4.2 (a) shows the return on assets (profitability) of the banks. Figure 4.2 (b) shows the ratios of loan impairments for the big banks (left-hand scale) and loan impairments for the small banks (right-hand scale) to their respective total loans and advances - Delinquency Ratio (DR). *Source:* South African Reserve Bank FSR (ROA) and authors' calculation from the SARB Banks Balance sheets

4.2 Model

Figure 4.3 provides the schematic representation of the model. We populate our model with the following agents: two households (low-income and high-income household), the representative firm, two banks (small and big bank), the central bank and the supervisory authority. The low-income household works for the firm and earns their wage. The low-income household also borrows from the small bank to smooth consumption due to credit market imperfections in the big bank's market. The high-income household owns the firm and the small and big banks. This household also deposits their savings into the big bank, which is assumed to be less risky than the small bank, and earn interest on their deposits. The representative firm hires labour from the low-income household. New investments by the firm are funded by new borrowing from the big bank. The banking sector is assumed to be heterogeneous, consisting of the more secure big bank and riskier small bank. These two types of banks enjoy monopolistic power in their respective markets. The big bank converts loans from the high-income household into business loans to the firm and lend to the small bank in the interbank market. Contrary to De Walque et al. (2010), we assume that the high-income household, the firm and the banks are not distinct from each other. Therefore there are dividend payments to the high-income household and all profits by the firm and the banks are either payed out or used for the next period's funding.

We follow the literature on financial stability by incorporating financial frictions, loan defaults and liquidity. As in Goodhart et al. (2009), loan defaults arise in equilibrium as agents decide how much of their loans they will pay back. Similarly to De Walque et al. (2010), we assume that the big bank cannot default on its obligations to the high-income household. We assume that the small bank and the low-income household can default on their obligations. This means that a low-income household default may lead to the small bank default on the interbank market, which in turn curtails business financing to the firm through the big bank and creates a reduction in output. For each agent defaulting on their obligation, the cost of default is given by a penalty that reduces both their utility and their ability to borrow. Liquidity is injected into the economy by the central bank through the interbank market. The big bank has excess liquidity whereas the small bank is short of liquidity. Therefore, the small bank borrows in the interbank market to be able to lend to the low-income households. The central bank intervenes in the interbank market through liquidity injections or withdrawals, thereby influencing the interbank rate and restoring financial stability. We also incorporate a supervisory authority to administer the fund requirements for the banks.

Figure 4.3: Nominal flow between agents



4.2.1 Firms

The firm is owned by the high-income household, to whom the firm pays for capital (K_t). The firm hires labour (N_t) from the low-income household and pays wages (W_t). It chooses new loan borrowing (L_t^f) from the big bank at the price $1/(1+r_t^f)$ to fund new capital investment. The firm also chooses the amount to repay on the previous loan (α_t) to maximise the discounted sum of all the expected payoffs (π_f). The firm incurs both monetary and non-monetary costs for defaulting on a loan. Non-monetary cost (d_f) represent reputation losses while monetary cost (ω_f)

represent higher search cost to obtain a new loan because of bad reputation. Only the latter affect the firm's profit. The firm produces output (Y_t) using labour and capital according to the Cobb-Douglas function, where (u) is the share of capital and ($1 - u$) is the share of labour:

$$Y_t = \varepsilon_t K_t^u N_t^{1-u} \quad (4.1)$$

and ε_t is the total factor productivity, which is given by:

$$\varepsilon_t = (\varepsilon_{t-1})^{\rho_\varepsilon} \exp(\mu_t^\varepsilon) \quad (4.2)$$

The firm's maximisation programme is:

$$\max_{N_t, L_t^f, K_t, \alpha_t, \pi_t^f} \sum_{s=0}^{\infty} E_t \{ \beta_f^s [\pi_{t+s}^f - d_f(1 - \alpha_{t+s})] \} \quad (4.3)$$

subject to the following constraints:

$$K_t = (1 - \tau)K_{t-1} + \frac{L_t^f}{1 + r_t^f} \quad (4.4)$$

where τ is the capital depreciation rate.

$$\pi_t^f = \varepsilon_t K_t^u N_t^{1-u} - W_t N_t - \alpha_t L_{t-1}^f - \frac{\omega_f}{2} [(1 - \alpha_{t-1}) L_{t-2}^f]^2 \quad (4.5)$$

Equation (4.4) is the equation of motion for capital. The equation shows that current capital investment equals the non-depreciated capital from the previous capital stock and new loan borrowing. Equation (4.5) defines the profit for the firm. Profits equals output less wages to the workers, loan repayment and default cost. The maximisation of the objective function (4.3) subject to budget constraints (4.4) and (4.5) yields the following first order conditions:

$$(1 - u)\varepsilon_t K_t^u N_t^{-u} = W_t \quad (4.6)$$

$$u\varepsilon_t K_t^{u-1} N_t^{1-u} = \lambda_t^f - E_t[\beta_f \lambda_{t+1}^f (1 - \tau)] \quad (4.7)$$

$$\frac{\lambda_t^f}{1 + r_t^f} = E_t[\beta_f \alpha_{t+1} + \beta_f^2 \omega_f (1 - \alpha_{t+1})^2 L_t^f] \quad (4.8)$$

$$L_{t-1}^f = \beta_f \omega_f (1 - \alpha_t) L_{t-1}^f + d_f \quad (4.9)$$

Equation (4.6) equates the marginal product of labour to wages. Equation (4.7) equates the marginal product of capital to its shadow price today, λ_t , less the discounted shadow price of tomorrow, λ_{t+1} . Loan demand by the firm is defined by equation (4.8), which states that the shadow price of capital is equal to the discounted expected total cost, part of it paid tomorrow based on the decided payment rate and the remaining cost (monetary cost for defaulting) paid in two periods time. Lastly, equation (4.9) equates the marginal cost of paying back the loan today to the discounted marginal search cost of tomorrow plus the marginal disutility cost.

4.2.2 Households

Low-income households

The low-income household works for the firm and earn wages for their labour. They borrow loans (L_t^p) from the small bank at the price of $1/(1 + r_t^p)$ to smooth their consumptions (C_t^p). We assume that the low-income household measures their consumption relative to the high-income household. The low-income household derives utility from own consumption (C_t^p) and disutility from working (N_t^p), defaulting on previous loan (d_p) and consumption of the high-income household (C_t^r). The parameter ϱ is the jealousy parameter, which measures how much the low-income household wants to keep up with the high-income household. The parameter ϕ_p is the leisure relative preference parameter. The objective function of the low-income household is:

$$\max_{C_t^p, L_t^p, N_t^p, \eta_t} \sum_{s=0}^{\infty} E_t \{ \beta_p^s [\ln(C_{t+s}^p - \varrho \frac{C_t^r}{C_t^p}) + \phi_p \ln(1 - N_t^p) - d_p(1 - \eta_{t+s})] \} \quad (4.10)$$

subject to the following constraint:

$$C_t^p + \eta_t L_{t-1}^p + \frac{\gamma_p}{2} [(1 - \eta_{t-1}) L_{t-2}^p]^2 = W_t N_t^p + \frac{L_t^p}{1 + r_t^p} \quad (4.11)$$

Equation (4.11) equates current expenses, which include consumption and loan repayments, of the low-income household to the current wages and loan borrowing. The maximisation of the objective function (4.10) subject to the budget constraint

(4.11) yields the first order conditions:

$$\frac{1 + \varrho \frac{C_t^r}{(C_t^p)^2}}{C_t^p - \varrho \frac{C_t^r}{C_t^p}} = \lambda_t^p \quad (4.12)$$

$$\frac{\lambda_t^p}{(1 + r_t^p)} = E_t[\beta_p \lambda_{t+1}^p \eta_{t+1} + \beta_p^2 \lambda_{t+2}^p \gamma_p (1 - \eta_{t+1})^2 L_t^p] \quad (4.13)$$

$$\lambda_t^p L_{t-1}^p = E_t[\beta_p \gamma_p (1 - \eta_t) (L_{t-1}^p)^2 \lambda_{t+1}^p] + d_p \quad (4.14)$$

$$\frac{\phi_p}{1 - N_t^p} = \lambda_t^p W_t \quad (4.15)$$

Equation (4.13) defines the loan demand by the low-income household, which equates the shadow price of low-income loans to its discounted expected costs paid today and in two period time. Equation (4.14) equates the marginal cost of paying the loan today to the marginal cost of paying tomorrow. Lastly, substituting equation (4.12) into (4.15) yields the marginal rate of substitution between consumption and leisure to the opportunity cost of an additional unit of leisure.

High-income households

The high-income household owns the firm and the banks. They derive utility from their consumption (C_t^r) and disutility ($\chi/2$) for holding a quantity of deposit different from the steady state level (\bar{D}_r). They maximise the following utility function:

$$\max_{C_t^r, D_t^r} \sum_{s=0}^{\infty} E_t \left\{ \beta_r^s \left[\ln(C_{t+s}^r) - \frac{\chi}{2} \left(\frac{D_{t+s}^r}{1 + r_{t+s}^r} - \frac{\bar{D}_r}{1 + r^r} \right)^2 \right] \right\} \quad (4.16)$$

subject to the budget constraint:

$$T_t + C_t^r + \frac{D_t^r}{(1 + r_t^r)} = D_{t-1}^r + (1 - \nu_b) \pi_{t-1}^b + (1 - \nu_z) \pi_{t-1}^z + (1 - \nu_f) \pi_{t-1}^f \quad (4.17)$$

Equation (4.17) equates tax transfers (T_t), consumption (C_t^p) and deposits (D_t) to deposit repayments from the big banks and dividend payments from the banks and the firm. The maximisation of the objective function (4.16) subject to the budget constraint (4.17) yields the following first order conditions:

$$\frac{1}{C_t^r} = \lambda_t^r \quad (4.18)$$

$$\frac{1}{C_t^r} \frac{1}{1+r_t^r} = \beta_r \frac{1}{C_{t+1}^r} - \chi \left(\frac{D_t^r}{1+r_t^r} - \frac{\bar{D}^r}{1+r^r} \right) \quad (4.19)$$

Equation (4.19) is the Euler equation for the rich households adjusted with the marginal cost of deviating from the deposit target.

4.2.3 Banks

Big banks

The big bank operates in a monopolistic market and can be likened to a deposit bank in De Walque et al. (2010) and Carrera and Vega (2012) papers. Unlike in the above mentioned papers where these type of banks only collect deposits and lend in the interbank market, the big bank also lends to the firm. Table 4.2 represents the balance sheet of the representative big bank. On the liabilities side, the bank collects deposits (D_t) from the high-income household at the deposit rate (r_t^d) determined by the bank. The assets side indicate that the bank lends to firms (L_t^f) at the lending rate $1/(1+r_t^f)$ and to the small bank (L_t^b) in the interbank market at the interbank rate $1/(1+i_t)$.

Table 4.2: Balance Sheet of the Big Banks

Assets	Liabilities
Commercial loans (L_t^f)	Deposits (D_t)
Interbank loans (L_t^b)	Equity (F_t^b)

We follow the maximisation strategy of De Walque et al. (2010). Over and above its profit, the bank also enjoys utility d_F^b from keeping funds above the capital requirement by the supervisory authority. The parameter κ is a fixed coverage ratio of risky assets, and \hat{w}_t^z and w_t^f are the weights on the interbank loans and firm loans respectively. Therefore the big bank chooses D_t^r , L_t^b and F_t^b to maximise the sum of its expected payoffs:

$$\max_{B_t^b, \pi_t^b, D_t^r, L_t^b, F_t^b} \sum_{s=0}^{\infty} E_t \{ \beta_b^s [\ln \pi_{t+s}^b + d_F^b (F_{t+s}^b - \kappa (\hat{w}_t^z L_t^b + w_t^z L_t^f + w_t^b B_t^b))] \} \quad (4.20)$$

subject to the following constraints:

$$F_t^b = (1 - \xi_b) F_{t-1}^b + \nu_b \pi_{t-1}^b \quad (4.21)$$

$$\pi_t^b = \delta L_{t-1}^b - \frac{L_t^b}{1+i_t} + \alpha_t L_{t-1}^f - \frac{L_t^f}{1+r_t^f} + \frac{D_t^r}{1+r_t^r} - D_{t-1} + \zeta_b(1 - \delta_{t-1})L_{t-2}^b + \zeta_{bf}(1 - \alpha_{t-1})L_{t-2}^f + (1 + \rho_t)B_{t-1}^b + B_t^b \quad (4.22)$$

Equation (4.21) states that the bank accumulates its current funds from the share $(1 - \xi_b)$ of previous funds F_{t-1}^b and the share ν_b of previous profit π_{t-1}^b not distributed into the insurance scheme to the supervisory authority or for dividend payments. This equation allows a feedback loop between the real economy and the financial sector, Gerali et al. (2010). Equation (4.22) defines the bank's profit. Parameters ζ_b and ζ_{bf} represent the fraction of defaulted loans that the big bank recovers from the insurance scheme, with $\zeta_b, \zeta_{bf}, \nu_b$ and $\xi_b \in [0, 1]$.

The maximisation of the objective function (4.20) subject to the budget constraints (4.21) and (4.22) yields the first order conditions:

$$\frac{\lambda_t^b}{1 + r_t^r} = \beta_b \lambda_{t+1}^b \quad (4.23)$$

$$\frac{\lambda_t^b}{1 + i_t} = E_t[\beta_b^2 \lambda_{t+2}^b \zeta_b(1 - \delta_{t+1}) + \beta_b \lambda_{t+1}^b \delta_{t+1}] - d_F^b \kappa \hat{w}_t^z \quad (4.24)$$

$$\frac{\lambda_t^b}{(1 + r_t^f)} = E_t[\beta_b \lambda_{t+1}^b \alpha_{t+1} + \beta_b^2 \lambda_{t+2}^b \zeta_{bf}(1 - \alpha_{t+1})] - d_F^b \kappa w_t^f \quad (4.25)$$

$$d_F^b \nu_b = (\lambda_t^b - \frac{1}{\pi_t^b}) - E_t[\beta_b(1 - \xi_b)(\lambda_{t+1}^b - \frac{1}{\pi_{t+1}^b})] \quad (4.26)$$

Equation (4.23) is the Euler equation for the deposit from the high-income household. Equation (4.24) defines the supply of interbank lending to the interbank market. The equation equates the marginal cost of interbank lending to the discounted expected payments by the small bank less the marginal cost of capital regulation. Similarly, equation (4.25) defines the supply of loans to the firm.

Small banks

The small bank borrows from the big bank in the interbank market and provides household loans (L_t^p) at the lending rate $1/(1 + r_t^p)$ to the low-income household. Similarly to the big bank, we assume that the small bank enjoys a linear utility d_F^z for having funds over and above the minimum requirement. And as with the firm and the low-income household, the small bank also faces a non-monetary cost d_z and search costs ω_z for defaulting on its interbank loan with the big bank. The

parameter κ is a fixed coverage ratio of risky assets. The parameters \bar{w}_t^p and w_t^z are the weights on the loans to the low-income household and book value, respectively. Equation (4.29) defines the bank's profit. The parameter ζ_p represent the fraction of defaulted loans that the small bank recovers from the insurance scheme, with ζ_p , ν_p and $\xi_p \in [0, 1]$.

Table 4.3: Balance Sheet of the Small Banks

Assets	Liabilities
Household loans (L_t^p)	Interbank loans (L_t^{bz})
	Equity (F_t^{bz})

The small bank's maximisation programme is:

$$\max_{\pi_t^z, L_t^{bz}, L_t^p, \delta_t, F_t^z} \sum_{s=0}^{\infty} E_t \{ \beta_z^s [\ln \pi_{t+s}^z - d_z (1 - \delta_{t+s}) + d_F^z (F_{t+s}^z - \kappa (\bar{w}_t^p L_t^p + w_t^z B_t^z))] \} \quad (4.27)$$

subject to the following constraints:

$$F_t^z = (1 - \xi_z) F_{t-1}^z + \nu_z \pi_{t-1}^z \quad (4.28)$$

$$\begin{aligned} \pi_t^z = & \eta_t L_{t-1}^p - \frac{L_t^p}{1+r_t^p} + \frac{L_t^{bz}}{1+i_t} - \delta_t L_{t-1}^{bz} + \zeta_{zp} (1 - \eta_{t-1}) L_{t-2}^p - \frac{\omega_z}{2} [(1 - \delta_{t-1}) L_{t-2}^{bz}]^2 + \\ & (1 + \rho_t) B_{t-1}^z + B_t^z \end{aligned} \quad (4.29)$$

Similar to the big bank, equation (4.28) defines the evolution of the funds for the small bank. The maximisation of the objective function (4.27) subject to the budget constraints (4.28) and (4.29) yields the first order conditions:

$$\frac{\lambda_t^z}{1 + i_t} = E_t [\beta_z \lambda_{t+1}^z \delta_{t+1} + \beta_z^2 \lambda_{t+2}^z \omega_z (1 - \delta_{t+1})^2 L_t^{bz}] \quad (4.30)$$

$$\frac{\lambda_t^z}{(1 + r_t^p)} = E_t [\beta_z \lambda_{t+1}^z \eta_{t+1} + \beta_z^2 \lambda_{t+2}^z \zeta_{zp} (1 - \eta_{t+1})] - d_F^z \kappa \bar{w}_t^p \quad (4.31)$$

$$\lambda_t^z L_{t-1}^{bz} = E_t [\beta_z \lambda_{t+1}^z \omega_z (1 - \delta_t) (L_{t-1}^{bz})^2] + d_z \quad (4.32)$$

$$d_F^z \nu_z = \left(\lambda_t^z - \frac{1}{\pi_t^z} \right) - E_t \left[\beta_z (1 - \xi_z) \left(\lambda_{t+1}^z - \frac{1}{\pi_{t+1}^z} \right) \right] \quad (4.33)$$

Equation (4.30) defines the interbank loan demands by the small bank in the in-

terbank market. Equation (4.31) defines the supply of loans to the low-income household. Similar to the firms, equation (4.32) defines the cost of paying the interbank loans today to the monetary and non-monetary penalty costs of paying in the next period.

4.2.4 The Central bank and supervisory authority

The central bank conducts monetary policy operations by injecting ($M_t > 0$) or withdrawing ($M_t < 0$) liquidity in the interbank market through the open market operations. This allows the central bank to let the interbank rate be endogenously determined and clear the interbank market in equation (4.34):

$$(M_t + L_t^b)(1 + i_t) = L_t^{bz} \quad (4.34)$$

where the money supply follows an autoregressive process

$$M_t = \rho_m M_{t-1} + u_t^m \quad (4.35)$$

with the persistence parameter $\rho_m = 0.95$, liquidity shock $u_t^m \sim N(0, \sigma_m^2)$ where $\sigma_m = 0.01$. To close the model, we follow De Walque et al. (2010)'s no financing constraints case and assume that the central bank finances the liquidity injections itself. Therefore, households only finance the insurance scheme via taxes defined by equation (4.36):

$$T_t = \zeta_b(1 - \delta_{t-1})L_{t-2}^{bz} + \zeta_{bf}(1 - \alpha_{t-1})L_{t-2}^f + \zeta_p(1 - \alpha_{t-1})L_{t-2}^p - \xi_z F_{t-1}^z - \xi_b F_{t-1}^b \quad (4.36)$$

The supervisory authority sets the capital requirement (κ) for both banks. It also assigns the risk weights w_t^f , \bar{w}_t^p , \hat{w}_t^z and w_t^a , $a \in \{s, b\}$ to loans to the firms (L_t^f), low-income households (L_t^p), and small banks (L_t^{bz}) and market book investment (B_t^a , $a \in \{s, b\}$) respectively. Since we are not interested in analysing the effects of regulatory changes from Base I to II, we only follow the Basel I regime. Therefore, the risk-weights are constant and not risk-sensitive.

4.3 Aggregation and market clearing

There are 6 markets in the economy, which include the goods, labour, low-income household credit, high-income deposit, firm credit and interbank markets. The

model consists of variables $r_t^f, i_t, r_t^p, r_t^r, C_t^p, C_t^r, K_t, Y_t, L_t^f, L_t^{bz}, L_t^p, W_t, T_t, N_t, N_t^p, \pi_t^b, \pi_t^z, \pi_t^f, F_t^b, F_t^z, D_t$ and the TFP ε_t .

The labour market: Substituting equation (4.12) into (4.15) equates the marginal rate of substitution between consumption and leisure to the opportunity cost of an additional unit of leisure.

$$\phi_p \frac{C_t^p - \varrho \frac{C_t^p}{C_t^r}}{1 + \varrho \frac{C_t^p}{(C_t^r)^2}} \frac{1}{1 - N_t^p} = (1 - u)W_t \quad (4.37)$$

Equation (4.38) equates the demand for labour to the supply of labour, where N_t^p is the amount of labour by the low-income households and $N_t^p + N_t^r = 1$, the total population.

$$N_t = N_t^p \quad (4.38)$$

The final goods and service market: The aggregate resources are:

$$Y_t = C_t + K_t + (1 - \tau)K_{t-1} \quad (4.39)$$

where total consumption is a sum of consumption by the high-income and low-income households, respectively - $C_t = C_t^r + C_t^p$.

The credit market: The credit markets for the low-income households or firms clear when the demand for loans equals the supply of loans by the banks. The demand for loans by low-income households is given by equation (4.13) whilst the supply for loans is given by equation (4.31). Similarly, the demand and supply for loans for firms are given by equations (4.8) and (4.25) respectively.

The interbank market: The interbank market clears according to equation (4.34).

$$(M_t + L_t^b)(1 + i_t) = L_t^{bz} \quad (4.40)$$

The Capital market: The capital market is defined by equation (4.41).

$$K_t = (1 - \tau)K_{t-1} + \frac{L_t^f}{1 + r_t^f} \quad (4.41)$$

$$\ln \varepsilon_t = \rho_\varepsilon (\ln \varepsilon_{t-1}) + \mu_t^\varepsilon \quad (4.42)$$

In addition to the above equations, we also have Equations (4.5), (4.11), (4.17), (4.21), (4.22), (4.28), (4.29) and (4.36), which are the constraints for firms, banks,

households and the central bank.

4.4 Calibration

The description of the data and data sources used for the calibration are provided in Appendix 4.7.2. Table 4.4 and 4.5 provide the calibrated parameter values and the implied steady state values, respectively. We refer to a period as a quarter. Therefore, the maturity of any loan or investment is one-quarter.

Table 4.4: Calibrated parameters

<i>Banks</i>			
$\kappa = 0.10$	$\beta_b = 0.99$	$\beta_z = 0.99$	$B^z = 0.27$
$\zeta_b = 0.80$	$\zeta_{bf} = 0.8$	$\zeta_{zp} = 0.80$	$\bar{w}^f = 1.20$
$\bar{w}^p = 1.50$	$\hat{w}^z = 0.50$	$\nu_b = 0.50$	$\nu_z = 0.50$
$d_F^b = 4863.52$	$d_F^z = 566.34$	$d_z = 1127.61$	$\omega_z = 1.95$
$\xi_b = 0.01$	$\xi_z = 0.07$	$B^b = 0.27$	
<i>Firms</i>			
$u = 0.33$	$\tau = 0.025$	$\omega_f = 1.55$	$d_f = 0.27$
$\beta_f = 0.99$			
<i>Households</i>			
$\chi = 0.01$	$N = 0.24$	$D^r = 0.97$	$\beta_r = 0.99$
$d_p = 0.01$	$\gamma_p = 0.95$	$\beta_p = 0.99$	$\varrho = \{0.00, 0.10\}$

Notes: β_x = discount rates for $x \in \{b, z, f, p, r\}$. *Banks:* κ = minimum own funds; B^b and B^z are the market books; ζ_{bf} , ζ_{zp} and ζ_b = recovery rate of defaulted loans from the insurance scheme; \bar{w}^f , \bar{w}^p and \hat{w}^z = Basel weights on assets; ν_b and ν_z = dividend policy; d_F^b and d_F^z = utility to having more own funds; d_z = disutility of default; ω_z = default penalty; x_{ib} and x_{iz} = own funds contribution to the insurance scheme. *Firms:* u = share of capital; τ = depreciation rate; ω_f = default penalty; d_f = disutility of default. *Households:* χ = the deposit gap disutility; N = the labour force; D_r = the deposits; γ_p = the penalty rate; ϱ = relative consumption motive.

Table 4.5: Steady state values

<i>Interest rates and repayment rates</i>			
$i = 1.43\%$	$r^f = 2.07\%$	$r^p = 4.71\%$	$r^r = 1.01\%$
$\delta = 0.98$	$\alpha = 0.95$	$\eta = 0.83$	
<i>Assets and Liabilities</i>			
$D/L=6.13$	$B^z/B^b = 1$	$\pi/L=1\%$	
<i>Macroeconomic variables and profits</i>			
$K/Y = 8$	$C/Y = 0.68$	$L/Y = 0.26$	$T/Y = 0.6\%$
$\epsilon = 1$			

Notes: Interest rates and repayment rates: i = interbank rate; r^f = firm loan rate; r^p = low-income loan rate; r^r = deposit rate; δ , α and η = loan repayment rates. *Assets and Liabilities:* $L = L^f + L^p$ = total loans; π/L = total profits over total assets of the banks = return on assets; $F = F^b + F^s$ = total funds for the banks; $\pi = \pi^b + \pi^s$ = total profits for the banks. *Macroeconomic variables and profits:* K/Y = capital to output ratio; $C = C^r + C^p$ = total consumption by the households; T = taxes; ϵ = productivity factor. Interest rates are quarterly rates.

4.4.1 Households

The discount factor for both households is set at 0.99, which is the level common in the literature. The default rate for the low-income households is calculated using the ratio of non-performing loans to total household loans from the balance sheets of the small banks between 2002Q1 and 2014Q3. This gives us an average default rate of 17%, implying that the repayment rate for the low-income households (η_t) is 0.83. This level is close to that by Ngalawa and Viegli (2013). According to the authors, the probability of loan repayment for a quasi-emerging market economy's informal financial sector is 0.85. Though we look at the formal financial sector for low-income households in an emerging market, the two markets are similar as the formal sector is a substitute for the informal sector for low-income households. The total hours worked by the small households is 0.24³.

4.4.2 Banking sector

Similar to the households, we set the discount rate for both banks at 0.99. The steady state quarterly interest rates for the firm (r_t^f), interbank loans/deposits (i_t), high-income household deposits (r_t^r) and the loans to the low-income households (r_t^p) are set at their steady state values from equations. For the high-income household

³The number is calculated assuming that on average low-income households work 10 hours a day for 5 days in a week for 42 weeks.

deposits, $r_t^r = 1/\beta - 1 = 0.01$. The steady state values for i_t , r_t^f and r_t^p are 1.43%, 2.07% and 4.71% from equation (4.24), (4.25) and (4.31) respectively. The real return on market book is calculated as the return on the Johannesburg Stock Exchange All Share Index ($\rho_t=3\%$). We assume the same return for both the big and the small banks. Similarly to De Walque et al. (2010), we use the z-score method to represent the probability of default by the small banks (δ_t). The z-score measures the distance of the banking system from insolvency, with a high level implying sound financial stability, Andrianova et al. (2015). It is inversely related to financial fragility, and is given by:

$$Z_t = \frac{ROA_t + \frac{Equity_t}{Assets_t}}{\sigma_{ROA}} \quad (4.43)$$

where ROA is the return on asset and σ_{ROA} (financial fragility) is the standard deviation of the ROA. Higher levels of the z-score implies higher financial stability. The z-score is calculated using the two small banks' balance sheet data. We find that the average probability of default for the small banks is 4%. However, we set the default rate lower at 2% ($\delta_t = 0.98$) to ensure that the repayment rate for small banks is greater than that of the firms. We follow De Walque et al. (2010) and assume every period, banks allocate 50% of their profits to own funds ($\nu_b = \nu_z = 0.50$). The calibrated contribution to own funds by the bank is 0.01 for the big banks (ξ_b) and 0.07 for the small banks (ξ_z).

In South Africa, the capital requirement of 8% of risk-weighted assets was changed to 10% in 2001, Mboweni (2004). Therefore, we set $\kappa = 0.10$. Assets are allocated weight according to their riskiness, with risky assets receiving the highest weight, which is 1.50 according to the Basel agreement. Similar to De Walque et al. (2010), we also set the weight of the interbank (\hat{w}^z) and firm (\bar{w}^f) loans to 0.50 and 1.20 respectively. We set the weight for loans to the low-income households (\bar{w}^p) slightly above the loans to the firm at 1.50. This implies that we regard loans to low-income households as the riskiest loans in the economy. Lastly, as in De Walque et al. (2010), we also assume that 80% of defaulted loans (interbank, low-income and firms) are recovered from the insurance scheme ($\zeta_b = \zeta_{bf} = \zeta_{zp} = 0.80$).

4.4.3 Real sector

We follow De Walque et al. (2010) and assume a default rate (α_t) of 0.95 for the firms. Alternatively, we calculate the default rate for the non-financial corporations as a ratio of the number of liquidation and insolvency to the total number of tax

paying firms⁴. The ratio is calculated across industries that are likely to have more big firms than small firms since we are only interested in big firms. These are the firms that have higher probabilities of getting loans from the big banks. The selected industries are manufacturing, mining and quarrying and electricity, gas and water supply. We get $\alpha_t=0.99$, which we think is too high to generalise for all firms. Given the above, we can then use the steady state equation to determine the disutility of firms for defaulting on loans. We set the capital share (u_t) to 0.33, and therefore the labour share ($1 - u_t$) to 0.67. The quarterly depreciation rate (τ) is set to 0.025. The discount rate for the firms is also set at 0.99.

4.5 Simulations

We are interested in the effects of endogenous default, liquidity injection, relative consumption motives and bank profitability (market book) on the economy. Prior to investigating the effects of each shock, we first test our model against real data to see if it is able to reproduce the real business stylised facts. We then start our analysis by looking at the effects of introducing endogenous defaults rates in our model. We follow with the effects of liquidity injection by the central bank in the presence of the relative consumption motive by the poor households. Lastly, we investigate how instability in the banking sector is transmitted to the rest of the economy. We run our models under the Basel I regime⁵.

4.5.1 Business cycle moments

To compare the performance of our model to the real data, we run simulations with a positive productivity shock and endogenous default for firms, small banks and the low-income households. The positive productivity shock follows the following autoregressive process: $\varepsilon_t = (\varepsilon_{t-1})^{\rho_\varepsilon} \exp(\mu_t^\varepsilon)$, with $\rho_\varepsilon = 0.95$, $u_t^\varepsilon \sim N(0, \sigma_\varepsilon^2)$ and $\sigma_\varepsilon = 0.01$. Table 4.6 compares the first and second moments of our model to that of the data. For the first moments, our model performs well for most of the variables. For the second, the model is not able to reproduce the procyclicality of the interest rates and interbank loans (L_t^b) as observed in the data. Lastly, most variables in the data exhibit positive autocorrelation for all the variables, whilst some variables in our model exhibit negative autocorrelation.

⁴The data on the number of liquidation and insolvency of firms and the annual financial statements of the industries is compiled by the Statistics South Africa (StatsSA) and South African National Treasury. The data on the total number of tax paying firms is obtained from the South Africa Revenue Services (SARS)

⁵The Basel II regime was introduced in 2008.

Table 4.6: Real Business Cycle moments

	Mean		Correlation with output		First-order autocorrelation	
	Data	Model	Data	Model	Data	Model
r_t^p	16.16%	15.64%	0.55	-0.21	0.45	-0.16
i_t	2.19%	5.66%	0.57	-0.60	0.45	0.01
r_t^f	11.16%	10.70%	0.53	-0.54	0.45	-0.09
r_t^r	1.66%	4.07%	0.55	-0.42	0.45	-0.14
L_t^b	0.03	0.29	0.64	-0.83	0.78	0.63
L_t^{bz}	0.00	0.29	0.00	-0.83	0.00	0.63
L_t^f	0.12	0.25	0.46	0.82	0.55	-0.18
L_t^p	0.01	0.00	0.09	1.00	0.88	0.73
D_t^r	0.75	2.67	0.37	0.90	0.81	0.45
Y_t	1.00	1.00	1.00	1.00	0.56	0.72
C_t	0.77	0.68	0.97	0.88	0.58	0.82
I_t	0.18	0.25	0.89	0.63	0.59	-0.04

Notes: This table shows the real business cycle moments for the real data and the model. We use the yearly data from 2002 to 2013. Interest rates are real terms and annualised. Except for interest rates, all variables have been logged. $F_t = F_t^b + F_t^s =$ total funds for the banks, $\pi_t = \pi_t^b + \pi_t^s =$ total profits for the banks, $C_t = C_t^r + C_t^p =$ total consumption by the households. Investment $I_t = K_t + (1 - \tau)K_{t-1}$.

4.5.2 Endogenous default rates

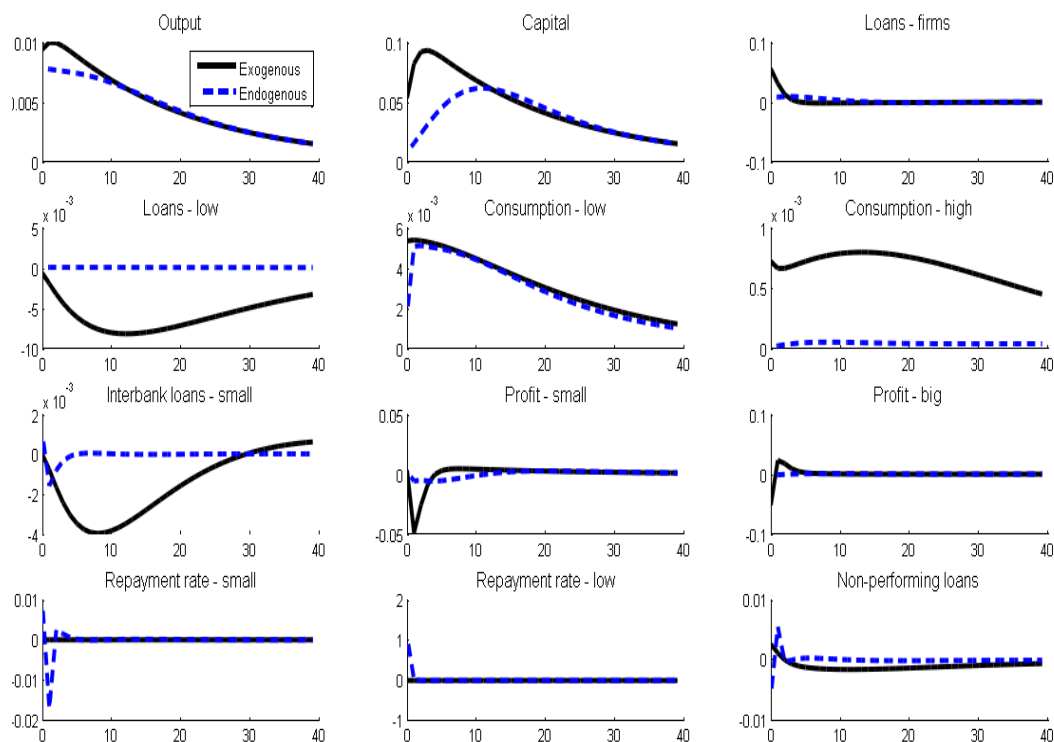
We start our simulations by looking at the effects of a positive productivity shock in the absence and presence of endogenous default. We restrict our simulation to only look at endogenous default for small banks and low-income households. Figure 4.4 presents the results for both exogenous and endogenous default rates. The results for a positive productivity shock with exogenous default are as in the real business cycle literature: a positive productivity shock increases the total productivity factor, which then increases output, wages and capital investment. All interest rates increase except for the loan rate to the low-income households. Using our model, the results show that firms increase their borrowing to fund capital investment, increasing the firm loan rate. On the contrary, higher wages reduce the demand for loans by low-income households. This reduces the low-income households' interest rate and thereby reducing the profitability of the small banks .

In the presence of endogenous default rates, a positive productivity shock increases the loan repayment by the low-income households and decreases the payment rate by the small banks. Since endogenous defaults for the small banks and low-income households also reduce output, wages and capital investment by the firms

also decrease. The reduction in wages increases the low-income households' loan demand, which increases the low-income household interest rate. At the same time, the reduction in the repayment of the small banks increases the interbank rate.

Overall, the results indicate that endogenous default rates for both the small banks and the low-income households cause some financial instability by increasing the overall risk (non-performing loans). Even though we find that endogenous default rates for the small banks and low-income households stimulate the demand for low-income household loans and interbank borrowing by the small banks, the effects on output and capital investment are negative - dampening rather than accelerating the positive productivity shock. This is in contrast to the findings by De Walque et al. (2010). We obtain similar results when we make the default rate for the firms endogenous. With endogenous default rates for the firms only, the increase in output allows firms to repay more of their loans. This increases liquidity in the financial system, and limit the increase in the interbank interest rate, interest rate for the firms and the deposit rate, making it cheaper to borrow for the low-income households. These results highlight the findings by Goodhart et al. (2009). The authors also find that in the presence of endogenous defaults for both banks and households, a positive technology shock has a negative effect on financial stability in the short run.

Figure 4.4: Endogenous default



Note: Variation from the steady state, in % points.

Liquidity shock and relative consumption motive

Liquidity injections provide cheap money to borrowers. Given the excess liquidity in the system, equilibrium in the credit and deposit markets would then be restored through lower interest rates. This would therefore reduce deposits by the savers, as evident in the literature ⁶. Therefore, consumption of the savers will increase.

Low-income households may aspire to live a certain lifestyle similar to that of high-income households. This may result in a higher demand for credit than if there was no such desire as the low-income households wish to consume more than they can afford with their wages. We investigate the effect of this relative consumption motive on both the economy and the banks' behaviours. We estimate our model with a positive liquidity shock under two scenarios. In the first scenario, we assume that there is no relative consumption motive by the low-income households, $\varrho = 0$. Euler equation (4.12) collapses to the standard form. In the second case, we set $\varrho > 0$. Following Klein and Krause (2014), we set $\varrho = 0.1$. Figure 4.5 shows the results for the liquidity shock only (benchmark) and the liquidity shock in the

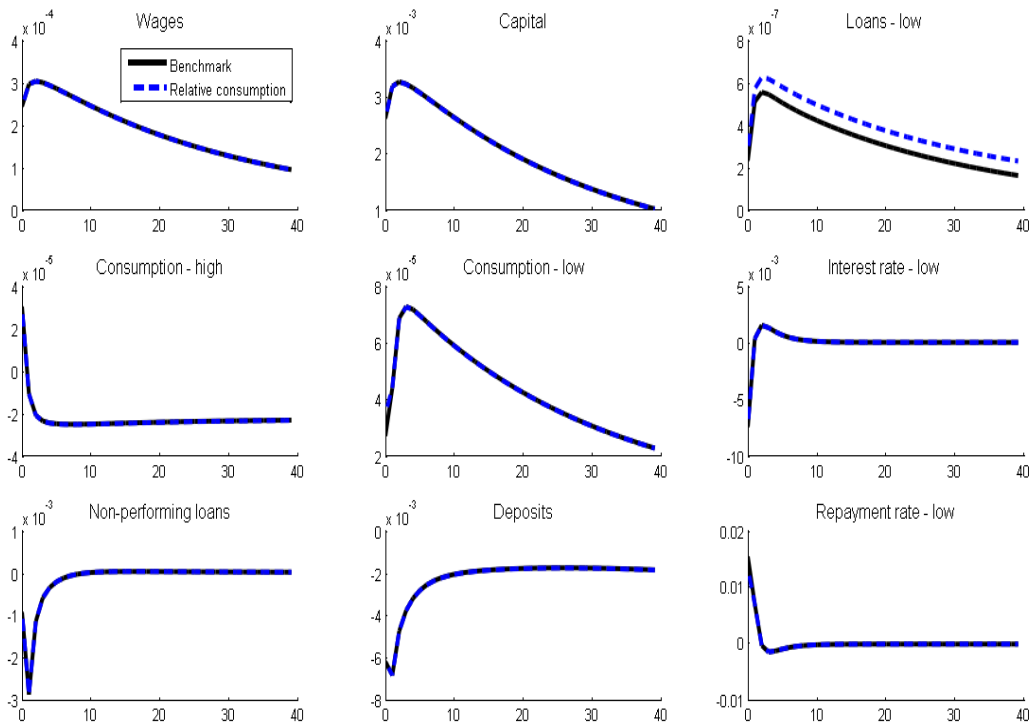
⁶De Walque et al. (2010).

presence of the relative consumption motive.

Increase in liquidity results in cheap borrowing by all agents - firm loans and low-income household loans increase. This reduces interest rates in the credit market for the firms and low-income households. The repayment rates for the small banks, low-income households and firms increase and thereby reducing the overall risk in the banking sector as seen in the decrease of non-performing loans. However, both the increase in wages and the reduction in interest rate for low-income households' loans reduces the profitability of the small banks.

When we introduce the relative consumption motive, we find that the effects of the relative consumption motive is limited to the demand for loans, with no effect on consumption and other variables of the small banks. Therefore our model is not able to show any increase in consumption to support our story. Therefore, a better model specification is required.

Figure 4.5: Liquidity shock and Relative consumption motive



Note: Variation from the steady state.

4.5.3 Market book value shock and liquidity injections

In this section, we use our model to understand how a reduction in profitability of the banks impact the whole economy. Following De Walque et al. (2010), we introduce a negative market book shock, which is equivalent to a reduction in the banks' profitability, and no productivity shock. The return for the market book follows an autoregressive process of $\rho_t = \bar{\rho}^{(1-\rho_\rho)}(\rho_{t-1})^{\rho_\rho} \exp(u_t^\rho)$, with $\rho_\rho = 0.50$, $u_t^\rho \sim N(0, \sigma_\rho^2)$ and $\sigma_\rho = 0.01$. According to the authors, a degree of persistence of 0.50 means that it takes a year for the shock to disappear. As in De Walque et al. (2010), the liquidity injections M_t follows the following rule:

$$M_t = v(i_t - \bar{i}) \quad (4.44)$$

with $v \geq 0$, such that M_t increases (decreases) when the interbank rate is higher (lower) than the long run \bar{i} . To model liquidity, De Walque et al. (2010) set $v = 100$. According to the authors, this is equivalent to a 10% increase in liquidity by the central bank. All other shocks are set to their steady state values. We also set the repayment rates for all the agents to be endogenous. We consider the scenario of a market book without the central bank's intervention ($v = 0$) as our benchmark model and that with such an intervention ($v > 0$).

Figure 4.6 shows the results for the benchmark model with no liquidity injections ($v = 0$) and the model with liquidity injections ($v > 0$). Starting with the scenario of no liquidity injection, a decrease in market book value for the banks reduces the liquidity in the interbank market. Agents who depend on loans from the big banks face a credit crunch - both the interbank loans and firm loans decrease. This increases the interbank rate and the firm loan rate. A decline in loans to the firm reduces capital investment, output and the demand for labour by the firms. Lower output reduces the repayment rate for the firms. With lower wages, loans to low-income households decline, reducing the interest rate. The reduction in the interest rate helps low-income consumers to repay some of their loans in the short-run, temporarily reducing their default rates. The overall effects without the central bank's intervention is an increase in non-performing loans and a reduction of macroeconomic variables.

The intervention of the central bank mitigate the negative effect of the fall in market book on the economy and also improve financial stability. The increase in liquidity by the central bank increases liquidity in the interbank market. Therefore, the availability of funds reduces the increase in both the interbank rate and the firm loan rate and further reduces the loan rate for low-income households. This

stimulates loan demand by the firms and the low-income households, thereby reducing the negative impact of the market book shock on output and low-income households' consumption. However, the profitability of the small banks (and the big banks) decrease as they are lending more at a lower rate. Overall, liquidity injection helps to reduce the overall risk in the banking sector (non-performing loans) and stabilise the financial system quicker.

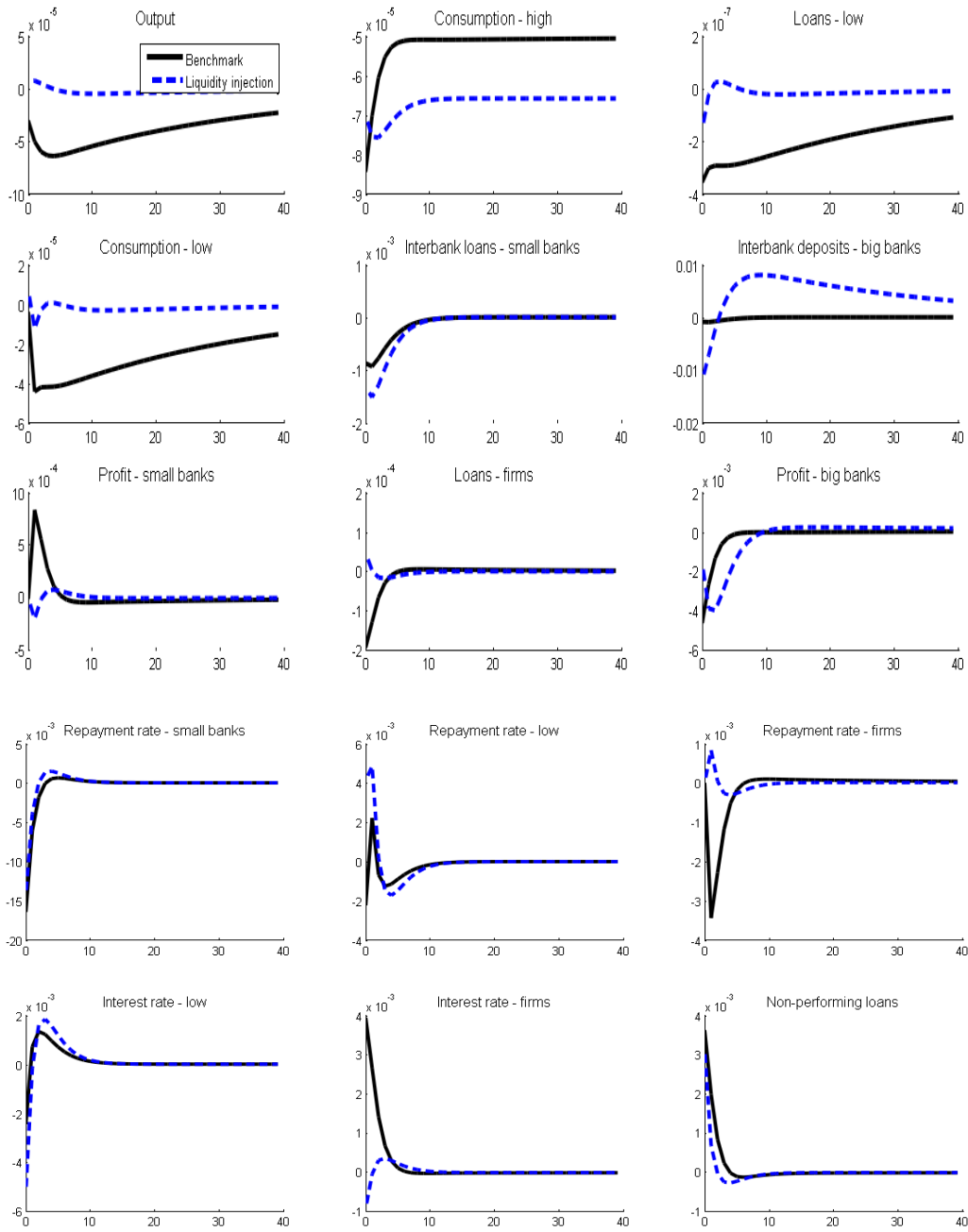
An illustration: Global vs. local banking crisis

We conclude our analysis by investigating how a market book shock from either the small or the big banks are propagated through the rest of the financial sector and the economy. We consider two scenarios. In the first scenario, we look at the impact of a reduction in market book value for the domestically important banks on the interbank market and the whole economy. This is analogous to the impact of the 2008 financial crisis on the local big banks which reduced their profitability.

Small to medium bank crises in South Africa are mainly due to liquidity pressures. Therefore, in the second scenario we look at the reduction in market book value for the small banks. In both scenarios, we investigate the effects of market book value in the absence of liquidity injections by the central bank. The return on market book follows an autoregressive process of $\rho_t = \bar{\rho}^{(1-\rho)}(\rho_{t-1})^\rho \exp(u_t^\rho)$, $x \in b, z$, and with $\rho_\rho=0.50$, $u_t^\rho \sim N(0, \sigma_\rho^2)$ and $\sigma_\rho = 0.01$.

Figure 4.7 presents the impulse response functions of a negative market book shock to the big banks and the small banks without liquidity injections. Since the effects on the interbank deposits and interbank loans are the same for the two scenarios, we only include interbank loans in our results. We start with the results for the big banks. From the figure, we can see that a negative market book shock to the big banks reduces the interbank deposits or loans by the big banks. Therefore, all interest rates increase. The loans to the firms decrease as the cost of borrowing is too high. Firms reduce their demand for capital and labour, reducing wages and output. As a result, consumption for low-income households decrease. Overall, the effects on the economy is high defaults across all borrowing agents - repayment rates for the firms, small banks and low-income households decrease, causing an increase in non-performing loans. Due to the size of the big banks, the total profitability of the small and the big banks decreases. Therefore, a negative market book shock to the big banks causes financial instability.

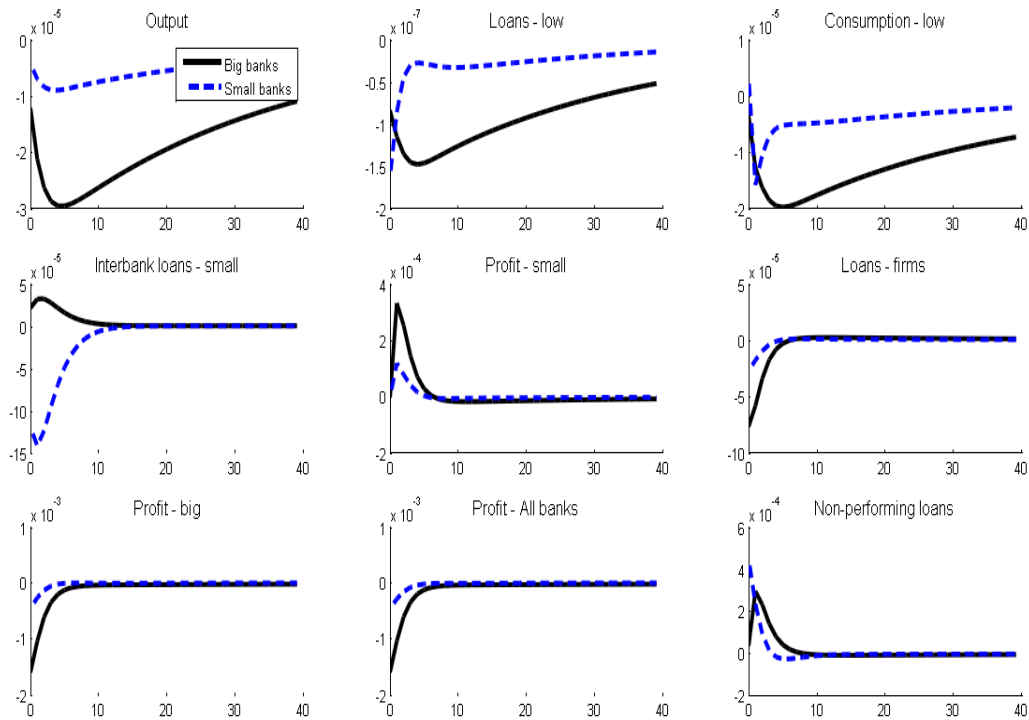
Figure 4.6: Market book shock and Liquidity injections



Note: Variation from the steady state.

A fall in the market book of the small banks reduces interbank loans or deposits, increasing the interbank rate. Similar to the big banks, the lack of liquidity injection also reduce output, capital and wages. Consumption by the low-income households also decrease. However, the effects are smaller compared to that of the big banks.

Figure 4.7: Market book shocks by bank size



Note: Variation from the steady state, in % points.

From the results, we can see the importance of financial stability in both the small and the big banks. Both produce high default rates. The results also highlight the systemic risk that can be caused by the collapse of the big banks, causing an increase in default rates across all borrowing agents. For example, even though low-income households do not borrow directly from the big banks, the big banks cause a much bigger negative welfare effects on their consumption. Again, this shows how the small bank acts as a transmitter of shocks to the low-income households. Effects of the small banking crises on macroeconomic variables and low-income households welfare are short-lived, whereas the big banks seem to have longer impact. Therefore, central bank intervention is important to prevent any bank crisis, big or small. However, it is very important to ensure the financial stability of the domestically important banks as they pose higher risk to the economy and the banking sector.

4.6 Conclusion

In this chapter we develop a DSGE model to capture the relationship between a heterogeneous banking sector and a heterogeneous household sector, which we consider a fair representation of the South African financial sector. Our aim is to study how financial shocks are transmitted to and from the rest of the economy. Given the many failures of the small and medium banks and the stability of the big banks in South Africa, understanding the peculiarities between the two types of banks is important for the central bank and policy makers.

Notwithstanding its ability to reproduce some of the real business cycle moments, this model provides a starting point for modeling a DSGE model suitable for financial stability dynamics in the South African banking sector. Our results for a negative market book shock in the presence of endogenous default is able to show how the South African economy has been able to survive banking crises by small banks, as has been evident from the 2014 African Bank crisis. Effects of the small banking crises on macroeconomic variables and low-income households welfare are short-lived, whereas the big banks seem to have longer impact. Even though the big banks have managed to be resilient during the 2008 financial crisis, the model shows that a financial crisis emanating from these banks will be detrimental for both the economy and the financial sector.

This model is only a starting point. Even though we attempted to characterise the South African banking sector and socio-economic dynamics, further research is required. Firstly, our DSGE model assumes that the South African Reserve Bank follows a simple interest rate rule. Future models should incorporate the South African Reserve Bank's inflation targeting framework and more realistic macro-prudential policies for South Africa. Even though we have emphasised how monopolistic the banking sector in South Africa is, we do not model this characteristic. For example, Gerali et al. (2010) model a monopolistic banking sector for the loan and deposit market. Lastly, we tried to characterise the low income household sector "keeping up with the Joneses" consumption behaviour using the external habit formation. However, the relative consumption motive for the low income households does not provide the link between higher consumption and higher loan demand. Therefore, our results do not support our hypothesis of higher income fueled by debt. Limitation of the models inherited by default from following De Walque et al. (2010) can be found in their paper.

4.7 Appendices

4.7.1 Steady state solutions

Firms

$$W = (1 - u)\varepsilon\left(\frac{K}{N}\right)^u \quad (4.45)$$

$$u\varepsilon\left(\frac{N}{K}\right)^{1-u} = \lambda^f(1 - \beta_f(1 - \tau)) \quad (4.46)$$

$$\frac{\lambda^f}{1 + r^f} = \beta_f\alpha + \beta_f^2\omega_f(1 - \alpha)^2L^f \quad (4.47)$$

$$L^f = \beta_f\omega_f(1 - \alpha)(L^f)^2 + d_f \quad (4.48)$$

Big banks

$$\frac{1}{1 + r^r} = \beta_b \quad (4.49)$$

$$\frac{1}{1 + i} = \beta_b(\beta_b\zeta_b(1 - \delta) + \delta) - \frac{d_F^b\kappa\hat{w}^z}{\lambda^b} \quad (4.50)$$

$$\frac{1}{(1 + r^f)} = \beta_b(\alpha + \beta_b\zeta_{bf}(1 - \alpha)) - \frac{d_F^b\kappa w^f}{\lambda^b} \quad (4.51)$$

$$\left(\lambda^b - \frac{1}{\pi^b}\right) = \frac{d_F^b\nu_b}{(1 - \beta_b(1 - \xi_b))} \quad (4.52)$$

Small banks

$$\frac{1}{1 + i} = \beta_z\delta + \beta_z^{2z}\omega_z(1 - \delta)^2L^{bz} \quad (4.53)$$

$$\frac{1}{(1 + r^p)} = \beta_z(\eta + \beta_z\zeta_{zp}(1 - \eta)) - \frac{d_F^z\kappa\bar{w}^p}{\lambda^z} \quad (4.54)$$

$$L^{bz} = \beta_z\omega_z(1 - \delta)(L^{bz})^2 + \frac{d_z}{\lambda^z} \quad (4.55)$$

$$\left(\lambda^z - \frac{1}{\pi^z}\right) = \frac{d_F^z\nu_z}{(1 - \beta_z(1 - \xi_z))} \quad (4.56)$$

Low-income households

$$\frac{1 + \varrho \frac{C^r}{(C^p)^2}}{C^p - \varrho \frac{C^r}{C^p}} = \lambda^p \quad (4.57)$$

$$\frac{1}{(1 + r^p)} = \beta_p \eta + \beta_p^2 \gamma_p (1 - \eta)^2 L^p \quad (4.58)$$

$$L^p = \gamma_p (1 - \eta) (L^p)^2 + \frac{d_p}{\lambda^p} \quad (4.59)$$

$$\frac{\phi_p}{1 - N^p} = \lambda^p W \quad (4.60)$$

High-income households

$$\frac{1}{C^r} = \lambda^r \quad (4.61)$$

$$\frac{1}{C^r} \frac{1}{1 + r^r} = \beta_r \frac{1}{C^r} - \chi \left(\frac{D^r}{1 + r^r} - \frac{\bar{D}^r}{1 + r^r} \right) \quad (4.62)$$

4.7.2 Data

We use real monthly data from 2002Q1 to 2014Q3. All nominal data are deflated using the GDP deflator. All BA900 data is obtained in the balance sheets of the South African banks from the South African Reserve Bank (SARB).

Banks

- Interbank deposits: quarterly average of the monthly deposits denominated in Rands from South African bank (s). Includes NCD's/PN's and other deposits. *Source:* SARB BA900, line item 3.
- High-income consumer deposits: quarterly average of the monthly deposits by households. *Source:* SARB BA900, line item 27.
- Interbank loans: quarterly average of the monthly deposits, loans and advances to SA banks. Includes negotiable certificates of deposits or promissory notes issued by banks with maturity of up to 1 month, more than 1 month to 6 months (unexpired maturity), more than 6 months (unexpired maturity) and other deposits and loans and advances to SA banks. *Source:* SARB BA900, line item 111.

- Market book: quarterly average of the monthly investment and bills by the banks. *Source*: SARB BA900, line item 195.
- Loans to firms: quarterly average of the monthly overdrafts, loans and advances to non-financial corporate sector. *Source*: SARB BA900, line item 214.
- Loans to the low-income consumer: quarterly average of the monthly overdrafts, loans and advances to the household sector. *Source*: SARB BA900, line item 216.
- Own funds: quarterly average of the monthly total equity. *Source*: SARB BA900, line item 96.
- Profits: defined as net income to total assets. Because there is no data on net income for the banks, net income is calculated as a product of the return on assets published in the SARB Financial Stability report and total assets in BA900. The data covers the period 2003Q1 to 2015Q4.
- Other assets: the difference between total assets and the sum of market book value, interbank deposits and loans to firms.
- Other liabilities: the difference between total liabilities and the sum of deposits and interbank loans.
- Interbank rate: quarterly average of the weekly 3 months Johannesburg Interbank Average Rate (JIBAR/JIBA rate). *Source*: SARB.
- Deposit rate: deposits rates were taken from the current available data from the large banks' websites. Average of the rates for 3 months (or closest to 3 months) fixed deposits. Following which, the calculated difference between the calculated current average rate and the current interbank rate is 120 (negative) basis points. Therefore we computed the series for other previous periods as the interbank rate less 120 basis points.
- Borrowing rate (firms): using the prime rate by banks, which is the prime plus 350 basis points.
- Borrowing rate (low-income consumers): calculated as the prime rate plus 500 basis points. This assumes that low-income consumers are riskier than firms. This can be justified by the ability for banks to attach firms' assets.

- Return on market book: quarterly average real return on the Johannesburg Stock Exchange All Share Index.
- Default rate (small banks): calculated z-score for the small banks, as discussed in sub-section 4.4.2.

Firms and Consumers

- Investment: quarterly seasonally adjusted real gross fixed capital formation (investment). *Source*: SARB.
- Gross Domestic Product: quarterly seasonally adjusted gross domestic product at market prices (GDP). *Source*: SARB.
- Consumption: seasonally adjusted individual consumption expenditure of total domestic economy. Quarterly data is an interpolation of annual values. *Source*: SARB.
- Default rate (firms): as already discussed in sub-section 4.4.3, the default rate for the non-financial corporations can be calculated as a ratio of the number of liquidation and insolvency to the total number of tax paying firms.
- Default rate (low-income consumer): as already discussed in sub-section 4.4.1, we calculate the default rate for the low-income households as the ratio of non-performing loans to total household loans from the balance sheets of the small banks.

Chapter 5

Concluding Remarks

In this study, our objectives are to: (1) study the importance of internal and external variables for financial stability; (2) determine the role of the structure of the banking sector in the transmission of monetary policy and macroeconomic shocks; and (3) understand financial stability in the context of both the South African financial system structure and demographic dynamics.

We start with a cross-sectional analysis of how external and internal variables affect local financial stability in Chapter 2 . Our focus is on high income and the upper middle income countries given the attention they have received in the financial crises and fragility literature. We restrict our analysis to financial fragility rather than on predicting financial crises. We use the measure of financial fragility by the IDFF and define financial openness analogous to trade openness in order to be able to compare their impact. Our sample is from 1999 to 2011. We find that financial openness has a negative effect on the financial systems of high income countries, whereas the effect on upper middle income countries is insignificant. However, these results are not robust to the dynamic model specification. Financial openness is not significant when we control for the dynamic of financial stability and endogeneity. This indicates that further estimations need to take into account both the endogeneity issues and finding better model specifications.

Contrary, we find that trade openness has a significant (positive) effect on financial stability for the upper middle-income countries. Local variables such as credit, stock market capitalisation and real exchange rate growth are better at explaining local financial stability for both the high income and the upper middle income countries. These results are consistent with some of the literature on financial crises and fragility (Demirgüç-Kunt and Detragiache (1998*a*, 2000, 1998*b*), Hardy and Pazarbaşıoğlu (1999), Caballero (2014) and Davis and Karim (2008)). The same variables used to predict financial crises do prove useful in understanding

local financial conditions. These results support Taylor (2012)'s viewpoint of looking within the borders of the country (internal factors) in understanding financial stability.

In Chapter 3 and 4 we look at the role of the banking structure for monetary policy and financial stability respectively. We investigate the transmission of monetary policy through the bank-lending channel in South Africa during the period 2002M1 to 2014M7 in Chapter 3. Unlike the previous South African literature, we use disaggregated bank level data. Our hypothesis is that small banks in South Africa are subject to credit market imperfections. The disaggregation allows us to show the heterogeneity in the response of different types of loans and bank sizes.

Our structural vector auto-regressive results show that small banks are more affected by contractionary monetary policy, whereas the big banks can adjust their loan portfolios to cushion the effects. However, these results (and the current literature) assume that the transmission of monetary policy and the way the exogenous shocks are generated remain constant over time. We show that this is not the case. To do so, we utilise the time-varying parameter vector autoregressive (TVP-VAR) model which allows for both the coefficients and the variance of the shocks to vary over the time. The results do indicate that following the 2008 financial crisis, both the big banks and small banks became more responsive to a monetary policy shock, though the big banks were able to contain their non-performing loans.

In Chapter 4, we develop a dynamic stochastic general equilibrium model to understand financial stability in the context of both the South African financial system structure and demographic dynamics. This model characterise the banking heterogeneity in Chapter 3. Another main characteristic in this model is the household heterogeneity, which is implicitly implied in Chapter 3. The household sector heterogeneity characterises the high inequality amongst the South African population that is divided between low-income and high-income households. We incorporate the relative consumption motive to capture the culture of “keeping up with the Joneses” that have resulted in high consumption driven by debt as low-income households aspire to live a certain lifestyle similar to the high-income households.

The literature on the stability of the banking sector in South Africa either focus on evaluating banking performance using financial ratios (Kumbirai and Webb (2010)) or stress testing analysis (Falkena et al. (2004) and Havrylchyk (2010)). We see this chapter as a contribution to the South African literature in understanding financial stability in the context of both our financial system structure and demographic dynamics. We calibrate the model using South African data - the banks'

balance sheets and real economic data. Our model indicate that endogenous default rates for both the small banks and the low-income households cause some financial instability by increasing the overall risk (non-performing loans). The model also shows that liquidity injections (cheap money) in the presence of the relative consumption motive increases loan demand by the low-income households relative to the base scenario when there is no relative consumption motive. Surprisingly, the impact on the overall risk (non-performing loans) is muted. And lastly, we find that adverse shocks to the banks' balance sheets have welfare effects, especially for low-income households.

Even though we attempted to characterise the South African banking sector and socio-economic dynamics in Chapter 3 and 4, further research is required. Starting with Chapter 4, our DSGE model assumes that the South African Reserve Bank follows a simple interest rate rule. Future models should incorporate the South African Reserve Bank's inflation targeting framework and more realistic macro-prudential policies for South Africa. Even though we emphasise how monopolistic the banking sector in South Africa is, we do not model this characteristic. Lastly, we tried to characterise the low income household sector "keeping up with the Joneses" consumption behaviour using the external habit formation. However, the relative consumption motive for the low income households does not provide the positive correlation between higher consumption and loan demand. Limitation of the models inherited by default from following De Walque et al. (2010) can be found in their paper. Another limitation is our results in Chapter 3. The insignificance of consumer loans across all models and the weakness of corporate loans for small banks limit our analysis of the monetary policy transmission on consumers. Perhaps other model specifications need to be explored. For the TVP-VAR, the non-convergence of the stochastic volatility indicate that either a larger number of iterations are required or that there are some technical data issues that we are currently not aware of.

The takeaway message in this PhD is that we should move away from viewing the banking sector through one lens, that is the big four banks, when doing empirical research in South Africa. This approach understates the inherent financial (in)stability for the small banks and limits our understanding of the asymmetric effects of monetary policy. The stability of these small banks is important if the aim is to increase competition within the banking sector and promote financial inclusion for those who may not afford to bank with the big four banks. Otherwise, the big banks will keep acquiring these failing small banks, and thereby further increasing their market domination.

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