UNIVERSITY OF KWAZULU-NATAL

Financial stability and monetary policy in South Africa

By

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DECLARATION

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DEDICATION

To Umftwanekhosi Majahonke and Inkhosikate Lahlophe

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ABSTRACT

This thesis is presented in three distinct but related essays. The first essay (Chapter four) explores how financial stress interacts with monetary policy. Financial stress was measured using a time-varying financial conditions index constructed by Kabundi and Mbelu (2017) for South Africa employing thirty-nine monthly financial market variables and macroeconomic variables. The study employed a Markov Switching Vector Autoregression (MSVAR) model estimated with Bayesian methods to investigate this dynamic relationship. The findings reveal that interest rates respond negatively to a high financial stress shock, leading to an increase in credit growth. Despite the expansion of credit, real GDP growth increases marginally and then gradually declines. Given the complementary objectives of financial stability and monetary policy, it is concluded that monetary policymakers need to consider financial stability. Furthermore, the impact of monetary policy is not restricted to adjustments in interest rates; it affects other factors such as lending risk functions.

The second essay (Chapter five) examines the interaction of housing-related macro-prudential policies and monetary policy. The study uses housing cycles in a Dynamic Stochastic General Equilibrium (DSGE) model with a small, open economy framework. We estimate the model with Bayesian techniques using South African data covering the period 2000Q1 to 2018Q4. The results indicate that monetary policy has negligible effects on house prices. We consider a loan-to-value (LTV) tool for macro-prudential policy. The results show that a one per cent rise in the LTV ratio, a tight macro-prudential policy, leads to increasing house prices, with significant effects on Consumer Price Index (CPI) inflation. The effects on CPI inflation suggest that monetary policy is not very effective. Efficient policy frontier analysis indicates that the introduction of macro-prudential policy yields an improved, effective outcome that

lowers output and inflation volatility. The findings suggest that there is a need for coordination of monetary policy and macro-prudential policy.

The third essay (Chapter six) investigates monetary policy and the role of countercyclical bank capital regulation in fostering macroeconomic and financial stability. We employ a DSGE model with a borrowing cost channel and endogenous financial frictions driven by bank losses, bank capital costs and credit risk. The study finds that a policy regime that combines an optimal Taylor rule and macro-prudential policies shows a clear trade-off between price and macroeconomic stability. The results emphasise the significance of the Basel III Accord in mitigating the output-inflation variability faced by the policy authorities, and questions the simultaneous deployment of an optimal Taylor rule.

ABBREVIATIONS

SARB	South African Reserve Bank
CCB	Countercyclical Capital Buffer
SIFI	Systemically Important Financial Institutions
BIS	Bank for International Settlements
RCAP	Regulatory Consistency Assessment Programme
LCR	Liquidity Coverage Ratio
FCI	Financial Conditions Index
FSI	Financial Stress Index
DSGE	Dynamic Stochastic General Equilibrium
PCA	Principal Component Analysis
GDP	Gross Domestic Product
FAVAR	Factor-Augmented Vector Autoregressive
MHM	Modified Harmonic Mean
MDD	Marginal Data Density
MPI	Macroprudential Policy Instrument
IS	Investment-Savings
LM	Liquidity Preference-Money Supply
BCBS	Basel Committee on Banking Supervision
FSB	Financial Stability Board
IOSC	International Organization of Securities Commissions

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The financial system in the real economy plays a key role in sustaining healthy economic growth through the provision of funds for investment opportunities, enhanced capital accumulation and improvements in the allocation of risks. Prior to the global economic crisis of 2007/2008, the global financial system witnessed very rapid, but unsustainable growth, which led to successive macroeconomic distortions and financial imbalances. These imbalances and distortions were exacerbated by the crisis (Ioana, 2013). Indeed, the crisis initially manifested in developed economies because emerging markets, like South Africa are relatively less susceptible to subprime assets.

As the impact of the crisis extended to emerging markets, global de-leveraging and increased risk aversion sparked by the world-wide liquidity crisis, caused severe price volatility (International Organization of Securities Commissions (IOSC), 2009). The economic literature identifies a macro-prudential framework as a 'missing ingredient' in the regime that preceded the economic and financial crisis. According to the Bank of England (2009), the current framework, with its micro-prudential orientation, cannot handle a severe crisis. Its inefficiency is evident in the decline of liquidity and capital ratios in the United Kingdom and the United States (US) over the past 100 years. Despite the reversal of these trends, prudential regulation is unlikely to mitigate the increase in aggregate leverage and maturity mismatch. The Basel Committee on Banking Supervision (BCBS) and the Financial Stability Board (FSB) recently developed proposals to address systemic risk by fostering the formation of a coherent macro-prudential framework. This is consistent with calls from the Group of Twenty (G20) economies to establish initiatives to quantify the function of macro-prudential policy.

Macro-prudential policy can be quantified using a macro-prudential Raw index that incorporates 30 elements grouped into eight categories. According to Lombardi and Siklos (2016), these consist of: (1) a deposit insurance scheme; (2) policymakers' level of authority in implementing macro-prudential policy; (3) the degree of accountability and transparency in the macro-prudential regime; (4) how the use of macro-prudential tools impacts the monetary policy transmission mechanism; (5) several institutions accountable for the maintenance of financial stability and their authorisation; (6) how far the current macro-prudential regime is from implementing the FSB/G20 recommendations; (7) governance of the macro-prudential framework; and (8) how fast the Central Bank reacts in terms of implementing the FSB/G20 measures aimed at ensuring the stability of the financial system. With regard to these Raw index values, South Africa, which is a member of the G20, does not outline the role played by macro-prudential policy in the monetary policy transmission mechanism (Lombardi and Siklos, 2016). Therefore, the role that the macro-prudential policy regime plays in the Central Bank's monetary policy functions is likely to be a vital factor in assessing its ability to mitigate financial shocks that pose threats to the financial system. Designing a policy embedded within a macro-prudential framework could assist the monetary and financial authorities to build resilience and predict possible economic imbalances.

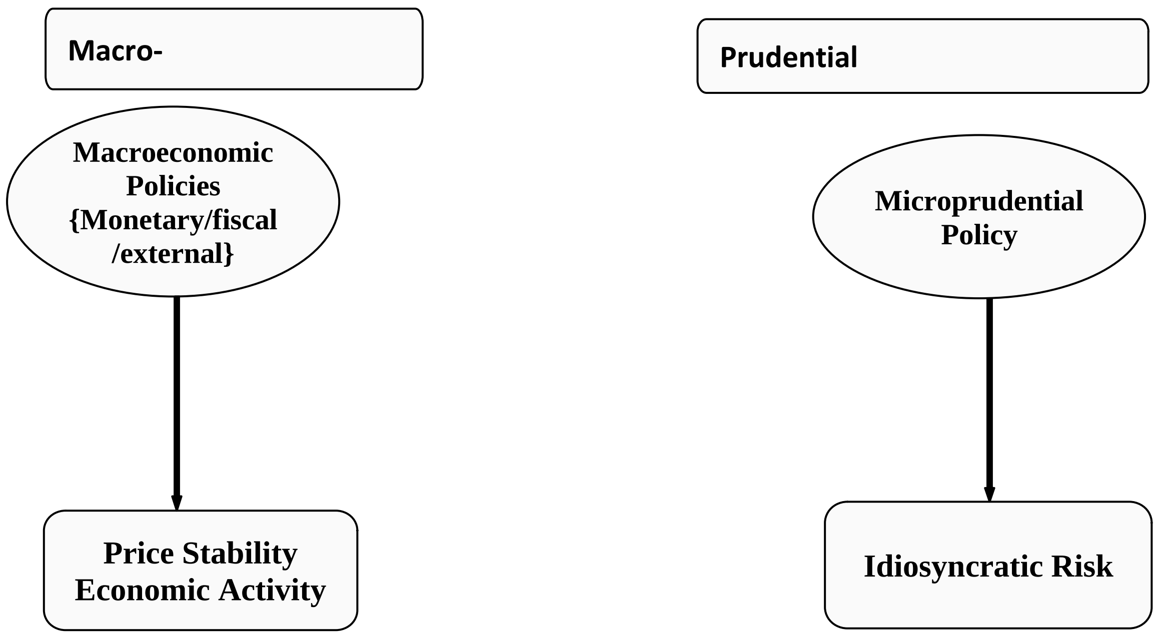
The ultimate objective of macro-prudential policies centres on the prevention and mitigation of systemic risk, including reinforcement of the financial system as resilience against the crisis, as well as smoothening the financial cycle, with a view to providing effective and efficient financial services that can enhance the real economy (International Monetary Fund (IMF), 2013). The policy employs multifarious tools. According to Tomuleasa (2013), the most common include the liquidity ratio, debt-to-income ratio, leverage ratio, and the loan-to-value (LTV) ratio. These tools are blunt and highly flexible. Some could be used in specific sectors based on their unique requirements, which is cost-effective. They are also implemented where a contractionary monetary policy is undesirable.

In previous times, it was thought that policies adopted by individual institutions would suffice to mitigate systemic risk; this was tagged the ‘fallacy of composition’. In the new framework, the Central Bank and the supervisory authorities are given new mandates and macro-prudential tools to guarantee financial stability (FSB-IMF_BIS, 2011). These tools play a multi-dimensional role, including controlling structural or cross-sectional risks, and cyclical or time-varying risks relating to a credit boom. An example is the Countercyclical Capital Buffer (CCyB), which was incorporated into the global regulatory framework in Basel III (Crockett, 2000).

There is no consensus among scholars on the role played by monetary policy in dealing with systemic risk in the presence of credit booms and under circumstances where monetary policy and macro-prudential policies are complements or substitutes (IMF, 2013). In the pre-crisis regime, some policymakers supported the employment of monetary policy (specifically, the role of interest rates) as an instrument to tackle financial imbalances (White, 2006; Borio 2016). Complementing this point of view, some argued for a combination of monetary and macro-prudential policies (Shin, 2015). However, others were of the opinion that employing monetary policy to promote financial stability plays a small or no role in controlling financial imbalances (Svensson, 2018; Kohn, 2015).

A synchronised framework that harnesses monetary policy and macro-prudential policies to enhance financial stability and reduces the opposing interests of a “push-me, pull-you” effect, and thus mitigates negative outcomes, is both necessary and possible. Policymakers and regulators in South Africa’s financial system have been caught up in this effect. Indeed, as this research suggests, if Central Banks hope to avoid the worst consequences of threats to the financial system, monetary policy and financial stability need to be employed as active complementary tools for successful policies. However, achieving financial stability is difficult in light of several financial distortions that continue to change over time. Figure 1.1 depicts the state of the world before the 2007/2008 financial crisis. In the pre-crisis period, there were no linkages between macroeconomic policies (monetary and fiscal policies) and micro-prudential policy (financial supervision). Thus, financial risk and economic risk were independent. During this period, policymakers did not consider the financial risk that might arise due to the implementation of policies that aimed to stabilise prices and maintain sustainable economic growth. The micro-prudential policies also aimed to achieve financial stability at individual financial institutions without accounting for economic risk. The overall risk that the financial system might be susceptible to and the adverse effects of systemic risk were also not taken into consideration. Thus, maintaining financial stability at the level of individual financial institutions is insufficient to achieve such stability for the entire financial system.

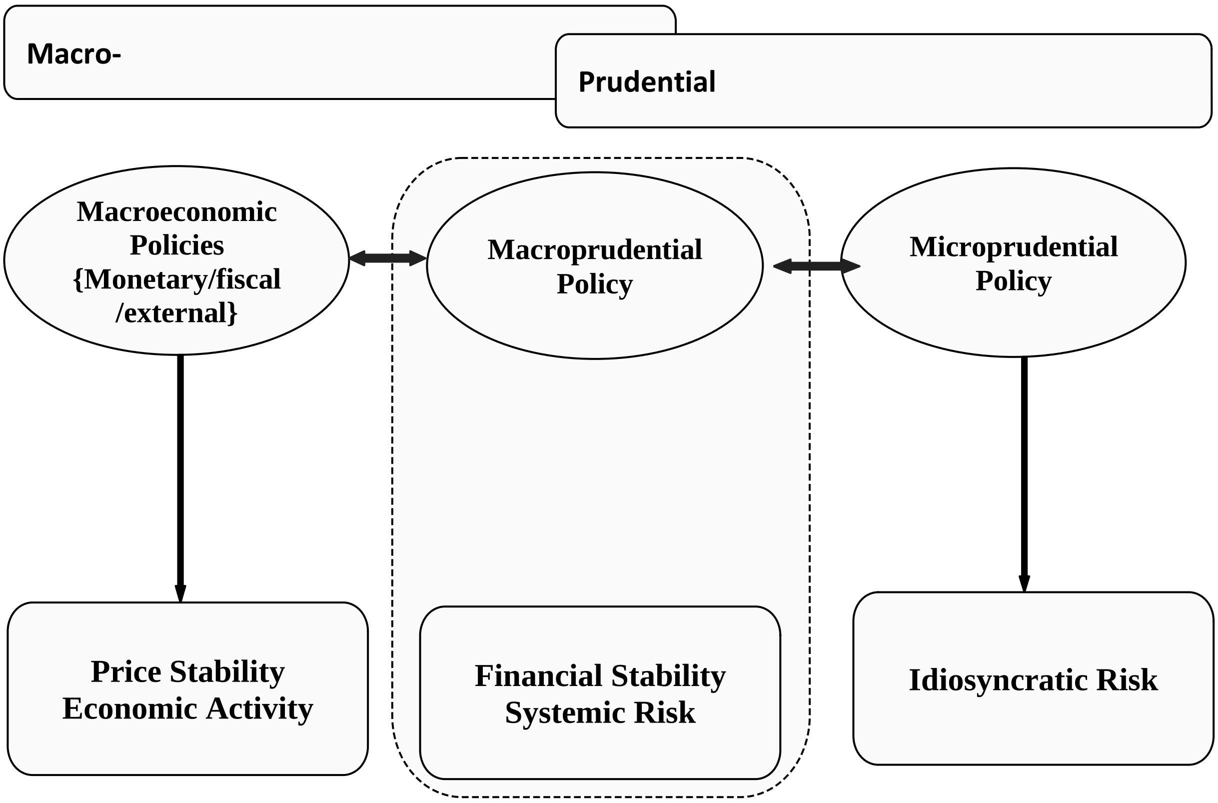
Figure 1.1 Policies and objectives Pre-Crisis worldview



Source: IMF, 2013

The post-crisis global situation depicted in Figure 1.2 highlights the importance of coordinating macroeconomic and micro-prudential policies through a macro-prudential policy that aims to achieve and maintain financial stability for the entire financial system. It shows that macro-prudential policy links with economic risk and financial risk to achieve its objectives through identifying, monitoring and controlling systemic risks using several tools to curb the ability of the financial system to extend excessive credit. In addition, macro-prudential policy requires support from other economic policies to achieve its objectives.

Figure 1.2 Policies and objectives Post-crisis worldview



Source: IMF, 2013

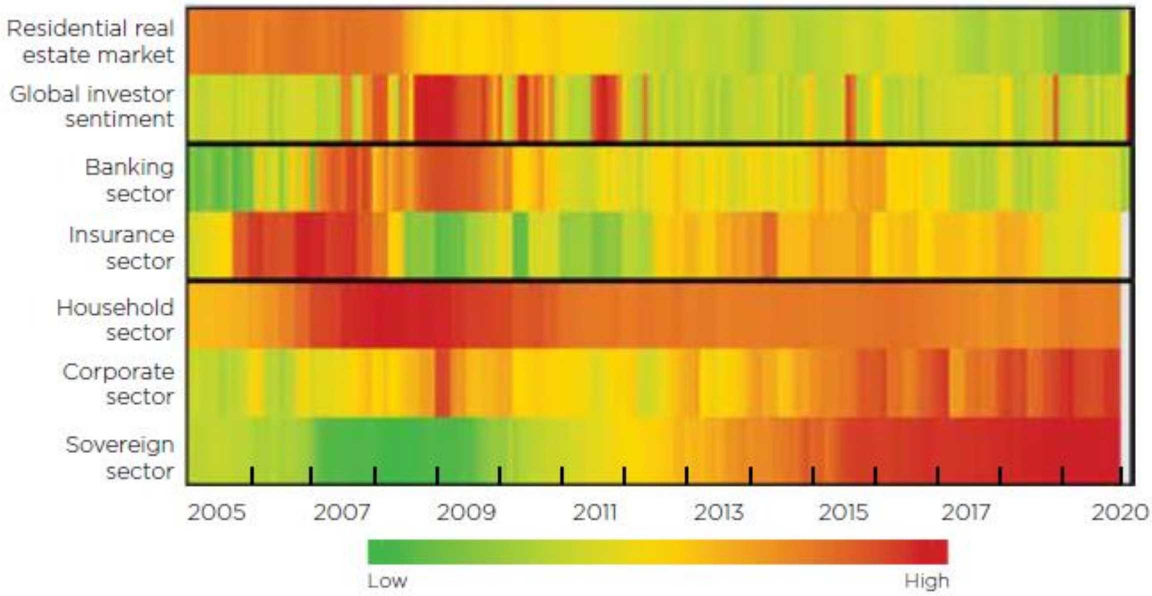
Smets (2013) identifies three divergent views on policy interactions. The first is the "modified Jackson Hole consensus" that posits that financial stability complements price stability. It contends that monetary policy needs to pursue price stability and that macro-prudential policy should only be responsible for financial stability with a distinctive category of instruments. Overall, the "modified Jackson Hole consensus" emphasises that there is limited interaction between macro-prudential and monetary policies; therefore, policymakers may separate the instruments, objectives and transmission mechanisms of both.

The second view is "leaning against the wind" which states that monetary policy can affect risk-taking by financial intermediaries while fragile financial intermediaries might adversely impact price stability. This approach emphasises that financial stability is introduced within the confines of monetary policy's secondary objectives, thus broadening the policy horizon.

The final view is that financial stability is price stability. This contends that financial stability and price stability are coordinated; it is, therefore, not possible to distinguish between them. It stresses that coordination of the two policies is necessary because it addresses the problem of time inconsistency that emerges given that the financial cycle is longer than the business cycle (Smets, 2013).

The South African financial system is under stress but has remained resilient in the face of a challenging environment (SARB, 2019). Both non-bank financial institutions and commercial banks have been subjected to pressure as a consequence of the current fall in financial asset prices. The supply of term funding available to banks has been reduced due to bank depositors prioritising short-term deposits. The level of stress is shown in the financial stability heat map (see Figure 1.3), which shows where the source of the stress originates. The figure illustrates that risk at household level, and among corporates and sovereign sectors is increasing. In the corporate and household sectors, sluggish income growth reflects the fragility of a particular class of borrowers. For their part, sovereign sectors have experienced a persistent rise in debt (as a percentage of Gross Domestic Product (GDP)) over the past ten years.

Figure 1.3: Financial stability heat map



Source: SARB,2020

Both monetary and macro-prudential policies will require not only new strategies but also a path-breaking cooperative agenda that can be sustained over the long run. The absence of one policy results in a stronger than usual reaction of the other and is not sustainable. Each can have a positive externality on the other, which might risk non-achievement of their respective goals. A positive externality presents an unparalleled opportunity to establish appropriate institutions and instruments.

1.2 Background

The 2007/2008 global financial crisis challenged the monetary policy framework that seemed successful in stabilising economies during the great moderation period. The great moderation period's standard view was that inflation targeting as a monetary policy strategy is not required to take into account financial developments such as excessive credit-financed real estate (Borio et al., 2001). The only exception occurs when such developments affect the inflation outlook.

Since the global crisis occurred during a stable and low inflation regime, the build-up of financial imbalances disrupted the macroeconomy and financial stability. These financial imbalances are characterised by changes in the economic environment that are procyclical (excessive credit growth and asset prices) (Borio et al., 2001). Monetary policy has come under scrutiny since the crisis because price stability proved to be an insufficient condition for financial stability. In addition, financial instability might have adverse feedback effects on the real economy (Bean et al., 2010; Mishkin, 2009).

Financial stability was generally left to micro-prudential policy, reinforcing the commonly held view of strict divisions between monetary policy and prudential guidelines. Micro-prudential policy aims to supervise and regulate individual financial institutions in order to build the resilience of the financial sector. Measures considered to promote financial stability include the Basel Capital Adequacy Accord (Basel I) by the Basel Committee on Banking Supervision in 1988, among others. The Basel I Accord had a "one size fits all" weighted risk classification and Basel II was adopted in 2004 to address this shortcoming. However, the Basel II Accord is likely to be procyclical compared to its predecessor (Repullo and Suarez, 2013; Kashyap and Stein, 2004).

Moreover, micro-prudential regulation (Basel II) was weakened by the global financial crisis through its exposure of excessive on- and off-balance sheet leverage together with insufficient liquidity buffers (Repullo and Suarez, 2013). The reasoning is that bank capital regulation obliges banks to retain less capital during an expansion of the business cycle and more in the contraction phase. This amplifies business and financial cycles and has an adverse effect on financial stability and price stability.

The important issue that arose from this backdrop was the environment in which the relationship between monetary policy and financial stability exists. Monetary policy and financial stability have complex and contradictory linkages (Billi and Verdin, 2014). Their interaction has shifted due to the changing economic environment that has proven conventional wisdom wrong. The new economic environment is founded on the understanding that guaranteeing the safety and soundness of single financial institutions is insufficient to ensuring stability of the whole financial system. Given that the vulnerabilities and risk are aggregates, it is necessary to employ a systemic approach to financial stability (IMF, 2011). The lack of a framework to predict financial imbalances and prevent systemic risk led to the emergence of macro-prudential policy.

The adoption of the Basel III capital regulation provides a macro-prudential overlay to prevent the accumulation of systemic risk over time. However, the Basel III Accord is the subject of ongoing debate in the literature. One view states that its implementation has yielded significant benefits (Ayadi et al., 2012) while another expresses concern about the high costs of implementing it (Ojo, 2010; BIS, 2011), which may affect growth and lending. The Basel III capital requirements were introduced in 2010 to achieve financial stability. The Accord enhances banks' ability to absorb losses during periods of financial distress through increasing the quality and quantity of bank capital. In order to promote financial stability, the new framework requires banks to maintain a minimum capital requirement of 8 per cent of risk-weighted assets as well a 2.5 per cent capital conservation buffer.

Furthermore, to counteract the procyclicality of Basel II, Basel III introduced a Countercyclical Capital Buffer. To prevent excessive credit growth and the build-up of systemic risk, banks are required to hold 2.5 per cent of their capital during expansionary periods. During contractionary periods, the capital buffer requirements are relaxed to assist banks in covering their losses and coping with the shock, without compromising their capacity to meet the regulatory requirements (BCBS, 2009).

The crisis has shown that the build-up of financial imbalances might have adverse macroeconomic consequences for most economies, especially advanced economies (Caruana, 2016). However, in this era of sluggish growth, emerging market economies such as South Africa are not immune to the problems faced by developed nations. South Africa fared well during the global financial crisis because its financial system is well equipped and capitalised to survive liquidity stresses. Moreover, the country has a well-established supervisory and regulatory system that complies with international regulatory best practice in securities regulation, banking and insurance (Hollander and van Lill, 2019). Although resilient, the financial system confronts several challenges. According to the South African Reserve Bank (SARB) (2018), financial stability risks include a low growth rate, precarious domestic fiscal position and a decrease in the quality of assets on banks' balance sheets.

All these risks and vulnerabilities contribute to systemic risk. There is growing consensus among Central Banks that macro-prudential policy should be adopted. However, there is no agreement in the literature on the most appropriate macro-prudential policy instruments. This is due to a lack of data, and limited analysis and analytical tools to inform these policy decisions. According to BIS (2010), the use of macro-prudential instruments is judgmental and discretionary rather than rules-based. The literature on time consistency indicates that, discretion-based solutions are time-inconsistent (Kyland and Prescott, 1977).

1.3 Problem statement

Many studies have argued that monetary policy should concentrate on achieving price stability. For instance, Borio and Lowe (2004) point out that when inflation is stable, there can be no build-up of financial imbalances; and Bernanke and Gertler (2001) argue that monetary policy should only focus on inflation. Other studies have maintained that macro-prudential policy, which is implemented for financial stability, should be coordinated with monetary policy. For example, Mishkin (2009) argues that aggressive monetary policy easing during financial instability is effective as it minimises the probability of negative feedback loops. Cecchetti and Li (2008) suggest that for monetary policy to be effective during financial distress, the interest rate policy should account for (procyclical) capital-adequacy requirements. However, several other studies maintain that financial instability can hinder the effectiveness of monetary policy. For instance, Montes (2010) and Nair and Anand (2020) state that financial instability related to asset price crashes and bank panics is likely to make monetary policy less effective in promoting economic recovery. Furthermore, it can hinder the effectiveness of monetary policy transmission (Billi and Verdin, 2014).

There is no consensus in the literature on whether Central Banks should extend monetary policy beyond price stability. However, periods of financial instability have shown that the direct effect of credit controls, financial regulation and the high cost of borrowing have intensified procyclicality in financial markets and business cycles (see Angeloni and Faia, 2013; Liu and Seeiso, 2012). The 2007/2008 global financial crisis is an example of how financial instability can disrupt the functioning of the real economy. As a small, open economy, South Africa is susceptible to uncertainty and risk from the global financial environment (SARB, 2016). Subsequent to the 2007/2008 financial crisis, policy rate differentials between advanced economies and emerging markets led to capital inflows (in the latter) that created a risk for macroeconomic and financial stability (Unsal, 2013).

The primary aim of macro-prudential policy is financial stability, which calls for mechanisms to influence the economic outcomes of different countries. All over the world, the authorities are experiencing challenges in implementing macro-prudential policy. However, the objective of monetary policy and macro-prudential policy is clear in terms of how each affects credit growth. Credit growth can emanate from households' loans (house prices) and corporate loans.

There is insufficient understanding of macro-prudential policy in terms of its transmission mechanisms, effectiveness and impact on the financial sector and the real economy. These policies still remain an open question especially in emerging markets such as South Africa.

The South African financial system is under stress but has remained resilient in the face of a challenging environment (SARB, 2019). The level of stress mainly originates from the household sector, sluggish income growth reflects the fragility of a particular class of borrowers (households). As a result, the housing market trends and developments serve as imperative financial stability indicators of the financial system health and economic confidence. In South Africa, residential loans account for the largest share of mortgages, loans and advances(estimated at 60% of total credit) (SARB, 2016). There has been, however, a rise in the ratio of mortgage instalments to average rent in South Africa since the beginning of 2016, because of an increase in the cost of owning a house (for example, taxes and rates) and the repayment burden. This may cause more stress to an already high leveraged investor in buy-to-rent property.

The “Tinbergen principle” states that policymakers should ensure a minimum of one policy tool per policy objective. However, the policy instruments of monetary and macro-prudential policies are interrelated (Schoenmaker and Weirts, 2011), and still remains an open question especially on their implications on the overall economy. This emerged from Central Banks globally including the South African Reserve Bank on expanding its objective by incorporating financial stability. This presents a new challenge to the SARB due to the mutual dependence of both the monetary policy and macroprudential policy goals. It is against this backdrop that this study investigated the concomitant implications of macro-prudential and monetary policies for financial stability in South Africa.

South Africa is an emerging market economy that is susceptible to global and idiosyncratic risk that affects its financial market. It has the most advanced and sophisticated financial system in Africa and was hence the focus of this research. The study contributes to the literature in several ways. First, it employs a financial conditions index (FCI) that covers a wider range of financial variables than previous studies (Kabundi and Mbelu, 2017) to investigate potential nonlinearities between the real economy and the financial sector. Second, the study introduces an innovative way of combining endogenous formation of risk of default at the bank capital and firm levels, which generate transmission between bank capital requirements, the real economy and the financial system. To the best of the researcher's knowledge, this is the first study in South Africa to introduce financial shocks, bank capital risk and regulatory requirements which directly affect the cost of borrowing and the degree of risk in the financial system. Third, for the first time, the relationship between macro-prudential policy and monetary policy in South Africa is analysed in a small open Dynamic Stochastic General Equilibrium (DSGE) model.

1.4 Aim and Objectives of the Study

Given this background, the study aimed to investigate the effectiveness of monetary policy in South Africa in the presence of macro-prudential policy and how both policies bring about stability in the economy. It sought to achieve the following three objectives.

(i) To investigate how financial stress affects the economy in South Africa.

(ii) To analyse the interaction of macro-prudential and monetary policies and house prices in an open economy, using data for South Africa.

(iii) To evaluate the macro-prudential role of bank capital regulation and monetary policy in fostering financial stability and economic stability in South Africa.

1.5 Structure of the study

This study is presented in seven chapters. Chapter one presents a background, motivation, problem statement, the study's contributions and the research objectives. Chapter two outlines the monetary policy framework in South Africa and Chapter three reviews the macro-prudential policy framework with particular attention to South Africa's progress in adopting macro-prudential regulations. Chapter four investigates the transmission of shocks between the financial sector and the real sector during financially stressful regimes and tranquil periods using a Markov Switching Vector Autoregression model. The results indicate that during tranquil periods, monetary policy is less effective due to the likelihood of a build-up of financial imbalances. Therefore, when setting the policy rate, policymakers should consider financial stability. Chapter five analyses house prices, monetary policy and macro-prudential policy in a small open DSGE model. It shows that macro-prudential instruments (LTV ratio and property tax) can mitigate house price booms. At the same time the effect of interest rates on house prices is reduced. Chapter six examines price stability and financial stability when monetary policy interacts with macro-prudential policy. The study finds that combining macro-prudential policy with monetary policy following a financial shock only promotes financial stability. Therefore, macro-prudential policy and monetary policy should concentrate on achieving their respective objectives, i.e., financial stability and price stability. Chapter seven presents a summary, conclusion and recommendations and identifies areas for further research.

CHAPTER 2

THEORIES OF MONETARY POLICY AND MONETARY POLICY IN SOUTH AFRICA

2.1 Introduction

The preceding chapter presented background information and the problem statement, the research objectives and the structure of the study. This chapter presents an overview of monetary policy in South Africa to provide further insight into the shifting regimes and the interaction of monetary policy and financial stability. To promote a better grasp of the framework employed in the analysis and interpretation of the study's findings, it discusses the theoretical framework, the transmission mechanism of monetary policy, South Africa's monetary policy, and the interconnectivity of monetary policy and macro-prudential policy.

2.2 Theoretical Framework

The literature is awash with theories of monetary policy, ranging from the classical quantity theory of money to the Keynesian monetary theory, and the Taylor rule. The classical quantity theory of money, referred to as 'the ancient surviving theory in Macroeconomics' (see Blaug, 1985) was a dominant paradigm from the turn of the 19^{th} Century until the Keynesian revolution eclipsed it in the late 1930s. The theory, which is embedded in the Irving Fisher Quantity Theory of money forms the basis for the relationship between economic variables and money. It assumes that the velocity of money and output is constant; as a result, a rise in the quantity of money will, in proportion raise prices in line with the quantity theory. Long-run and short-run neutrality are affected by money supply and real factors and have long-run growth (Mankiw and Taylor, 2007). However, Keynes argued that the velocity of money is not constant, but unstable. Another assumption of the quantity theory of money was that there is no trade-off between inflation and output (Keynes, 1936). According to Keynes, the rationalisation of rigid prices and the adjustment of the quantity of money is rapid. It was assumed that money demand is endogenous and depends on interest rates and income, as indicated by the liquidity preference theory. Keynes' theory also assumes that interest rates and output are positively related, in reference to the link between liquidity preference and money supply (the LM curve). The basic version of the Investment and Savings, Liquidity Preference-Money Supply (IS-LM) model has a fixed price level; therefore, only output can be analysed in the short run (Hicks, 1937).

The liquidity preference theory is a combination of money demand and the quantity of money supply from the policy authorities to regulate the money equilibrium level. The assumption is that money supply is exogenous and a rise in money supply lowers interest rates to the point where the supply equals quantity of money demanded. Low interest rates have a positive feedback on the marginal efficiency of capital and investment; as a result, output expands. However, Leijonhufvud (1968) and Robinson (1962) empirically contested Hicks' IS-LM view of Keynes' general theory.

Keynes questioned the efficacy of monetary policy when the economy was faced with uncertainty in the financial markets and a liquidity trap. Keynesianism supports a clearer role for fiscal policy. Both the classical and Keynesian theories assume that money supply is exogenous. However, subsequent and modern theories discarded both theories (Romer, 2006). Keynes theory has also been challenged because long-term low interest rates are distorted through unsustainable asset price bubbles (Schwartz, 2009).

Friedman's (1956) restatement of the quantity theory of money broke the backbone of the Keynesian revolution in the 1950s and 1960s. Referred to as Orthodox Monetarism, Friedman maintained that economic instability can be largely attributed to changes in money supply, assuming a stable money demand function. Monetarists followed the principle of a trade-off between output and inflation, then revised the Philips curve with respect to real wages (Gottschalk, 2005). At the natural rate the labour market is at equilibrium; it is thus assumed that sticky wages are dominant. Nominal rigidities in prices and wages suggest that in the short run, real income is affected by monetary policy. An increase in money stock might result in limited growth in employment and real output in the short run, but has no effect in the long run because of the countervailing effects of a rise in the general price level. In the long run, money supply is inflationary; therefore, the theory assumes long-run monetary neutrality (Nogueira, 2009; Bernanke and Mihov, 1998).

The monetarist theory subsequently contested technological advances and volatility of the money demand function (White, 2013). The assumption of exogenous money supply, also challenged monetarism empirically and theoretically (Romer, 2006). Monetarists also assume a constant velocity of money (Mishkin, 2007). Evans' (1996) empirical study found that, money is non-neutral in the long run if it is not neutral in the short run, especially if growth is endogenous. However, when growth is exogenous, long-run neutrality is present.

Dominant post-modernism models include the New Keynesian Model, the New Classical Model, real business cycle models, and the New Consensus Model. These models differ in terms of their assumptions on nominal rigidities of prices and wages, and demand behaviour (Palley, 2007; Goodfriend and King, 1997). The New Classical Monetary Model assumes that all markets have fully flexible prices and perfectly competitive markets. The model also shows near neutrality of monetary policy in relation to real variables. Other assumptions of the New Classical model include the natural rate hypothesis, rational expectations, agents with imperfect information and continuous market clearing. The equilibrium dynamics of real interest rates, output and employment, are determined separately from monetary policy, and changes in technology, assuming that they are the only real driving forces.

The assumptions of the New Classical Monetary Model established the basis for the New Classical real business cycle (RBC) theory. This theory rests on two principles: (1) business cycles arise from rational agents' optimal response to real shocks such as technology in an environment where markets are perfectly competitive and frictionless; (2) money is less significant in the business cycle. According to the continuous market clearing assumptions and rational expectations hypothesis, anticipated monetary policy will not affect real GDP. In contrast, an unexpected monetary policy would temporarily affect real variables (Mankiw, 2006). A new Keynesian revolution in the 1970s rejected the assumption of the flexibility of prices and wages as well as instantaneous adjustment of the economy and continuous market clearing (Mankiw, 2006). These theorists integrated monopolistic competition and sticky prices into the RBC framework (Goodfriend and King, 1997).

The new Keynesian model posits that wages and prices are temporarily rigid when responding to external shocks, with changes in fiscal policy or monetary policy, and the adjustment of quantities. In the labour market households set wages, and in the goods market monopolistic competitive firms are price setters. New Keynesian theorists revised Keynesian models to bring them in line with microeconomic fundamentals. The theory maintains long-run neutrality and assumes that monetary policy only affects output in the short run.

The New Keynesian Model and New Classical Model gave birth to the New Consensus Model which retains rational expectations and upholds wage and price short-run rigidities. The New Consensus Model formed the basis for inflation targeting where price stability was the primary objective and growth the secondary objective. To achieve these objectives, monetary policy uses interest rates as a tool. The model assumes that stabilisation of both output and prices occurs in the short and long run. The short-run dynamics are founded on temporal nominal rigidities; however, as a result of rational expectations, the market clears and there is therefore no impact on long-run economic activity. Output stability can also be traced in the New Consensus Model aggregate demand curve, where the relationship between output and the real interest rate is negative. This relationship shows that interest rates impact economic demand, which then converges in the direction of the long-run supply side equilibrium (Fontana and Palacio-Vera, 2007).

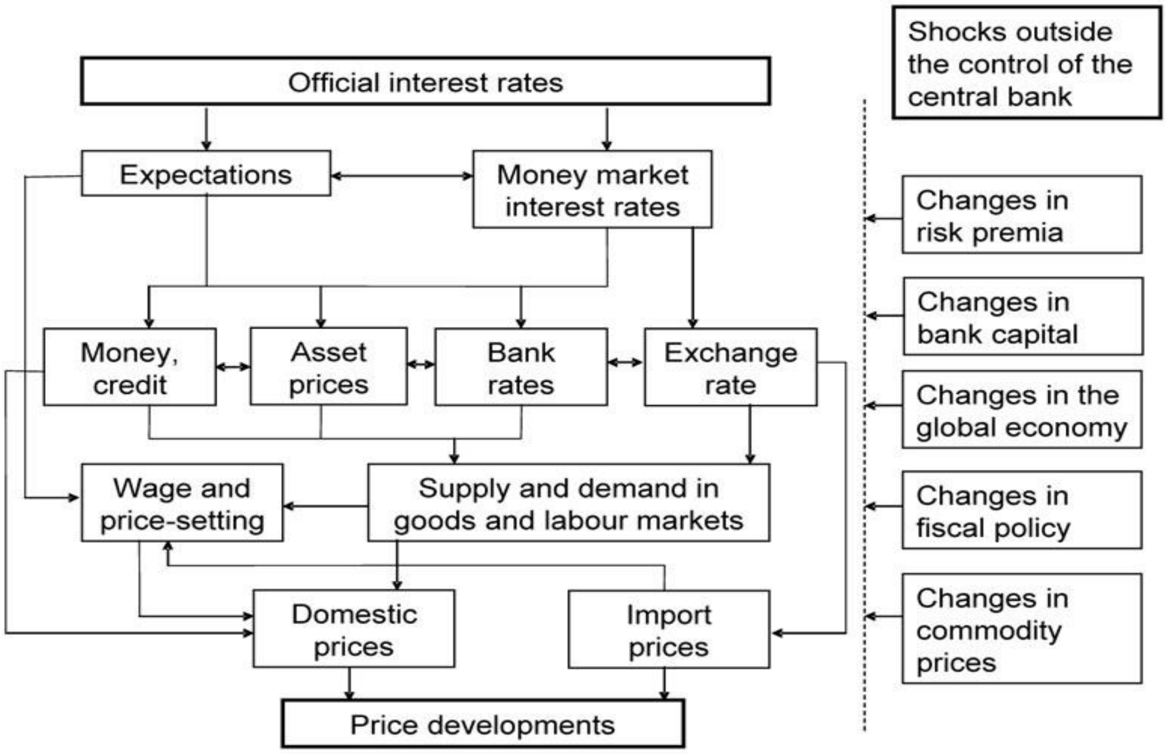
The New Consensus Model has been criticised for its assumptions and practicability (Arestis and Sawyer, 2008; Chari et al., 2008) and there is scant empirical literature to support it (Chari et al., 2008). The lack of attention to the role of the exchange rate and money, insufficient consideration of the labour, financial and capital markets, and the emphasis on one instrument and an independent Central Bank render this theory ineffective, especially in small, open, developing economies (Fontana and Palacio-Vera, 2007; Arestis and Sawyer, 2008; Arestis, 2009). The New Consensus Model might also not be appropriate for economies that experience consistent increases in inflation, nor might its assumption of inflation elasticity into other variables (Fontana and Palacio-Vera, 2007; Arestis and Sawyer, 2008). Output stability forward-looking targeting has been discussed in the literature that raises concerns on the role of monetary policy (Fontana, 2010).

2.3 Monetary policy transmission mechanism

The theoretical framework for monetary policy is rooted in the monetary policy transmission mechanism. There are two such mechanisms, viz., non-neoclassical channels and neoclassical channels (Boivin et al., 2011). Neoclassical channels of monetary policy are founded on Friedman's (1956) monetarist characterisation of the transmission mechanism. These channels mainly operate through the interest rate channel. Non-neoclassical channels, also known as credit channels, are founded on frictions in the credit market that are the result of asymmetric information between borrowers and lenders. The importance of these channels before the global financial crisis was mixed (see, for example, Ramey, 1993; Iacoviello and Minetti, 2008). However, empirical evidence from Cecchetti et al. (2009) and Mishkin (2009) showed that financial frictions affect the transmission of monetary policy and distort the real economy. During the global financial crisis, the interest rate channel was weakened (see Gambacorta et al., 2015), suggesting that the monetary policy might have changed.

According to Angelis et al. (2005), the transmission mechanism of monetary policy explains the complex process whereby changes in the monetary policy stance are transmitted to the real sector of the economy to achieve its objective, such as economic growth and a low and stable inflation rate. The main links in the monetary policy transmission mechanism are shown in Figure 2.1 and can be described as follows: The Central Bank sets the interest rate (monetary policy instrument) for the private interbank market. The interbank rates have a direct effect on other market interest rates. Changes in the interest rates affect other variables in the economy such as expectations, asset prices and exchange rates. These changes affect the aggregate demand for money, which in turn affects prices.

Figure 2.1 Monetary Policy Transmission mechanism



Source: Faure (2005)

Thus, monetary transmission channels operate through the effects that the official interest rate has on real estate prices, equity, interest rates, exchange rates, firms' balance sheets and bank lending (Ireland, 2005). The interest rate influences the decisions made by investors, firms, financial institutions and households, which changes the price level and economic activities. For instance, when the monetary authorities adopt tight monetary policy by raising the repo rate, this directly affects the money market by increasing the banks' interest rates. Thus, the cost of capital increases, causing investment expenditure to fall, and thereby leading to a decrease in aggregate output and demand. Five different channels generalise the transmission process, namely, the interest rate channel, exchange rate channel, money effect channel, asset price channel and credit channel.

The interest rate channel

Mishkin (1995) argues that monetary policy shocks are transmitted to the real economy using the interest rate channel. Mollentze (2000) elucidates that a rise in the repo rate is transmitted to other short-term money market rates, resulting in a higher cost of borrowing and hence a decrease in consumption and investment. The Central Bank loans money to banks and charges interest, which determines the interest rate in the real economy. The banks lend to investors who transfer the interest rate level to output and prices. The major characteristic of the interest rate channel is that it drives investment and consumption decisions. Policymakers respond to shocks using monetary policy instruments. Keynes points out that this channel operates through business decisions on investment expenditure. However, Mishkin (1995) argues that consumers' decisions about durable expenditure and housing are inherent in investment decisions.

The exchange rate channel

The exchange rate channel is more focused on monetary policy using the exchange rate's effect on net exports (Mishkin, 1995). Monetary policy impacts the exchange rate using interest rates. When interest rates rise, local currency deposits are increasingly attractive in comparison to foreign currencies, resulting in the strengthening of the domestic currency. Once the domestic currency appreciates, exports become more expensive than imports, thus causing a decrease in output. In contrast, when the local currency is devalued against foreign currencies, local exports are less expensive than imports, resulting in output growth.

The money effect channel

The monetarist theory assumes that a decrease in money supply causes consumers to reduce their spending due to their realisation that they hold little money at a given rate of interest

(Mishkin, 1995). The money effect moderates the influence of liquid asset adjustment and interest rates, which eventually minimise the direct relationship between fluctuations in aggregate money supply and absorption (Bolnick, 1991). It is assumed that output and prices respond to monetary shocks because consumers and investors imperfectly observe the results of former and current activities (Meltzer, 1995). This might be because of the time lag between detecting the impulses and the opportunity to differentiate between nominal and real shocks, and transitory and permanent impulses (Ngalawa and Viegi, 2011).

The asset price channel

A firm's physical and financial price might rise through an expansionary monetary policy as consumers spend their surplus money holdings. This causes upward pressure on the price of stocks. Due to lower interest rates (a rise in the money supply), the net worth of a firm rises and hence the company's cash flow, its creditworthiness and the value of its collateral (Norris and Floerkemeier, 2006). Output and investment expenditure consequently increase, as do lifetime income, consumption and financial wealth.

The credit channel

Agency problems that arise in credit markets are transferred via the bank lending channel and the balance sheet channel (Norris and Floerkemeier, 2006). The latter channel focuses on financial intermediaries that supply funds to borrowers. This channel emerges from asymmetric information in credit markets. However, the channel functions poorly due to practices such as third-party lending (Norris and Floerkemeier, 2006).

The bank lending channel is used to provide funds to borrowers. In this instance, the Central Bank increases the money supply using bank loans, that is, a rise in the quantity of money velocity through loan disbursement instead of the rate of credit. Contractionary interest rates will lead to a decrease in bank deposits, negatively affecting banks' capacity to supply loans to investors (Mishkin, 1995). Consequently, output growth falls. Alternatively, the Central Bank might decrease the legal reserve requirement of banks in order to increase their capacity to lend.

2.4 South African Monetary policy

Since the 1970s, South Africa's monetary policy has centred on direct controls, ranging from credit ceilings to cash reserve requirements and interest rate controls. According to Aziakpono and Wilson (2010), these aim to curb the increase in monetary aggregates to tackle inflation. The De Kock Commission of 1977 formulated a number of recommendations on monetary policy. The first was market-oriented monetary policy. This includes the adoption of an accommodation policy, also known as a discount policy which is in accordance with variable cash reserve requirements and open market operations. From the 1960s to 1981, the liquidity asset ratio-based system imposed quantitative restrictions on credit and interest rates. The mixed system was introduced during the transition period between 1981 and 1985 (Aron and Muellbauer, 2001). This was followed by a pre-announced M3 monetary target that employed the discount rate to influence market interest rates between 1986 and 1998. From 1998, the South African Reserve Bank employed daily tenders of liquidity using repurchase transactions whilst money growth guidelines and the target range for core inflation were announced every three years.

Targeting money supply was challenging because of financial liberalisation, which commenced in the 1980s, and the growing openness of the capital account from 1995 (Aziakpono and Wilson, 2010). The current monetary policy regime is inflation targeting that was implemented in February 2000. It uses the repo rate system. According to Aziakpono and Wilson (2010) the South African monetary policy regimes can thus be broken down into five distinct periods, namely, (i) a liquid asset ratio-based system with quantitative controls over credit and interest rates (1960-1981); (ii) a mixed system during the transition period (1981-1985); (iii) a cost of cash reserves-based system with pre-announced monetary targets (1986-1998); (iv) daily tenders of liquidity through repurchase transactions (repo system) and pre-announced (M3) targets and informal targets for inflation (1998-1999); and (v) the repo rate system with an inflation targeting regime (2000 to date).

2.4.1 Liquid asset ratio-based system (1960-1981)

From the 1960s until the early 1980s, South Africa adopted a restrictive monetary policy regime. It employed a liquid asset ratio-based system with the following instruments to impose controls on interest rates and credit: exchange rate controls, import deposit controls, credit ceilings and deposit rate controls. The interest rate only played a small role in this system as a monetary policy instrument because the liquid asset requirement was mainly used to achieve monetary policy control. As a result, commercial banks were required to hold a minimum proportion of deposits in reserves to reduce money growth and bank lending (Aron and Muellbauer, 2000). This limited their ability to increase lending and controlled the money in circulation. However, inflation remained volatile due to the limited use of the interest rate as a monetary policy instrument. In 1985 the inflation rate rose to 18.52 per cent from 6 per cent in the 1970s. This led to a mixed system during the transition from a liquid asset ratio system to a market-oriented approach (Moolman and Du Toit, 2004).

2.4.2 Mixed system (1981-1985)

The De Kock Commission recommended the mixed system that introduced a cash reserves-based system from 1981 to 1985 (Aron and Muellbauer, 2000). This was motivated by significant fluctuation in the velocity of money from 1976 following fluctuations in direct controls on interest rates and bank credit (monetary policy instruments). During this period the SARB's setting of the discount rate was influenced by market interest rates and the price of overnight collateralised lending. This regime was characterised by financial liberalisation, and other structural developments led to changes in output, and the growth of money supply and prices, and significantly minimised the effectiveness of money supply targets (Aron and Muellbauer, 2000).

2.4.3 Cost of cash reserves-based system with pre-announced monetary targets (1986-1998)

The de Kock Commission of Inquiry decided to extend its recommendations due to poor predictions of the value of the Rand between 1972 and 1978. The commission noted that the Reserve Bank was more likely to predict the future value of the Rand than the exchange rates market. In 1986, the cash reserves-based system pre-announced the monetary target range for broad money (M3) for the first time (de Kock Commission, 1985). The main instrument was the interest rate for regulating market interest rates and the cost of overnight collateralised lending (Aron and Muellbauer, 2000). This policy was more effective than the liquidity asset ratio-based system because the banks' high interest rates limited demand for bank credit by contracting the collateral against government bills. However, in the late 1990s, this regime was rendered infective by the opening up of the South African economy (Ludi and Ground, 2006), leading to a fourth monetary policy regime.

2.4.4 The repo system and pre-announced (M3) targets and informal targets for inflation (1998-1999)

From 1998, the SARB employed daily tenders of liquidity using repurchase transactions together with informal inflation targets and pre-announced (M3) targets. The emphasis was on short-term interest rates that were set using the daily tender amount for interest rates and repurchase transactions that are determined by market forces (SARB Quarterly Bulletin, June 1999). Money growth guidelines were not announced annually, but every three years due to the volatile correlation between prices and money. Inflation targeting was introduced as a new policy regime to combat this drawback.

2.4.5 The repo rate system with an inflation targeting regime (2000 to date)

The most recent monetary policy regime is the repo rate system that was adopted in February 2000. The South African Government, through the SARB adopted a repo rate system that relates to inflation targeting. The target has been changed a number of times depending on the response to exogenous shocks. For instance, in 2004 and 2005 the target was from 3 to 5 per cent, which rose from 3 to 6 per cent after 2006 (Aron and Meullbauer, 2006). It is possible to reduce the interest rate fluctuations that may arise from a progressively shortening target horizon (Monetary Policy Review, 2004:2). Mboweni (2002) argued that inflation targeting would improve the SARB's transparency and accountability, stabilise the value of money and nominal interest rates, provide an anchor for inflation expectations and reduce inflation and inflationary expectations by re-orienting people about the future.

According to Mishkin (2007), inflation targeting comprises of five basic elements: (i) medium-term numerical targets for inflation, (ii) timely responses to shocks to increase monetary policy transparency, (iii) the Central Bank's commitment to price stability, (iv) more accountable decisions by policymakers, and (v) communicating effectively with markets and the public about monetary policy strategies that are debatable and set policy tools that are not restricted to exchange rates or monetary aggregates. The achievements recorded during this regime and the ongoing need to stabilise prices resulted in its retention and extension.

The 2008/ 2009 global economic recession resulted in South Africa's Monetary Policy Committee meeting every month, except for July 2009, to evaluate the rapid changes in the economy and respond effectively. Preceding to the global financial crisis, the repo system was used in the inflation targeting framework. This framework targeted a CPI excluding mortgage rates, which changed to a headline inflation measure as from January 2009. Before to the financial crisis, the Central Bank also employed the overnight interest rate as a monetary policy instrument. However, the interest rate channel in South Africa was weakened following the crisis (Kabundi and Rapapal, 2019). A micro-prudential policy was considered as a complement to monetary policy and to manage idiosyncratic financial stability concerns. The financial crisis led to renewed debate in the literature on the relationship between monetary policy and financial stability, with suggestions that the target instrument in macro-prudential regulation might be appropriate.

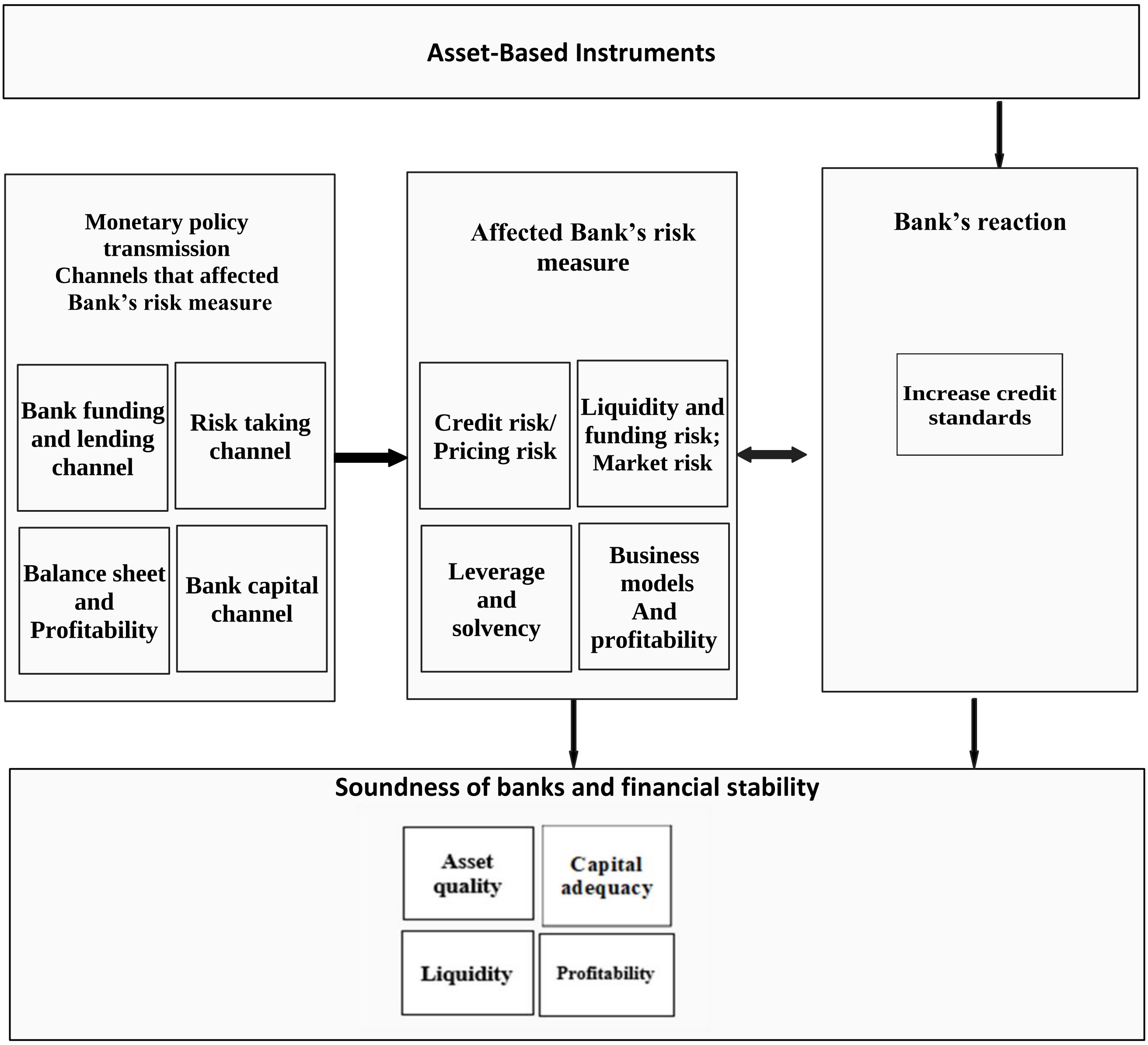
2.5 The interconnectivity of monetary policy and macro-prudential policy

Pre-crisis macroeconomic analyses ignored the role of financial intermediaries; the financial sector was thus regarded as a neutral middleperson in monetary policy transmission. The asset price channel might weaken or intensify the transfer of shocks; however, active risk-taking and financial institutions themselves were never seen as major sources of financial instability. The transmission mechanism of traditional and new instruments of macro-prudential policy and monetary policy is somewhat complex, but both policies must take account of the primary goals and probable effects of the other. The interaction between monetary and macro-prudential policies can be grouped into three categories, based on the macro-prudential policy instruments: asset, capital and liquidity-based.

Impact of monetary policy on asset-based macro-prudential instruments (MPI)

The monetary transmission channels that affect asset-based MPI include the balance sheet and profitability channel, the risk-taking channel, the bank funding and lending channel and the bank capital channel (see Figure 2.2). The linkages between the monetary and macro-prudential policies stem from the balance sheet and risk-taking channels; they arise from collateral constraints and information asymmetry. Banks are susceptible to uncertainty about the repayment of loans. A negative shock to financial market uncertainty and aggregate demand results in banks reducing leverage by limiting risky lending. They also require higher collateral. Therefore, adverse shocks are responsible for the reduction in credit supply. The primary impact is amplified by numerous market mechanisms, as the low supply of credit limits the market price of collateral and aggregate demand (Geanakoplos, 2009). Monetary policy might reduce this effect by changing the interest rate, thus affecting risk-taking by financial intermediaries and borrowing costs.

Figure 2.2 Impact of asset-based MPIs on the transmission mechanism



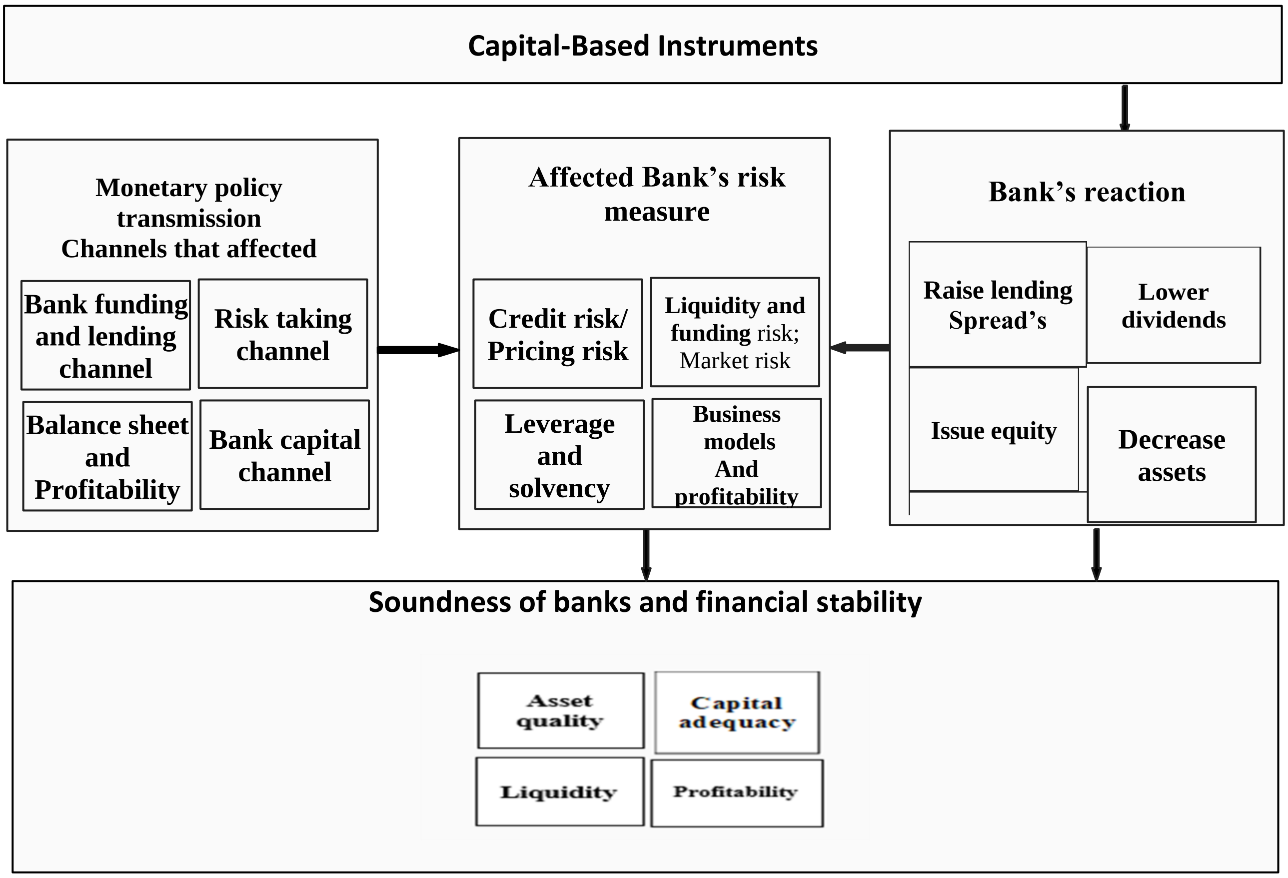
Source: ECB, 2017

Figure 2.2 also reveals that real estate MPI might cause some conflict between the two policies when the financial and economic cycles are not synchronised. Macro-prudential policymakers might reduce back leverage by adopting tools that target real estate exposure to mitigate the risk to financial stability. However, these measures might have a contractionary effect on the economy, thus offsetting the positive impact of monetary policy by making it difficult for monetary policy to counteract risks to price stability (Agenor and da Silva, 2014).

Impact of monetary policy on capital-based macro-prudential instruments (MPI)

The transmission channels of monetary policy that affect capital-based MPI include the risk-taking channel, the bank funding and lending channel, and the balance sheet and profitability channel (see Figure 2.3). In the risk-taking channel, restrained profitability causes banks to take more risks by increasing leverage, investing in riskier assets and expanding their balance sheets. Expanding balance sheets might conflict with macro-prudential goals, especially with a low interest rate policy during an economic contraction. During times of economic contraction, macro-prudential policymakers consider it inappropriate for banks to increase their risk positions. Therefore, they might see fit to tighten capital-based requirements.

Figure 2.3 Impact of monetary policy on capital-based MPIs on the transmission mechanism



Source: ECB, 2017

Figure 2.3 also shows that the bank funding and lending channels of monetary policy are associated with the cost of credit supply and the costs of funding in the economy. Expansionary interest rates result in a rise in the supply of credit and low funding costs. For instance, when interest rates are low because of low economic growth and low inflation, the macro-prudential authorities might release Countercyclical Capital Buffers.

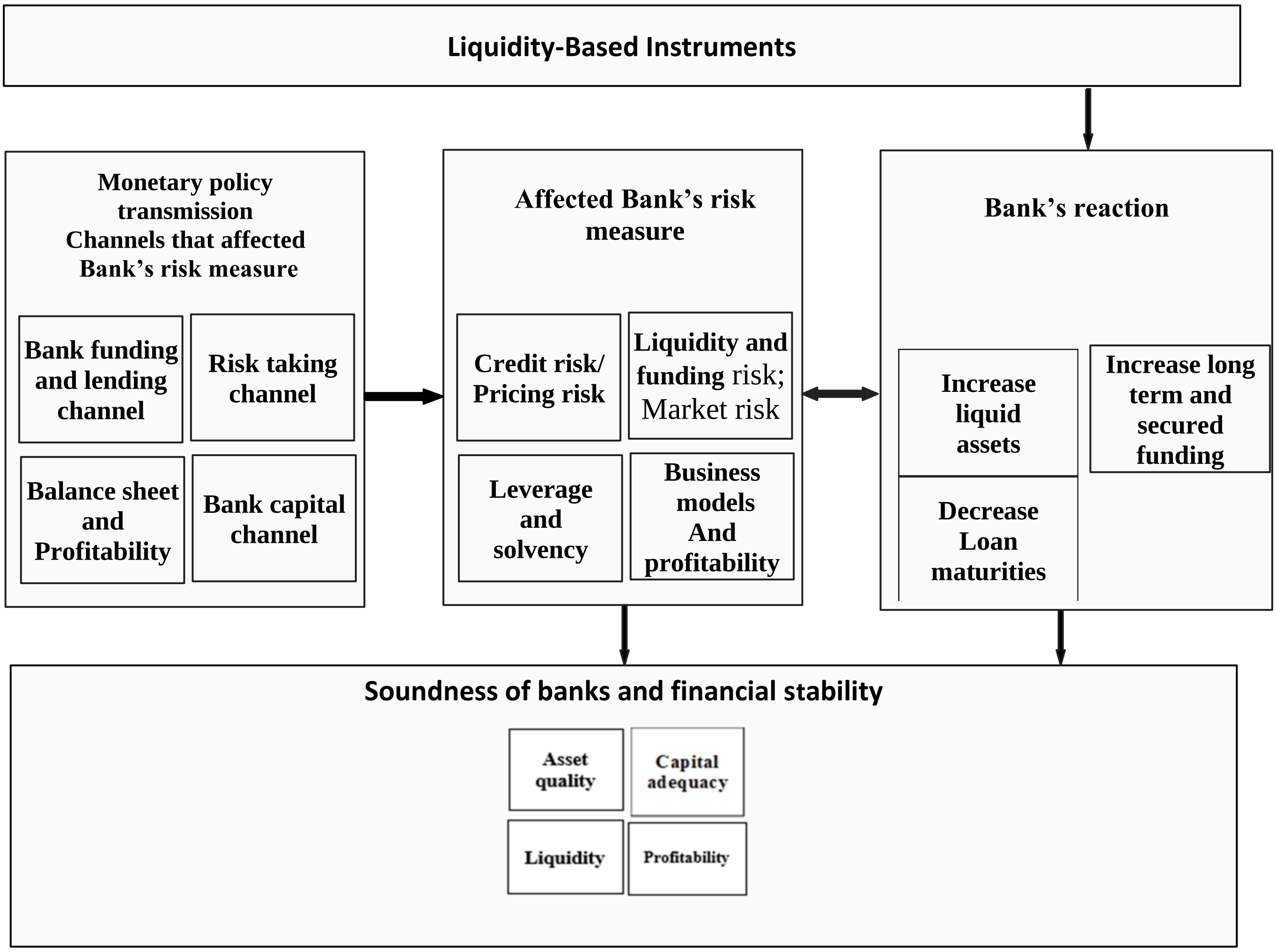
Figure 2.3 further illustrates that in the bank balance sheet and profitability channel, the banks' net interest margin is likely to be tighter when interest rates are low. Low interest rates tend to have adverse effects on banks' profitability. Thus, the macro-prudential authorities respond by tightening capital-based requirements. Lower interest rates result in higher asset price valuations and lower funding and impairment costs.

Overall, monetary policy's impact on capital-based macro-prudential instruments is ambiguous. The anticipated effects of the impact of capital-based macro-prudential instruments that aim to reduce risk could either be cancelled out or reinforced by monetary policy actions, depending on the dominant channel.

Impact of monetary policy on liquidity-based macro-prudential instruments (MPI)

The transmission channels of monetary policy that affect liquidity-based MPI include the risk-taking channel, the bank funding and lending channel, and the bank capital channel (see Figure 2.4). In terms of the risk-taking channel, the introduction of liquidity coverage ratio (LCR) regulations makes it necessary for banks to hold highly liquid assets which may interact with normal portfolio shifts encouraged by the risk-taking channel when interest rates are tight during an expansion. The LCR might dampen the risk-taking channel and vice-versa. The risk-taking channel is likely to change banks' desire to hold highly liquid assets, therefore interacting with the liquidity coverage ratio regulation.

Figure 2.4 Impact of monetary policy on liquidity-based MPIs on the transmission mechanism



Source: ECB, 2017

Figure 2.4 demonstrates that Central Bank lending might lead to conflict between secured and unsecured interest rates. This tension arises due to the LCR increasing demand for a particular type of secured funding, which might result in decoupling between secured and unsecured interest rates. The introduction of stable funding (which defines the LCR) might reduce monetary policy's effectiveness along with the repo and money market. An example is rising demand for financing backed by low-quality liquid assets from the Central Bank.

In the bank capital channel, high interest rates might result in a decrease in bank capital value. Given that the LCR encourages banks to hold a higher percentage of government bonds, which may have a longer duration, this may also alter the way monetary policy influences the bank capital channel.

2.6 Summary and conclusion

This chapter focused on theoretical issues, the monetary policy system, the approaches adopted by South African policymakers and the relationship between monetary policy and macro-prudential policy. It presented an overview of regime shifts and highlighted the need for debate on monetary policy frameworks. Different regimes have been adopted to stabilise prices in South Africa. The last monetary policy regime introduced inflation targeting in February 2000. The main reason South Africa adopted inflation targeting was to stabilise medium-term inflation expectations. Inflation targeting would arguably enable the monetary authorities to respond more aggressively to stabilise the real economy, without as many sacrifices in terms of price stability that would be required in the absence of well-anchored expectations. It was also noted that the shift towards inflation targeting needs to be reconsidered in light of the global financial crisis. This suggests that macro-prudential policy might be appropriate. The following chapter reviews macro-prudential policy and its implementation in South Africa.

CHAPTER 3

THE MACRO-PRUDENTIAL POLICY FRAMEWORK

3.1 Introduction

This chapter begins by discussing macro-prudential policy across the world. The focus then turns to South African macro-prudential policy in terms of its functions, objectives and decision-making powers.

3.2 Overview of the Macro-Prudential Policy Framework

The 2007/2008 financial crisis highlighted the need for macro-prudential supervision and regulation. The macro-prudential policy aims to stabilise the financial system. The failure of monetary policy and micro-prudential policy (that concentrates on the resilience of individual financial institutions) in some jurisdictions has contributed to system-wide risk that has a significant negative effect on the real economy (Bernanke and Gertler, 2001). In retrospect, there has been no clear understanding of system-wide risk (Catte et al., 2010). System-wide risk is defined as "any threat of disruption to financial services that is caused by an impairment of all or parts of the financial system that can potentially trigger negative repercussions on the real economy" (SARB, 2017, p. 33).

Systemic risk can stem from different sources, including excess risk-taking, lending risk, funding liquidity risk and concentration risk. Counteracting these risks produces a trade-off between financial and price stability that might be welfare improving (Hollander and van Lill, 2019). Therefore, macro-prudential policy gained ground in global organisations such as the Financial Stability Board (FSB) and the G-20. Furthermore, the authorities and academics have engaged in on-going debate on the macro-prudential policy shift from being a reactive policy (crisis management and resolution) to adopting the mechanism design approach of monetary policy (Hollander and van Lill, 2019).

The design of macro-prudential policy is distinguished from that of a monetary policy by the instruments that are responsible for achieving its goals (Svensson, 2018). The macro-prudential policy mainly focuses on the use of macro-prudential instruments to mitigate systemic risk. There are two types of systemic risk, namely, the time dimension and cross-sectional dimension. The time dimension aims to limit financial system procyclicality using prudential tools, thus calibrating at the stage of the business cycle (Shin, 2009; Brunnermeier and Pedersen, 2009; Brunnermeier et al., 2009; Borio and Zhu, 2008). It uses instruments that can vary based on the development of the cycle. The tools used for this dimension apply at all levels, and some are designed to tackle risk build-up in a specific sector. For example, countercyclical capital requirements address procyclicality of capital requirements (Repullo et al., 2009; Saurina and Trucharte, 2007; Kashyap and Stein, 2004). This instrument might be insufficient in times of distress; therefore, LTV ratios might be best suited to cause provision to rise during business cycle contractions (Borio et al., 2001). According to Hanson et al. (2011), employing minimum capital ratios during stable financial periods might significantly surpass the standards that markets might impose in financially unstable periods.

The cross-sectional dimension captures the systemic risk and calibrates the prudential tools in line with each institution’s share of systemic risk. In other words, instruments need to differentiate the maturity structure of the bank’s balance sheet. Such tools include the NSFR and liquidity coverage ratio (Basel Committee on Banking Supervision (BCBS), 2009), even though they have elements of procyclicality. Liquidity risk charges that penalise short-term funding can dampen the adverse procyclical effects of banks (Perotti and Suarez, 2011). The efficacy of macro-prudential policy is dependent on appropriate policy instruments that diminish the systemic risks resulting from both cross-sectional and time dimensions.

Each instrument is associated with an intermediate policy target of macro-prudential policy in reducing cyclical risk. Systemic risk emanating from excessive maturity transformation and leverage might be dampened by Debt-To-Income (DTI) and LTV restrictions (SARB, 2017). The LTV ratio prevents the expansion of mortgage credit from exceeding a particular percentage of the market value of a property. In contrast, the DTI ratio restricts expansion of credit beyond a multiple of a debtor's income (SARB, 2017). The objective of LTV ratio restrictions is to promote bank resilience by increasing the pledge of a mortgage loan, thus reducing losses during default (Wong et al., 2004; Crowe et al., 2011).

Similarly, the objective of DTI ratios is to reduce the debt level in a particular income bracket, thus enabling debtors to pay the debt (Igan and Kang, 2011). These ratios contract during an upswing and loosen during a downswing. Implementation of macro-prudential instruments also depends on the financial cycle phase. Each phase is guided by systemic risk indicators such as loan-to-deposit ratios, long-term assets to long-term funding loans ratios, and the ratios of liquid assets to total assets. These indicators require time-varying liquidity buffers in addition to minimum micro-prudential requirements for the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR) that can be applied as macro-prudential instruments. These instruments aim to address adverse externalities or spill-overs, resulting in excessive liquidity risk (Perotti and Suarez, 2009). The LCR seeks to increase the short-term resilience of the bank's liquidity risk profile by verifying that adequate unencumbered high-quality liquid assets can be readily changed into cash to fulfil liquidity requirements for 30 days (SARB, 2017). The NSFR's objective is to limit the probability of disruptions to a bank's regular source of funding which would reduce its liquidity and heighten the risk of it failing, possibly leading to wider systemic risk. Several policy discussion and research papers assess the ability of these macro-prudential tools to insulate the economy from financial instability.

The IMF has compiled a series of papers that identify existing macro-prudential instruments. For example, Lim (2011) shows that 34 tools can be employed to prevent the build-up of financial imbalances. Each measure is classified according to its potential indicator. As suggested by Blanchard et al. (2013), each measure can be differentiated in terms of its effects on borrowers and lenders. Cross-sectional measures are another way of identifying criteria that point to the probability of a crisis in the financial system; they are also designed to tackle the time-series dimension of financial stability (emanating from the procyclicality of the financial system). Multiple macro-prudential instruments are used simultaneously, depending on national economic conditions.

3.3 National Macro-Prudential Legislation

The national macro-prudential legislation sets out the functions, objectives and the powers of macro-prudential policymakers. This legislation guides policymaking and improves the accountability of policymakers (Villar, 2017). The main macro-prudential functions should be to identify systemic risks; and thereafter to formulate and implement policy responses (SARB, 2017). The SARB (2017) also asserts that macro-prudential policymakers should collect information, supervise regulated entities, issue regulations and ensure compliance with the applicable rules. In South Africa, the macro-prudential policy functions and decision-making powers conferred on the SARB were a natural extension once it adopted the objective of financial stability (SARB, 2017). These functions require strong governance, the amendment of current instruments and the development of new tools to measure and assess systemic risk.

The macro-prudential authority sets up an early warning system (EWS) to monitor the build-up of systemic risk and threats to the financial system using a specified set of indicators (Kabundi and Mbelu, 2017). These indicators must provide signals on the accumulation of financial imbalances before a crisis (Bank of International Settlements (BIS), 2012). For instance, in South Africa, the prevailing situation determines the SARB's indicators. It is also important to note that the FCI highlights global and idiosyncratic financial risks (Kabundi and Mbelu 2017). Thus, the authorities use the FCI as a broad measure that shows the cost of obtaining loans in the economy and as an early warning signal when making CCyB decisions (SARB, 2019). The size of the CCyB is estimated by a stress test on the banking system.

Stress tests are employed to evaluate the resilience of the South African banking sector in addressing plausible adverse scenarios (SARB, 2019). This is generally achieved through the development of a risk assessment matrix that identifies risk employing bottom-up and top-down stress tests (SARB, 2018). The stress test exercise focuses on domestic banks, including foreign exposure originating within South Africa. The test is able to effectively analyse the effects of various stress scenarios on solvency positions (market risk, credit risk and counterparty credit risk) and the liquidity profile of the South African banking sector. To identify the scenario design, the SARB employs a Core Econometric Model to obtain consistent international and local macro-financial scenarios, covering a three-year forecast horizon (SARB, 2016). The macro-financial scenarios include a baseline, harsh yet relatively short-lived V-shaped recession and a less severe but more protracted L-shaped recession. The common scenario stress test suggests the resilience of the banking sector, considering the financial stability risks.

Financial instability can be prevented by Central Banks using macro-prudential measures Claessens, 2015). To achieve this objective, it is imperative to continually monitor the risk to the financial system, assess and analyse the contributing factors, and determine the suitable policy reaction to tackle these risks and implement these measures. The monitoring process focuses on systemic vulnerabilities that spread adverse shocks, rather than the shocks themselves (Bernanke, 2013; Adrian, Covitz and Liang 2015). It also considers risk from systemically important financial institutions (SIFI), asset markets, the non-financial sector and shadow banks. The risk originates from financial cycles. To address this problem, the SARB can set its CCyB to target the forecast of its financial cycle (SARB, 2017). The CCyB shows how the policy should be implemented to reach their goal over the medium to long run (Svensson, 2018).

Another key aspect is that the institutional structure of macro-prudential supervision should consider country-specific conditions. In emerging countries, financial systems are dominated by banks, and the Central Bank is at the centre of macro-prudential arrangements (Villar, 2017). In other words, the objective of financial stability is delegated to the Central Bank. The reasons for this extension of the Central Bank's mandate are, firstly, the benefits of monitoring macroeconomic developments (Galati and Moessner, 2017). Secondly, centralising the macro-prudential responsibilities within the Central Bank facilities coordination of the activities of distinct agencies. Thirdly, monetary and macro-prudential policies' objectives overlap (Nier et al., 2011).

It should be noted that emerging markets and developed countries adopted macro-prudential tools before the 2007/2008 global financial crisis (Villar, 2017). While developed countries focused on borrower-based credit restrictions, particularly LTV ratios, emerging markets used credit growth foreign exchange deposits. However, South Africa has less experience in employing macro-prudential policy relative to the other G20 countries and fellow emerging market economies (Havemann, 2014; Lombardi and Siklos, 2016; Ceruttia, Claessens and Laevenc, 2017).

3.4 South African Macro-Prudential Legislation

In 2010, the Ministry of Finance mandated the SARB to supervise macro-prudential policy (National Treasury, 2016). The process to be followed in carrying out this mandate is outlined in the Financial Sector Regulation (FSR) Bill of 2016 (National Treasury, 2016). These steps include measures to prevent financial instability and to curb the adverse effects of systemic risk on the financial system (Borio and Shim, 2007; Hilbers et al., 2005). Furthermore, the FSR aims to promote coordination, cooperation, consistency and collaboration between the macro-prudential authority, the National Credit Regulator, the SARB, the Financial Sector Conduct Authority and other structures of government in ensuring a stable financial sector. The FSR has also established an advisory committee, the Financial Stability Oversight Committee (FSOC), that is presided over by the Governor of the SARB, and also comprises of representatives from the financial regulators, National Treasury and SARB officials (SARB, 2017). Similar to the institutional design of the SARB's monetary policy, the FSOC issues comprehensive biannual Financial Stability Reviews, reports and public statements and meets every six months to publish and table in Parliament a financial stability review that evaluates and identifies the risks to financial stability. Within the SARB, the Financial Stability Committee (FSC) is accountable for the formulation of macro-prudential policy. It is made up of members of the monetary policy committee and senior members of the SARB, which promotes communication among committee members and the interaction of both policies (Kohn, 2015). According to Villar (2017), coordination is achieved through an interagency committee.

In 2016 the Bank for International Settlements (BIS) distributed a questionnaire to 24 emerging market economy's Central Banks. South Africa is one of the 13 emerging economies with full control of macro-prudential instruments (Villar, 2017). These instruments include CCyBs, sector-specific capital requirements for LTV ratios and debt services-to-income ratios, and the banking sector, among other things (Villar, 2017). Decisions on their use lie with the Central Bank as the banking supervisor, the National Credit Regulator, and the prudential authority (Bank of International Settlements, 2016). The defining elements of South Africa's macro-prudential policy include its objectives, its tools and its scope (FSB-IMF-BIS, 2011). The macro-prudential policy aims to reduce endogenous risk propagation (Bank of International

Settlements, 2016). Another crucial role is to dampen unsustainable surges in leverage and risky funding options.

The aim of the macro-prudential instruments is to reduce the accumulation of systemic risk within the financial system by curbing the risk of concentration which emanates from financial institutions that have identical exposure or direct balance-sheet linkages (SARB, 2016). In 2012, the Basel Committee on Banking Supervision (BCBS) launched the Regulatory Consistency Assessment Programme (RCAP) to track progress in adopting domestic regulations, evaluate their consistency and analyse regulatory outcomes (BIS, 2019). At the end of September 2019, the SARB adopted capital conservation buffers, LCR regulations and risk-based capital rules. South Africa has implemented the disclosure framework to a significant extent; however, the implementaion of other Basel standards is still work-in-progress, meaning that the draft regulation was published.

In January 2016, South Africa phased-in the Domestic Systemically Important Bank (D-SIB) requirements and the CCyB (Bank of International Settlements, 2019). The CCyB aims to limit the banking sector's propensity to intensify the procyclical effect on the real economy through rapid credit decline and rapid credit supply, which arise in times of financial stress and financial tranquility, respectively (SARB, 2017), while the D-SIB focuses on the higher loss absorbency requirements and the assessment methodology (BIS, 2018). The leverage ratio based on the existing exposure definition was fully implemented in July 2016. South Africa also issued final rules for the NSFR. Other Basel standards that have been fully adopted include leverage, liquidity and disclosure. Furthermore, public disclosure came into effect in January 2015. However, while several policy tools have been identified to manage procyclical effects, there is no consensus on which tools to implement (SARB, 2017).

The macroprudential policies implemented in South Africa fall into three main categories: capital base, asset side base and liquidity base. The categories incorporate the following basel standards that have been adopted completely namely, capital, leverage, systemically important banks, Liquidity and Disclosure (BIS, 2018). The Countercyclical capital buffer and the domestic systemically important banks requirements in line with the international agreement was in force from 1 January 2016. Whereas, for the global systemically important banks indicators the prudential authority is not the home supervisor. Another international agreement was the pillar 3 disclosure requirements that were revised in 2016. Other disclosure requirements that were revised include leverage ratio, liquidity ratio, countercyclical capital buffer and remuneration. The disclosure requirements related to risk-weighted-assets overview and composition of capital have been implemented. In July 2016 liquidity requirements that monitor banks and a 4% leverage ratio requirement was implemented (BIS, 2019).

3.5 Summary and Conclusion

Despite its widespread acceptance and application, macro-prudential policy is still in its infancy. As such, several challenges and issues surround the macro-prudential policy framework, chief among which are the lack of a standard definition across economies for financial stability. The literature (see, for example, Allen and Wood, 2006; Padoa-Schioppa, 2003) defines financial stability as the robustness of the financial system to external shocks. Another definition highlights the endogenous nature of financial distress (SARB, 2017).

Furthermore, there is no consensus on the role of various tools in macro-prudential policy and no primary tool has been identified. In contrast, there is agreement on the range of monetary policy instruments, the primary one being interest rates, with communication playing a critical secondary role (Blinder et al., 2008). However, non-conventional tools have been employed in extreme cases where interest rates are approaching the zero-lower bound (Bernanke and Reinhart, 2004; Gertler and Karadi, 2011; Lenza et al., 2010). There is a gap in the literature on a comparable consensus on macro-prudential frameworks, models and tools (Hartmann, 2011). Implementation of the macro-prudential policy mandate, accountability and operational independence and the best possible use of such tools is still open to debate. According to Galati and Moessner (2013), the critical issue is to assess the mandate of the macro-prudential policy, i.e., whether it should be an independent authority or be set in line with the Central Bank's monetary policy decisions.

The primary issue is coordination of macro-prudential and monetary policy. The challenge is that these policies' tools and objectives are interrelated (Schoenmaker and Wierts, 2011). Macro-prudential policy mitigates systemic risks and produces buffers, and this assists the achievement of monetary policy objectives with regard to the risk of financial shocks (Villar, 2017). The macro-prudential policy can minimise the likelihood that monetary policy's effectiveness is diminished due to the risk of financial shocks, such as the zero lower bound. This might help to reduce conflict in pursuing monetary policy and reduce the pressure on monetary policy to 'lean against' financial instability, thereby enabling the monetary authorities to achieve price stability (Villar, 2017). Therefore, if implemented independently, monetary policy and macro-prudential policy may offset each other.

Furthermore, the organisation of the macro-prudential mandate lies in the potential trade-offs between the two policies. For example, Aikman et al. (2018) show that a loose interest rate might intensify the financial cycle. On the other hand, a tight macro-prudential policy might negatively affect credit provision and monetary policy transmission. Where the low interest rate is consistently in line with low inflation, the macro-prudential policy might promote excessive credit growth and the building of asset bubbles, inducing financial instability (Cecchetti and Kohler, 2012). As a result, the coordination of policy actions is of major importance. Overall, work needs to continue in tackling all the challenges in the financial system.

Financial stability has been a critical objective of the SARB since its establishment. Therefore, the macro-prudential policy task with additional powers mandated for the SARB was a natural extension once it assumed the role of supervising financial stability in South Africa. This task requires strong governance and the use of old and new tools to measure and assess system-wide risk. The SARB operational framework has been reinforced to support financial stability assessment, supervision and macro-prudential policy analysis in three principal areas, namely, (a) to assess the state of financial instability; (b) to forecast risk in the financial sector emerging from both the global and domestic market; and (c) to employ macro-financial models to investigate the intensity of system-wide risk.

CHAPTER 4

FINANCIAL STRESS AND MONETARY POLICY IMPLICATIONS IN SOUTH AFRICA

4.1 Introduction

As noted in Chapter two, debate on the interaction between monetary policy and financial stability has once again resurfaced in the literature. Financial stability can be measured by an FCI or a financial stress index (FSI). Chapter three highlighted that different types of systemic risk can contribute to financial instability. This chapter investigates how financial stress affects the economy.

Financial stress can be broadly defined as the extent of disruption to the normal operations of markets or infrastructure, and financial institutions when the smooth flow of funds among lenders and investors is weakened (Hakkio and Keeton, 2009). Scholars follow different approaches to narrow this definition to specific financial stress measures that they deem to be necessary. For example, Balakrishnan et al. (2011) defined financial stress as events related to a unexpected rise in risk, liquidity droughts, and large shifts in asset prices. The SARB (2016:6) describes financial stability as “the general confidence in the ability of financial institutions to continue to provide financial products and financial services, and the ability of market infrastructures to continue to perform their functions and duties in terms of financial sector laws, without interruption despite changes in economic circumstances”.

Financial instability can disrupt the overall functioning of the financial system, with severe implications for the real economy (SARB, 2016). The 2007/2008 global financial crisis is a good example. Financial instability can also undermine the effectiveness of monetary policy (Goodhart, 2006). Historically, the South African financial system has proven to be vulnerable to uncertainty and risk from the global financial environment (SARB, 2016). According to Cecchetti and Kohler (2010), maintaining a stable inflation rate through interest rate setting is not sufficient to prevent financial instability; this was evident during the global financial crisis.

In the above context, a financial stability-oriented monetary policy usually follows price stability and only deviates once financial instability becomes evident (Borio, 2016). This policy approach can be a problem because it does not react to financial stress build-ups, thus leading to a delayed response in relation to interest rates. To a certain extent, a financial stability-oriented monetary policy may accelerate the financial crisis instead of preventing it. In order to avoid this problem, financial stability needs to be monitored to differentiate between normal periods, financial stress build-ups and periods of financial stress. Early warning signals can be detected through an FSI or FCI (SARB, 2017). These indices differ in terms of their methodologies. The FCI uses different weights to capture financial markets while the FSI employs a constant weighting method, making it too restrictive (Aceomglu, Ozdaglar and Tahbaz-Salehi, 2015). The FCI also includes several additional variables, namely, year-on-year headline inflation, the GDP growth rate and global financial markets.

Few studies have been conducted on the construction of the FSI/ FCI in South Africa. Gumata et al. (2012) estimate an FCI from 1999 to 2011 using 11 nominal variables and the empirical technique of a principle component analysis and a Kalman filter with constant loadings. The authors find that the estimated indicators outperform the SARB’s leading indicators and have the ability to predict GDP growth. Thompson et al. (2015) improve the FCI constructed by Gumata et al. (2012) by extending the period to 1966 to 2011 and employing a recursive principle component analysis (PCA) using three macroeconomic variables (interest rates, output and inflation) and 16 monthly financial variables (including domestic and global measures), thus removing endogeneity from the index. Using a causality test, they find that the index is a good in-sample predictor of interest rates and growth in industrial production, but it fails to predict inflation. Kasai and Naraidoo (2013) employ more recent data covering the period 2000 to 2008 to construct an FCI using an equal-weighted average of five variables. Their FCI estimates include the response of monetary policy to maintain financial stability. The estimated FCIs in the foregoing discussion use constant weights that hardly construct the index in real-time. Kabundi and Mbelu (2017) closely follow the work of Koop and Korobilis (2014) who construct the FCI for the US using a time-varying factor model employing 39 monthly financial variables from January 2000 to April 2017. The estimated FCI includes several market financial conditions, namely, equity, real estate, credit, foreign exchange, funding and foreign data. The authors also use a time-varying parameter factor-augmenting vector autoregressive (TVP-FAVAR) model to construct the FCI that includes two macroeconomic variables.

Numerous studies have investigated the interaction between financial stability and the macroeconomy. For example, Ncube, Ndou and Gumata (2016) found that the South African economy tends to be sluggish during periods of financial stress and that a monetary policy rule is not aggressive when responding to financial stress. Similar findings were reported by Davig and Hakkio (2010) in the US, who argued that financial stress could significantly decrease economic activity. Also in the US, Hubrich and Tetlow (2015) used a Markov switching model incorporating price determination and found that conventional monetary policy is weak during high-stress regimes. In the context of South Africa, Balcilar et al. (2016) used an FCI constructed by Thompson et al. (2015) to test whether the reaction of the real economy is asymmetric to unanticipated changes in financial conditions. Thompson et al. (2015) found that the real economy reacts asymmetrically to financial shocks. In addition, it is observed that the Treasury Bill rate and manufacturing output growth are more affected by high financial stress shocks than low financial stress shocks, while inflation responds more to financial shocks during recessions than during periods of expansion. However, none of these studies employ an FCI compiled using a time-varying parameter factor-augmented vector autoregressive (TVP-FAVAR) model. The TVP-FAVAR improves the index because it accounts for evolving links between financial and macroeconomic variables (Aceomglu et al., 2015). Moreover, it is not too restrictive.

This chapter contributes to the literature by investigating the interaction between financial stress and the macro-economy within a framework of a time-varying FCI. Most of the literature in South Africa (see, for example, Balcilar et al., 2016; Ncube et al., 2016) examines the financial linkage to the real economy within an index constructed with the constant weighing method. We argue that this method does not account for the revolving relationship between financial and macroeconomic variables and is, therefore, less informative for policymakers.

The methodology used in this study enables a systematic examination of the linkages between the FCI and macroeconomic variables such as interest rates, credit, real GDP and inflation. These variables are embedded in a Markov-switching Vector Autoregression model with Bayesian estimation. The results show that financial stability needs to be taken into consideration when setting monetary policy. The study also finds that monetary policy loses its effectiveness during times of high financial stress, under the assumption that the interest rate channel might be impaired.

The remainder of the chapter is structured as follows: Section 4.2 defines financial instability and presents a brief overview of the FCI and monetary policy. Section 4.3 reviews the relevant recent literature. Section 4.4 describes the methodology and details of the main features of the FCI as well as the macroeconomic variables and data sources. Section 4.5 explains the study findings and Section 4.6 provides concluding remarks.

4.2.1 Financial stress and monetary policy

This section examines two categories of financial stress measurement, namely, the FSI and the FCI. It also explores the interaction between interest rates and the FCI.

The distinction between the FSI and FCI is relatively small. Both are constructed from a continuum of financial variables that denote the financing cost in the economy. The main difference between the FSI and FCI is their objectives (Kliesen et al., 2012). The FSI's objective is to observe instabilities in the financial system without considering how distress is evident in the real economy. In contrast, the FCI considers the link between financial distress and the real economy. A further difference is the set of indicators used in their construction (Hatzius et al., 2010). The FSI uses market prices-based measures while the FCI relies on quantities, prices, and other macroeconomic variables, namely inflation and output growth. Financial conditions index measures can forecast economic activity as indices of current and historical real economic activity. The broad approach of the FCI has the advantage of capturing a looming crisis in its infancy. As a result, the time varying parameter factor augmented vector autoregressive (FAVAR) model is used to construct this index.

The current literature has adopted numerous approaches to construct financial stability measurements. These include a reduced-form VAR model, the weighted sum approach and principal component analysis (Swiston, 2008; Goodhart and Hofmann, 2001). A limitation of all these models is that the amount of information incorporated is relatively restricted.

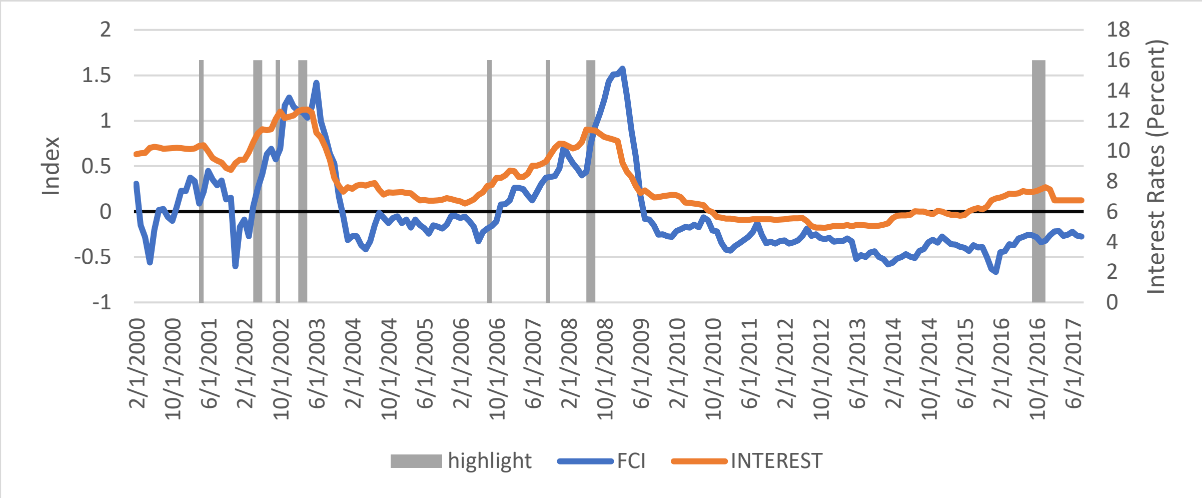
According to Hatzius et al. (2010), alternative measures of financial stability can improve forecasting performance by expanding the number of financial variables. For example, Gumata, Klein and Ndou (2012) used a Kalman filter and PCA with a constant weighting method to construct an FCI from 11 nominal indicators in South Africa. They found that their index has forecast data for near-term output growth which produces better results than the

SARB's leading indicator. Thompson et al. (2015) re-evaluated Gumata et al.'s (2012) FCI by employing a recursive PCA with constant loadings to inflation, interest rates and output (industrial production). The causality test demonstrates that their indicator is an excellent out-of-sample predictor of output growth but a weak predictive instrument for interest rates and inflation. The disadvantage of this approach is that it is too restrictive. To overcome this, Kabundi and Mbelu (2017) developed a South African FCI using the Koop and Korobilis (2014) approach. The benefit of using this measure is that it employs several weights connected with several sectors of the financial market so that it is comparatively easy to detect a sector that is under stress.

Historically, the view has been that monetary policy facilitates financial stability (Borio, 2016). This was the underlying assumption before the 2007/2008 global financial crisis. However, monetary policy frameworks do not include the accumulation of financial imbalances and instead focus on price stability (Cecchetti and Kohler, 2010). This was evident in 2007/2008 when the majority of finance hubs across the globe descended into financial crisis. At the same time, the monetary authorities focused their attention on monetary policy. This illustrates how monetary policy impacts the financial system.

Figure 4.1 shows the correlation between the FCI (a measure of financial stability) and interest rates (a measure of monetary policy) for South Africa from 2000 to 2017. The FCI is plotted on the primary index while interest rates are plotted on the secondary index. The two variables appear to trend together, although the FCI seems to be more volatile than interest rates. The grey-shaded areas in Figure 4.1 represent episodes of monetary contraction, and the non-shaded areas highlight episodes of monetary expansion. The FCI values that are above zero, which is the average risk level, reflect the likelihood of a financial crisis. When positive values are close to zero or further away from zero, they respectively signal a low or high probability of a financial crisis (Kabundi and Mbelu, 2017). Negative values show that the financial system is stable while values close to zero indicate an increase in financial stress.

Figure 4.1 Financial conditions index during periods of monetary expansion and contraction in South Africa



Source: SARB data, 2017

Prior to the financial crisis, there were periods when the South African economy experienced financial stress. For example, between November 2000 and December 2001, the country's FCI was above zero due to the weakening of the Rand caused by the Dotcom bubble. Interest rates remained relatively stable/constant during this period. However, in mid-2001, the monetary authorities increased interest rates and financial stability improved, with the financial stress levels falling towards their averages and continuing to levels below zero towards the end of 2001. At the beginning of 2002, a tight monetary policy led to the heightening of financial stress levels to a point where the stress levels surpassed interest rates. This was mainly driven by the further weakening of the domestic currency (the Rand) in 2001. Up until the 2007/2008 financial crisis, financial stress levels generally correlated with monetary policy, providing evidence of co-movement between the two variables from 2004 to 2005. This state of affairs changed during the global financial crisis.

Another plausible explanation for why South Africa's financial stress levels escalated, reaching 1.5, albeit with monetary policy easing aggressively, is linked to the global financial environment. The observed increase in financial stress was due to the worldwide rise in credit growth that caused an abnormality in the real estate market (Kasai and Naraidoo, 2011). However, the aggressive easing of monetary policy in 2010, 2011, and 2012 increased financial stress (Kabundi and Mbelu, 2017). These spikes resulted from the European debt crisis and the recession in the United States (Kabundi and Mbelu, 2017).

4.3 Literature review

A number of scholars have investigated the impact of the FCI and the FSI on economic activity since the 2007/2008 global financial crisis. The theoretical literature identifies three channels that account for the financial sector's linkage to the real sector. These channels, that largely relate to the whole liability and asset position of either borrowers or banks, include the liquidity channel, borrower balance sheet channel, and the bank balance sheet channel. The latter two are considered the financial accelerator (Bernanke and Gertler, 1995) that challenges the Modigliani-Miller view of the investment decision (Grinblatt and Titman, 2002). Both the bank balance sheet and the borrower balance sheet channels highlight the impact of the bank or borrower's equity position on the credit conditions these agents confront. These types of balance sheet channels emerge due to capital-market frictions, such as information asymmetries. For the bank balance sheet, capital-market frictions can also arise from regulatory requirements relating to bank capital. The liquidity channel emphasises the rigidities present in times of high stress that alter balance sheet variables.

Against this background, there has been increasing interest in examining how monetary policy-making processes have been affected by financial stress in the past few years. Especially, during the 2007/008 global financial crisis the transmission of monetary policy was impaired (Acharya et al., 2020). Theoretical studies show that the standard Taylor rule can be modified by taking into account credit spreads, asset prices, credit or leverage and exchange rates to explain financial stress (Taylor, 2008). For example, Curdia and Woodford (2010) incorporated credit frictions into the New Keynesian DSGE model. They found that monetary policy's reaction to either of these adjustments is less likely to be helpful. The magnitude of the reaction to spread adjustments is less robust to different assumptions about the disturbance type. Adopting a similar model, Teranishi (2012) found that the optimal reaction to a spread-adjusted Taylor rule of credit spreads is ambiguous, given the financial market structure.

Other studies used different proxies to broaden Central Banks' responses to financial stress variables (see Detken and Smets, 2004; Borio and Lowe, 2004; Bulir and Cihak, 2008). For example, Bulir and Cihak (2008) investigated the response of monetary policy using seven different measures of financial instability (time to the crisis, credit default swap spreads, and crisis probability) among 28 nations. They found an insignificant adverse reaction to several variables representing vulnerability (unconventional policy), whereas the panel setting shows otherwise. Another example (see Raputsoane, 2014) employs the Extreme Bounds Analysis method to analyse the interaction between monetary policy and financial stress indicator variables in South Africa. The results show a weak association between monetary policy and foreign exchange markets and also the commodities market.

Employing a financial stress dataset allows for broader analysis than that in the earlier literature that only considered singular measures. As suggested by Kashyap and Siegert, (2020) to identify financial stability risks one needs to collect granular data that will distribute debt across different borrowers. The single measures were later used as variables to construct the FSI (see, for example, Illing and Lui, 2006; Hollo et al., 2012; Gumata, Klien and Ndou, 2012). However, Acemoglu, Ozdaglar and Tahbaz-Salehi (2015) suggested that this index is too restrictive because it has a limited number of variables another challenge is that the risk might appear outside the banking system (Kashyap and Siegert, 2020). Consequently, one strand of the literature has sought to construct an FCI (see, for example, Kabundi and Mbelu, 2017; Bicchetti and Neto, 2017; Sethi and Acharya, 2019). It is also an aggregated index that covers a comprehensive perspective of the level of financial stress in the economy. It is highly likely to be more strongly associated with policymakers' perceptions of financial stress levels than a financial stress indicator variable. This will assist in enabling a more effective empirical estimation. A few empirical studies that use the FSI found that policymakers should implement policies that stabilise the financial sector in times of high financial stress. The economy seems vulnerable to additional growth during financial stress (Davig and Hakkio, 2010). During normal times, the policy authorities are required to closely monitor financial stress due to the build-up of financial distress that will increase the probability that the economy will enter a distressed state. Similar findings have been reported by Rey (2015), Cardarelli et al. (2011), Davig and Hakkio (2010), and Li and St-Amant (2010), emphasising that financial stress results in economic contraction.

The other strand of the literature employs a principal component analysis to construct a monthly FSI for emerging economies (see, for example, Cevik, Dibooglu and Kutan, 2013; Stolbov and Shchepeleva, 2016). The general conclusion in these studies is that financial stress negatively affects economic activity. These findings are supported by studies by Cardarelli et al. (2011), Balakishnan et al. (2011), and Park and Mercado Jr. (2014) that conclude that financial stress originating in advanced markets exerts significant influence on the financial stress conditions of emerging market economies. The degree of the transmission is dependent on the depth of the financial linkages between advanced and emerging economies.

Many studies have extensively researched the measurement of financial stress. A portfolio theory-based aggregation scheme is used to enhance the accuracy of the FSI. This scheme considers the interconnectedness of financial markets through time-varying cross-correlations (Chatterjee et al., 2017; Hollo et al., 2012; Louzis and Vouldis, 2012). These studies show that the transmission of shocks to the real sector differs depending on whether the financial stress is low or high.

Baxa, Horvath, and Vasicek (2013) examined how certain authorities reacted to financial stress events over the past 30 years employing a time-continuum varying parameter model. The results suggest that the authorities are most likely to change interest rates, mainly reducing them during high-stress times. These findings are consistent with (Lamers et al., 2019) who found that low interest rates benefit weaker banks at the expense of increasing financial stability risks in the future. The types of stress that the authorities are more likely to react to are bank stress and stock market stress. For instance, according to Martinez-Miera and Repullo, (2019); Jiang et al., 2019 monetary policy (through open market sales of government debt by a central bank) is effective when enhancing banks monitoring incentives through an increase in the intermediation margin. However, tight monetary policy reduces investment for both safe and risky firms. Therefore, the cost benefit analysis of the employing a monetary policy that does not incorporate the role of credit and asset prices may not be robust (Adrian and Liang, 2018). Hubrich and Tetlow (2015) found that the US's conventional monetary policy is weak during high-stress regimes. Their investigation was carried out using a Markov Switching Vector Autoregression model with Bayesian estimation. Ncube, Ndou and Gumata (2016) examine the relationship between economic activity and financial stress in South Africa using a bivariate VAR model. Their results show that the economy tends to be sluggish during periods of financial stress. The monetary policy rule is not aggressive when reacting to financial stress

(Ncube, Ndou and Gumata, 2016) and inflation's effect on economic activities tends to accentuate financial stress (Ncube, Ndou and Gumata, 2016).

The FCI is preferable because it can detect imminent financial stress levels in the early stages and readily identify the sector under stress (SARB, 2017). Therefore, Bacilar et al. (2016) use FCI variables to examine if the real economy in South Africa responds in an asymmetric way to financial shocks. A nonlinear logistic smooth transition vector autoregressive model is employed. The results indicate that the South African economy is more asymmetric when responding to financial shocks. Furthermore, manufacturing output growth is strongly affected by high financial stress shocks, and interest rates and inflation react more to low financial stress shocks. There is a paucity of literature on the implications of financial stress for the South African macroeconomy, especially for the FCI measurement that evolves between financial and macroeconomic variables (Kabundi and Mbelu, 2017). The earlier FCI suffers from two limitations (see Gumata et al., 2012; Kasai and Naraidoo, 2013; Thompson et al., 2015). Firstly, previous FCIs were constructed using constant weights that can hardly estimate the index in real time. Secondly, the FCI is not a good out-of-sample predictor. Therefore, this study employs the FCI constructed by Kabundi and Mbelu (2017) that overcomes previous indices' limitations.

4.4 Methodology

Following Sims, Waggoner and Zha (2008) and Sims and Zha (2006), the study adopts a Markov Switching Vector Auto regression (MSVAR) model with Bayesian estimation. The MSVAR framework was chosen because it provides a framework for nonlinearities that might be present by applying discrete shifts. The Time-Varying-Parameter (TVP) framework is another model that detects nonlinearities (Giorgio, 2005). However, it has drifting parameters which cannot identify flight-to-safety periods (Hubrich and Tetlow, 2015). The threshold vector autoregression model allows for discrete shifts in parameters, but the requirement is to pre-specify the threshold variable (Hartmann et al., 2015). Due to the various origins and propagation of financial events, it is reasonable to avoid pre-specifications. According to Sims and Zha (1998), an MSVAR model does not need a prior dating of financial stress periods, as an alternative identification of stress periods is part of the model's output, estimated concurrently with the stress forecast likelihoods in a maximum probability framework.

As a result, the MSVAR model does not lose information by transforming continuous variables into a binary dummy variable (Sims et al., 2008). For example, a marginal increase or decrease in volatility might be an early warning sign of a financial crisis, but a threshold process can erase this information. Furthermore, MSVAR models can differentiate between coefficient switching and variance switching. Variance switching proposes that financial distress is a matter of shock volatility, while coefficient regime-switching would suggest changes in the transmission shock structure.

4.4.1 Model specification of Markov Switching Vector Autoregression

The study employs an MSVAR model with Bayesian estimation that consists of five variables namely, an FCI, an exogenous variable, and the following endogenous variables: inflation (IF), interest rates (R), domestic credit to the private sector as a percentage of GDP (L), and real GDP growth (RGDP). The FCI variable is exogenous because the Central Bank's goal is price stability rather than financial stability, before the global financial crisis.

The MSVAR with Bayesian estimation model is a nonlinear vector stochastic processes that can be specified as:

$$y_t' A_0(s_t^c) = \sum_{j=1}^{l} y_{t-l}' A_j(s_t^c) + z_t' C(s_t^c) + \varepsilon_t'(s_t^v) \quad t = 1,2 \ldots T. \tag{4.1}$$

where y_t' denotes *n X 1* vector of endogenous variables; z_t' represents a matrix of exogenous variables, which comprises of constants in a column vector of 1_n, that is one intercept per equation; A_0 , A_j and, C is (*nXn*) matrices of parameters describing contemporaneous relations among the elements of y_t', (*n Xn*) matrix of coefficients and *n X 1* vector of exogenous parameters respectively, in regime (s_t^c); s is a (latent) unobservable regime variable, defining different states for residual variances, v is the slope and c intercept coefficients. l represents the VAR's lag length and T is the sample size. ε_t^1 denotes a vector *n X 1* of random disturbances. The diagonal *n X n* matrix (s_t^v) contains the standard deviations of ε_t^1. $\varepsilon_t^1(s_t^v)$ represents structural disturbances. (s_t^m) represents the number of states $1,2,\dots h^m$.

The first-order Markov process has the following transition probabilities:

$$\Pr(s_t^m = i|\ s_{t-1}^m = k) = p_{ik}^m,\ i,k = 1,2,\dots h^m \qquad (4.2)$$

where T is the sample size. Suppose $Y_t = \{y_0, y_1, \dots y_t\}$ denotes a vector of y. Assuming ε_t represents a conditionally standard normal:

$$p(\varepsilon_t|Y^{t-1}, s_t^m, A_0, A_+) \sim N(0_{nx1}, I_n) \qquad (4.3)$$

the variance-covariance matrix $\sum(s_t^m)$ of the correlated reduced-form regression residuals can be recovered as follows:

$$\sum(s_t^m) = \left(A_0(s_t^c)(s_t^v)A_0'(s_t^c)\right)^{-1} \qquad (4.4)$$

The switching in the coefficient regimes s_t^c, imparts switching in the reduced-form residuals as does switching in the structural variance-covariance matrix, through s_t^v.

The overall log marginal data density $\log p(y_T|z_T, \phi)$ can be acquired by

$$\log p(y_t|z_T, \phi) = \sum_{t-1}^{T} \log p(y_t|Y_{t-1}z_T, \phi) \tag{4.5}$$

where $p(y_t|Y_{t-1}z_t, \phi) = \sum_{i=1}^{s} p(s_t = i|Y_{t-1}, z_{t-1}, \phi)\, p(y_t|s_t = i, Y_{t-1}, z_t, \phi)$ (4.6)

and where $p(y_t|s_t = i, Y_{t-1}, z_t, \phi)$ is a density of a continuous random variable y_t restricted to state i, and

$$p(s_t = i|Y_{t-1}, z_{t-1}, \phi) = \sum_{s_{t-1}=j=1}^{s} p(s_t = i|s_{t-1} = j)p(s_{t-1} = j|Y_{t-1}, z_{t-1}, \phi) \tag{4.7}$$

The probability $p(s_t = i|Y_{t-1}, z_{t-1}, \phi)$ in equation (4.7) can be updated repeatedly. The updating technique comprises of the following computation:

$$p(s_t = i|Y_t, z_t, \phi) = \frac{p(s_t = i|Y_{t-1}, z_{t-1}, \phi) p(y_t|s_t=i, Y_{t-1}, z_t, \phi)}{\sum_{i=1}^{s} p(s_t = i|Y_{t-1}, z_{t-1}, \phi) p(y_t|s_t=i, Y_{t-1}, z_t, \phi)} \tag{4.8}$$

Denoting

$$\pi_{t,i} = p(s_t = i|Y_{t-1}, z_{t-1}, \phi), i = 1, \dots s,$$

and collecting $\pi_{t,i}$ in vector $\pi_t = (\pi_{t,1}, \pi_{t,2}, \dots, \pi_{t,s})$, equation (4.9) can be rewritten as

$$\pi_t = P\pi_{t-1} = P^2\pi_{t-2} = \cdots = P^t\pi_0 \qquad (4.9)$$

After an adequate number of iterations, a Markov chain reaches a stationary distribution π^*, where the anticipated state is independent of the current state, and which satisfies $\pi^* = P\pi^*$.

4.4.2 Sources of Data and definitions of variables

The study employs monthly frequency time series data from 2000:2 to 2017:8 obtained from the SARB. The cut-off dates are determined by data availability. Following Hubrich and Tetlow (2015), the study employs five variables, namely, an exogenous variable represented by the FCI and four endogenous variables, viz., real GDP growth, domestic credit to the private sector, interest rates and inflation. These variables are defined in Appendix A.

4.4.3 Unit root test diagnostic test

The concept of stationarity occupies a significant role in the time series literature. This unit root or stationarity test was first introduced by Granger and Newbold (1974). According to Said and Dickey (1984), the general approach is the Augmented Dickey-Fuller (ADF) test from the version by Dickey and Fuller (1979). These standard unit root tests are usually biased towards non-rejection of the unit root in the presence of structural breaks. According to Perrone (1989), the presence of structural breaks can be tested. However, Prodan (2008) demonstrates that it is challenging to accurately estimate the magnitude and number of multiple breaks, especially when the breaks are of different sign. To circumvent these issues, Rodrigues and Taylor (2012) and Ender and Lee (2012) suggest a Fourier unit root test in line with a variant of Gallants' (1981) Flexible Fourier Form (FFF). In time series, for a meaningful relationship between two variables, the series has to be stationary. A stationary time series has a constant mean, variance and covariance. These characteristics are known as white noise. To test for stationarity, one can use the Fourier ADF (Ender and Lee, 2012) or Fourier Lagrange Multiplier LM tests for unit roots (Schmidt and Phillips, 1992). The initial model of the Fourier test is shown below:

$$y_t = \alpha_0 + yt + \alpha_k sin\left(\frac{2\pi kt}{T}\right) + \beta_k cos\left(\frac{2\pi kt}{T}\right) + e_t,\ \ k \leq T/2 \qquad (4.10)$$

The residuals obtained are used in the following function:

$$e_t = \rho e_{t-1} + \varepsilon_t \qquad (4.1.1)$$

$$e_t = \sigma e_{t-1} + \varepsilon_t \qquad (4.1.2)$$

where ε_t denotes the white noise term. Equation 4.1.1 indicates the Fourier Lagrange multiplier test, while equation 4.1.2 shows the Fourier ADF test. The null hypothesis of both test $\rho = 1$ and $\sigma = 1$ indicates a unit root process. The alternative hypothesis of stationarity is represented by $\rho < 1$ and $\sigma < 1$.

Ender and Lee (2011) adopt the Lagrange multiplier methodology of Schmidt and Phillips (1992) by imposing the null restrictions and estimating the following regression using first differences:

$$\Delta y_t = \delta_0 + \delta_1 \Delta sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \Delta cos\left(\frac{2\pi kt}{T}\right) + \mu_t \qquad (4.13)$$

The detrended series employed the estimated coefficients $\tilde{\delta}_0$, $\tilde{\delta}_1$ and $\tilde{\delta}_2$.

$$\tilde{S}_0 = y_t - \tilde{\Psi}\, \tilde{\delta}_0 t - \tilde{\delta}_1 sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \Delta cos\left(\frac{2\pi kt}{T}\right), \qquad t = 2, \dots, T \qquad (4.14)$$

where $\tilde{\Psi} = y_1 - \delta_0 - \delta_1 \Delta sin(2\pi kt/T) - \tilde{\delta}_2 \Delta cos(2\pi kt/T)$. In order to test the regression, the detrended series is used

$$\Delta y_t = \phi \tilde{S}_{t-1} + d_0 + d_1 \Delta sin(2\pi kt/T) + d_2 \Delta cos(2\pi kt/T) + \varepsilon_t \qquad (4.15)$$

The LM test statistic is the t-test for the null hypothesis $\phi = 0$, which presents that y_t has a unit root. The assumption is that the innovation process ε_t satisfies Phillips and Perron's (1988) conditions to enable for heterogeneously distributed and serially correlated innovations. Equation (4.4) might be augmented with lagged values of $\Delta\tilde{S}_{t-1}$ such that the remaining serial correlation does not exist. According to Enders and Lee (2011), the asymmetric distribution of the LM test statistic is influenced by the frequency k, but is invariant to the magnitudes of y, β_k, α_0 and α_k. They determine that the value of k ranges between 1-5 and select the k, which minimises the sum of squared residuals from equation (4.4).

If there is a linear trend, a standard unit root test in the absence a nonlinear trend might be more appropriate than the Fourier Lagrange Multiplier unit root test. The F-statistic is used to test if there is a nonlinear trend:

$$F(k) = \frac{(SSR_0 - SSR_1(K))/2}{SSR_1(K)/(T-q)} \quad (4.16)$$

Where $SSR_1(k)$ presents the sum of squared residuals from equation (4.4), the total regressors are represented by q and SSR_0 is from equation (4.4) SSR without trigonometric terms. If the null of absence of a nonlinear trend is rejected, then the Fourier Lagrange Multiplier unit root test will be adopted; alternatively, the normal unit root tests in the absence of a nonlinear trend will be employed.

4.4.4 Correlation test diagnostic test

To ensure that the problem of multicollinearity does not exist in the study's estimations, this section presents the degree of association among the variables. The correlation coefficient measures the robustness of the relationship between two variables. The correlation coefficient ranges from 1 to -1 (Gujarati, 2004). When the correlation coefficient is zero for two variables, then the variables are not related. If the correlation coefficient's value is closer to one (the values are absolute), it shows a strong relationship between the two variables. A correlation coefficient closer to zero indicates a weak connection.

4.4.5 Lag length diagnostic test

For the MSVAR model with Bayesian estimation, the study employs a Schwarz information criterion (SIC). The SIC (or Bayesian information criterion) "provides a rough approximation of the Bayes factor which is easy to use and does not require evaluation of prior distributions" (Kass and Rftery, 1995, p. 791). The SIC is a lag-length selection criterion that allows for adjustments in the model and enables the attainment of well-behaved residuals. The lag length also allows for no serial correlation in the residuals (Elboure, 2008).

4.5 Empirical findings

4.5.1 Unit root test

The Fourier ADF and Fourier Lagrange Multiplier (LM) test results are presented in Table 4.1. Inflation, interest rates, and FCI variables are stationary at a 10 per cent level of significance. These results show that all variables are stationary in levels apart from credit to the private sector and output growth. In the case of credit to the private sector and output growth, the study fails to reject the null hypothesis of unit roots. As the output and credit variables are observed to have unit roots, at level but when differenced, they are made stationary at order one (1) and the test for unit roots is repeated using the Fourier ADF and Fourier LM test. The first difference results show that at a 10 per cent level of significance, both variables are stationary.

Table 4.1: Unit root test results Fourier ADF and Fourier LM

Variable	Fourier LM (Schmidt and Phillips, 1992)			Fourier ADF (Enders & Lee (2012)		
	Fourier	LM stat	Critical values 1%, 5%, 10%	Fourier	ADF stat	Critical values 1%, 5%, 10%
Output growth (1)	2	3.0288	4.2500 3.5700 3.2300*	1	3.7861	4.4200 3.8100 3.4900*
Interest rates	2	3.4110	4.2500 3.5700 3.2300*	1	3.6522	4.4200 3.8100 3.4900*
Credit to private sector (1)	2	3.4110	4.2500 3.5700 3.2300*	1	3.7861	4.4200 3.8100 3.4900*
Inflation	2	3.3910	4.2500 3.5700 3.2300*	1	3.6522	4.4200 3.8100 3.4900*
FCI	2	3.4110	4.2500 3.5700 3.2300*	1	3.6522	4.4200 3.8100 3.4900*

"***","**" and "*" represent statistical significance at 1%, 5%, and 10%, respectively. Break-in level

4.5.2 Correlation Matrix results

Table 4.2 shows the positive and negative strengths of association between the different pairs of variables (correlation matrix). Gujarati (2004) points out that correlation becomes a problem when it exceeds 0.8. Table 4.2 shows that none of the correlation coefficients exceeds 0.8 (in absolute value). Accordingly, the study concludes that collinearity is not a problem in our analysis of the data. The study also shows that FCI and output growth and FCI and inflation have a negative and weak relationship at -0.2007, -0.4376, respectively. Credit and interest rates indicate a weak and positive association with FCI. This suggests that the credit channel of monetary transmission might be impaired in South Africa. Gross Domestic Product, credit and FCI are positively and weakly associated with interest rates, while the correlation between inflation and interest rates is weak and negative. This suggests that the interest rate channel of monetary transmission may not be important in South Africa.

Table 4.2: Correlation

	GDP	INFLATION	INTEREST	CREDIT	FCI
GDP	1	-0.4703	0.0446	0.4034	-0.2007
INFLATION	-0.4703	1	-0.6562	-0.4077	-0.4376
INTEREST	0.0446	-0.6562	1	0.2961	0.7912
CREDIT	0.4034	-0.4077	0.2961	1	0.2716
FCI	-0.2007	-0.4376	0.7912	0.2716	1

4.5.3 Model selection

By comparing the fit of alternative models, for Bayesian estimations, the standard criteria used relate the marginal likelihoods (marginal data density) of selected model regime specifications, which is a measure of model fit. Other methods have been used to compute marginal likelihoods; for example, the standard calculation of modified harmonic mean (MHM) by

Gelfand and Dey (1994). The disadvantage with MHM computations is that it has a high probability of not working well with Markov switching models. In MHM computations, the model's posterior distribution may be far from Gaussian function properties, as is the current application (Fruhwirth-Schnatter, 2004). One alternative uses weighting functions to estimate the unidentified posterior mode (see Meng and Wong, 1996; Waggoner and Zha, 2012; Sims, Waggoner and Zha, 2008). In this instance, the marginal likelihoods are computed using the bridge sampling method (Meng and Wong, 1996). According to Fruhwirth-Schnatter (2004), the bridge sampling method is the most robust method for estimating and comparing the marginal data densities for Markov-switching models.

Fitting the MSVAR model to the data, the study estimates and compares the selected model regime specifications. X, #=1,2, #v, and #c indicate a constant model, the number of independent Markov states, variance switching, and coefficients switching, respectively.

X constant model: each variance and coefficient is time-invariant.

Xc #v: keeping coefficients constant while the variances switch following the #-regimes Markov process.

X #1c#2v: the coefficients and variances switch regimes independently.

X #cv: the coefficients and variances for each equation switch under the same #-regimes Markov process.

Table 4.3 shows the log values of marginal data density and compares the models with alternative specifications. The measure of model fit compares the log values of marginal data densities for each model. The values with the highest log marginal data density are selected. The best fit model is based on the coefficients and variances switching regimes independently. The constant parameter model is rejected since it has the lowest log MDD. The log values of the marginal likelihood associated with this model are far below the values of the other MDDs.

The difference between X #1c#2v and the second-highest MDD, X #cv, is of the order 24 in absolute value. The difference shows that changes occur in the variance of structural shocks and the systemic component of economic behaviour.

Table 4.3: Goodness-of-fit statistics and selected model regime specifications

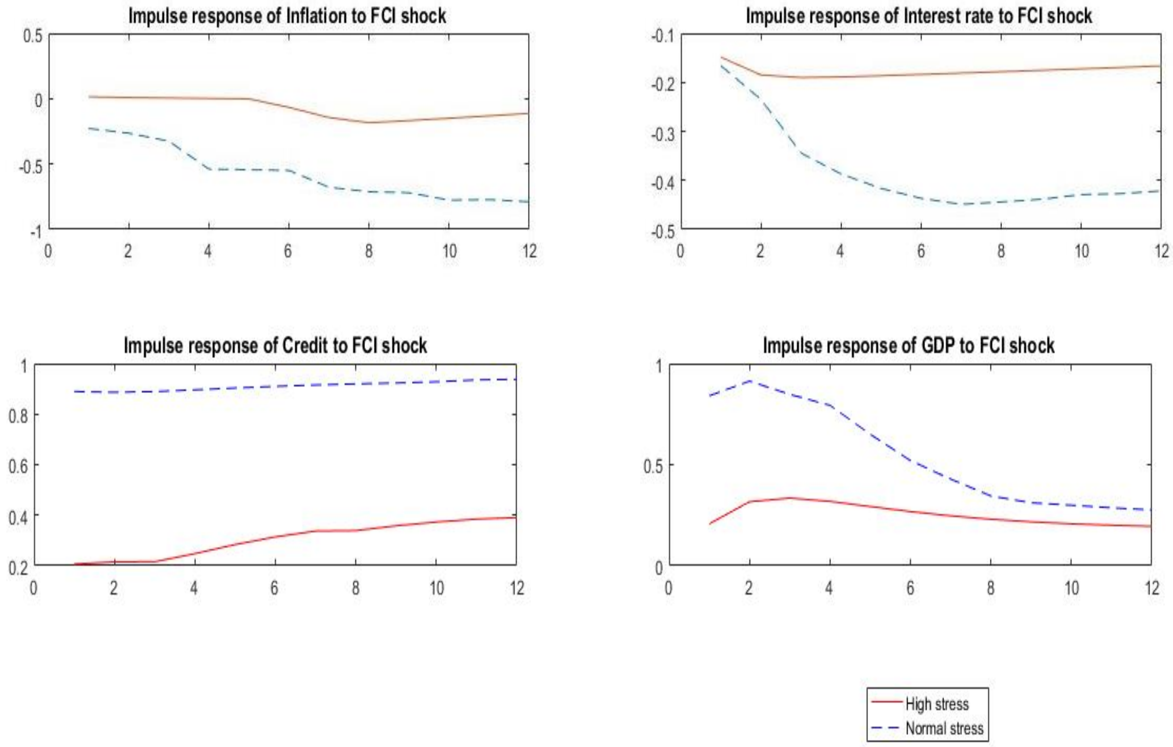
Model	Specification	Log MDD
X	Time-invariant model	-182.2612
X #v	2 synchronized regimes in shock variances	137.7123
X #1c#2v	2 regimes for both the coefficients and variances in all equations (not synchronised)	187.3664
X #cv	2 regimes synchronised equation for both the coefficients and variances	163.6732

4.5.4 Transmission of financial conditions index Shock

Figure 4.2 shows the impulse responses of real GDP, inflation, interest rates and credit to the FCI. The solid red lines represent high financial stress regimes, while the blue dashed lines depict low financial stress regimes. As shown in Figure 4.2, inflation's response to financial stress decreases irrespective of the regime. The results indicate a period of constant inflation which marginally declines in response to high financial stress. This finding is consistent with Martin and Millas (2013), implying that high financial stress causes disinflation, but contradicts Peersman's (2012) findings. For the low-stress regime, inflation decreases substantially, turning negative following a financial shock. Negative inflation suggests that a financial shock reduces borrowing costs during tranquil times, which are a key component of credit. This result complements Meh and Moran (2010), who found that banks charge a lower deposit rate after a financial shock, prompting a decline in consumption, which, in turn, causes a fall in inflation.

As depicted in Figure 4.2, both the high financial stress and tranquil periods have a negative effect on interest rates. Short-term interest rates increase marginally during high financial stress regimes but decrease in low financial stress regimes. The symmetric response indicates a low interest rates setting across different regimes as during normal periods, there can be indications of financial stress. This finding is in line with Bulir and Cihak (2008) and Baxa et al. (2013), who found that interest rates are lowered whenever the financial system is unstable. Such negative interest rate setting behaviour suggests stronger credit growth.

Figure 4.2: Impulse responses of real GDP, Inflation, interest rates and credit to a financial conditions index shock.



The bank lending channel suggests that excessive credit growth is associated with episodes of high interest rates, which are most likely more tolerant in lending terms, as demonstrated by Jimenez and Saurina (2006). Furthermore, Borio and Zhu (2007) argue that higher interest rates impact credit supply and banks' risk tolerance. In line with these studies, the results show that changes in credit availability reflect a sticky tendency of interest rates and insensitivity of borrowers to changes in interest rates. When a change in demand for credit is of such severity as to cause a substantial shift in lending risk functions, credit availability may change in a direction that offsets rather than reinforces the effect of interest rate changes. Consistent with Guttentag (1960), credit availability might change in a direction that neutralises rather than strengthens the impact of interest rates changes. Therefore, monetary policy is less effective during high financial stress regimes because the interest rate channel might be impaired.

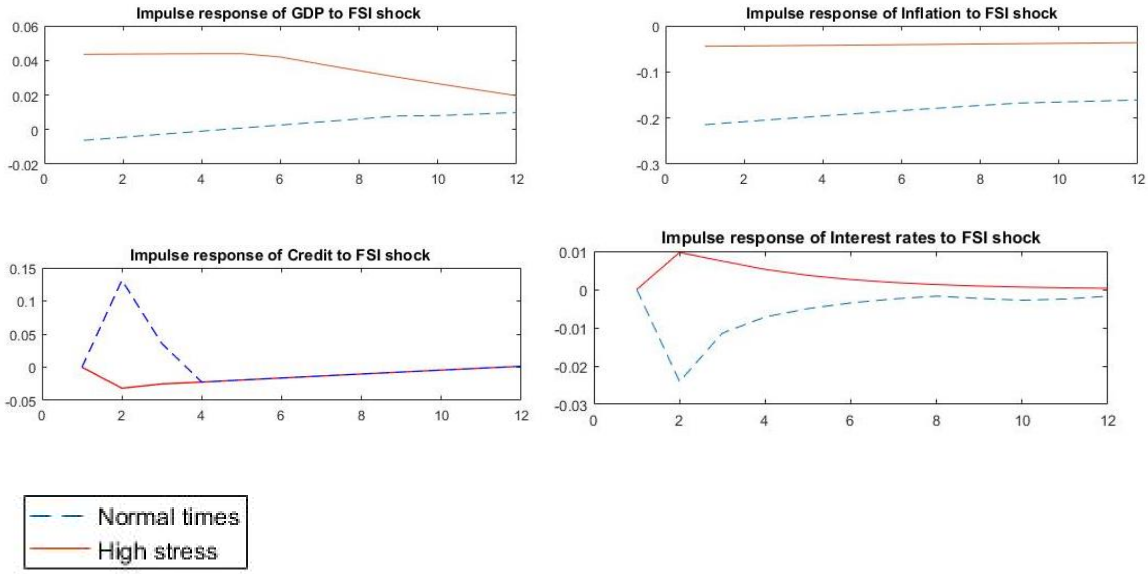
Figure 4.2 shows that low financial stress levels lead to strong GDP growth. Thereafter, output growth starts to decline. Output growth is initially sluggish before it falls in response to high financial stress. These findings confirm the results of Jorda et al. (2011), Schularick and Taylor (2012) and Borio and Lowe (2004), who examined the behaviour of credit and money fluctuations, financial crisis and policy responses. These studies' findings indicate that credit is mainly allocated for mortgages, which are non-GDP transactions. This linkage is consistent with the borrower balance sheet channel and empirical evidence from Balke (2000) that states that financial shocks have a more significant effect on output in high financial stress regimes than in normal times.

The low interest rates translate into a modest increase in credit due to slow GDP growth, and a sluggish deleveraging process by households and financial intermediaries during periods of high financial stress. The degree of liquidity in the financial system does not always cause financial imbalances; hence, monetary policy is ineffective. This is consistent with Turner (2013), who concluded that excessive money supply is not a forward indicator of inflation, but credit is a forward indicator of deflation. The observed decrease in market liquidity and funding liquidity are mutually reinforcing and produce loss spirals during periods of financial distress. This accords with what one expects in theory (Brunnermeier and Pedersen, 2009). In theory, one expects that a decrease in liquidity forces banks to provide less market liquidity. Therefore, the interest rate channel is weakened during periods of high financial stress, similar to Gambacorta et al.'s (2015) findings.

To confirm the robustness of the results, different specifications of the data are estimated. First, we change the sample period from 2006:1 to 2015:12, and the FCI is replaced by the FSI. The FSI is a measure of financial stress periods in the financial system (Illing and Liu, 2006). It employs four financial market variables, namely, equity funding, real estate, funding and foreign exchange rates (SARB, 2015). The South African FSI is calculated using a constant weighting method (Gumata, Klein and Ndou, 2012).

Figure 4.3 shows the impulse responses of real GDP, inflation, interest rates and credit to an FSI shock (high-stress state (solid red line) versus low-stress state (blue dashed lines)). It illustrates that real GDP growth is higher during periods of high financial stress, then gradually falls, returning to equilibrium. This result corroborates Ciccarelli, Maddaloni and Peydro's (2010) finding that high stress is a positive shock of financial stress, leading to a gradual decline in output growth. During tranquil periods, real GDP growth displays a small response that gradually increases, contrary to King and Levine (1993), who found that growth increases during tranquil periods. This argument concurs with Davig and Hakkio (2010), who found that rising financial stress can slow the economy's growth in the US. It therefore confirms the findings from the FCI shock (see Figure 4.2) that GDP growth is sluggish in response to an FSI shock. It is also indicative of the fact that during normal times, policymakers need to continually monitor financial stress because events that trigger such stress are likely to slow growth.

Figure 4.3**:** Impulse response of real GDP, Inflation, interest rates and credit to financial stress index shocks.



In Figure 4.3, inflation's response to a high financial stress shock is disinflation. This is surprising because it is near zero, raising the spectre of deflation. These results confirm the work of Gilchrist et al. (2015) and De Fiore and Tristani (2013) that argues that a disinflationary response occurs after a high financial stress shock if aggregate supply channels dominate.

Figure 4.3 further shows that an increase in credit supply through the cost channel may have unintended disinflationary effects. This finding corroborates the work of Barth and Ramey (2001), who stated that high credit spreads during a financial crisis increase the cost of working capital which, in turn, raises a firm's marginal costs. The tranquil regime shock gradually increases negative inflation (deflation). On the other hand, the deflationary response can be a result of low borrowing costs during normal financial stress times. The monetary policy cost channel can further explain the deflationary response. Deflationary pressure can also be counteracted by the dominance of the aggregate supply channel, as evidenced by credit's positive reaction to financial shocks. The results from Figure 4.2 are confirmed by the FSI shock (see Figure 4.3).

High financial stress shocks have disinflationary effects, which is not desirable in an already low inflation environment. A significant implication of these results is that financial stress shocks decrease output and, at the same time, decrease inflation. In theory, one expects the inverse relationship between output and inflation.

The results presented in Figure 4.2 exhibit a slight variation from the FSI shock (see Figure 4.3). Figure 4.3 shows that interest rates increase in response to high financial stress regimes but decrease in response to low-stress regimes, similar to Li and St-Amant's (2010) findings. The increase in interest rates implies restrictions on loans supply to the domestic private sector. Therefore, lower credit availability decreases both inflation and output growth. This suggests that credit might mainly be demand-driven. A high interest rate might lower the supply and demand for credit. When interest rates rise, the cost of borrowing (lending rate) increases, reducing loan demand. Credit is constrained during high financial stress periods. To empirically combine the effects of a two regime model to construct a single regime model we use a Vector Autoregression model in Appendix B. The results show that financial shocks have a negative effect on interest rates.

4.6 Summary and conclusion

This chapter investigated the interaction between financial stability and the real economy. Financial stability was measured using a time-varying FCI, which accounts for the revolving relationship between financial and macroeconomic variables and is therefore more informative to policymakers. We employed an MSVAR model with Bayesian estimation for analysis. MSVAR models can differentiate between coefficient switching and variance switching.

Variance switching indicates that financial distress is dependent on shock volatility, while coefficient regime-switching would propose changes in the transmission shock structure. For this study, regime-switching lies not only in the variance of structural shocks, but also in the systemic economic behaviour component.

In line with Bulir and Cihak (2008) and Baxa et al. (2013), we found that interest rates decline whenever the financial system is unstable. The South African monetary authorities responded by cutting the repo rate during the 2008 global recession, in line with the model predictions analysed in this chapter. Based on the findings, we recommend that financial stability be taken into consideration when setting monetary policy. One way would be to augment the Taylor rule with financial stability indicators such as asset prices, credit exchange rates and spreads with the guidance of the financial stress levels. The study also found that monetary policy loses its effectiveness during normal times as output increases and inflation decreases. Overall, the financial system tends to be procyclical. This means that bank regulation encourages credit growth during economic expansion and limits credit extension during economic contractions. This amplifies both the business and financial cycle and has negative implications for price and financial stability. Chapter five introduces the target instruments of macro-prudential regulations that might be more appropriate for achieving financial stability.

CHAPTER 5

MACRO-PRUDENTIAL POLICY AND HOUSE PRICES IN AN ESTIMATED DSGE MODEL FOR SOUTH AFRICA

5.1 Introduction

This chapter takes the relationship between monetary policy and financial stability discussed in Chapter four and investigates the relationship between macro-prudential and monetary policies and house prices. The literature on the relationship between house prices and monetary and macro-prudential policies and possible promotion of financial and price stability is reviewed. The evidence presented in Chapter four supports the proposition that monetary policy should be combined with a macro-prudential policy that facilitates financial stability. For a robust conclusion for policy consideration, this chapter includes empirical analyses on whether these policies should be coordinated.

The South African financial system weathered the global financial crisis of 2007/2008 fairly well (Hollander and van Hill, 2019). Although it displayed resilience to the shock, South Africa is a small, open economy. Its internal financial conditions are thus not immune to the effects of international interest rates. The continuous rise in national asset prices, mainly house prices, has led to policy authorities utilising macro-prudential policy tools. These tools include a countercyclical LTV ratio and countercyclical stamp duty taxes, among others. Both instruments are tightened during an economic boom to restrain high growth of credit and impede bubbles like house price bubbles. Therefore, the regulations promote financial stability by discouraging the accumulation of assets prone to systemic risk. The central issue is the design of national macro-prudential policies in the context of open economies. Furthermore, economies have asynchrony of financial cycles which undermines the effectiveness of the macro-prudential policy (Galati and Moessner, 2012).

In many developed and emerging market economies, the primary objective of monetary policy is clearly set out as price stability; the policy tool is uniquely identified as the rate of interest; and inflation targeting is prevalent as a monetary policy framework of choice. Similarly, the primary aim of macro-prudential policy is unambiguously specified as financial stability, which calls for mechanisms to influence the economic outcomes of different countries. However, implementing macro-prudential policy poses several challenges that include distinguishing the impact of individual policies, choice of appropriate instrument(s), and policy communication with the public, among others (see Born et. al, 2012; Utari and Arimunti, 2012; Agur and Sharma, 2014). While the objectives of monetary policy and macro-prudential policy is clear, in terms of how each affects credit growth, there is insufficient understanding of the transmission mechanism, effectiveness and impact of macro-prudential policy on the financial sector and the real economy. The study is expected to contribute to the literature of emerging market economies by providing some general guidance on the most appropriate macro-prudential policy instruments.

The “Tinbergen principle” states that policymakers should ensure a minimum of one policy tool per policy objective. However, the instruments of monetary and macro-prudential policies are interrelated (Schoenmaker and Weirts, 2011), especially for emerging markets such as South Africa. The failure of monetary policy and micro-prudential policy (that concentrates on the resilience of individual financial institutions) in some jurisdictions has contributed to system-wide risk that has a significant negative effect on the real economy (Bernanke and Gertler, 2001). In retrospect, there has been no clear understanding of system-wide risk (Catte et al., 2010). System-wide risk is defined as “any threat of disruption to financial services that is caused by an impairment of all or parts of the financial system that can potentially trigger negative repercussions on the real economy" (SARB, 2017, p. 33).

South Africa is an emerging market economy that is susceptible to global and idiosyncratic risk that affects its financial market. It has the most advanced and sophisticated financial system in Africa and is hence the focus of this paper. South Africa is also the only African country that is part of the Group of 20 (G20). Among the G20 emerging economies, the South African Reserve Bank (SARB) has had limited experience in implementing macroprudential policies (Lombardi and Siklos, 2016; Ceruttia, 2017). However, in relation to the prudential standards, the SARB has been at par with fellow emerging countries. The country has a well-established regulatory system as well as a large and globally integrated financial sector (Lombardi and Siklos, 2016). In this regard, the gross external position of the country's private sector computed as the sum of liabilities and total foreign assets (estimated at 283% of GDP in 2017) reflects the degree of global integration (Hollander and Van Lill, 2019).

The housing market globally has been directly blamed for many of the financial crises (SARB, 2018). As a result, the housing market trends and developments serve as imperative financial stability indicators of the financial system health and economic confidence. In South Africa, residential housing accounts for about 22% of household total assets, while mortgage loans account for the largest component of banks assets at approximately 35.5% of total bank loans and advances.

In South Africa, residential loans account for the largest share of mortgages, loans and advances(estimated at 60% of total credit) (SARB, 2016). The country's mortgage instalment-to-rent and house price-to-rent ratios show the affordability of owning a house compared to renting. Theoretically, increasing interest rates might result in an upward movement of the price-to-rent ratio through higher repayment instalments overtime. There has been, however, a rise in the ratio of mortgage instalments to average rent in South Africa since the beginning of 2016, because of an increase in the cost of owning a house (for example, taxes and rates) and the repayment burden. This may cause more stress to an already high leveraged investor in buy-to-rent property.

There is no consensus in the literature on how monetary policy impacts house prices. Studies have considered shocks namely aggregate supply, monetary policy, aggregate demand and foreign shocks as key drivers of house prices (see, for example, Boa et al., 2000; Tomura, 2010; Ng and Feng, 2016). The overall conclusion drawn from these studies' historical shock decomposition indicates that foreign demand positively affects house prices and output, especially for fixed exchange rate countries. Nonetheless, Funke and Paetz (2013) show that foreign demand shocks have a smaller impact than house preference shocks in explaining house prices. This is consistent with Gupta and Sun's (2018) finding that foreign demand shocks make a minor contribution to house prices since the exchange rate is floating; and that monetary policy shocks help to stabilise house prices. However, Funke et al. (2018) conclude that monetary policy shocks do not explain house price volatility, but technology shocks play a significant role.

Macro-prudential policy tools such as reserve requirements, loan to value ratios, and capital requirements, among others, have been used in emerging countries because they are effective in limiting credit growth during a boom period (Quint and Rabanal, 2014; Brzoza-Brzezina et al., 2013; Claessens et al., 2013). The housing market meltdown related to the subprime mortgage crisis of 2007 revived the authorities' interest in macro-prudential policies as instruments for stabilising the housing and credit markets in both developed and emerging countries. An extensive body of literature has highlighted the application of macro-prudential policy instruments rather than monetary policy tools in several countries and investigated their effectiveness in dampening house prices and credit growth (Claessens, 2015). Tovar et al. (2012) show that reserve requirements had a moderate but transitory effect on private bank credit growth in six Latin American countries. According to Vandenbussche et al., (2012) other types of macro-prudential policies, such as non-liquidity measures and the capital adequacy ratio, influenced house price inflation in European countries. Macro-prudential measures in these countries were found to reduce housing prices and credit growth by 4-6 per cent (Borio and Shim, 2007). The most current study by Cerutti et al. (2017) investigated the effectiveness of debt service-to-income (DSTI) and LTV restrictions on house prices, household credit growth, corporate credit, and domestic bank credit. They found that these limits reduced credit growth while the restrictions on financial institutions' tax had substantial adverse impact on growth of house prices for emerging countries.

Focusing on macro-prudential tools alone provides a tractable analysis. More specifically, there is no common ground on alternative policy tools such as property tax to tackle volatility from the housing market. The other strand of literature considers the impact of property taxes on house prices and credit. For example, Davidoff and Leigh (2013) showed that rising property tax reduced the Australian house prices. Similar results were found in Shanghai, where the average house price fell by 11 to 15 per cent after the introduction of property taxes (Bai et al., 2014). This is consistent with Kuttner and Shim's (2016) finding that property taxes reduced the growth of housing prices by three to four percentage points. However, transaction taxes have no impact on house prices (Agregger et al., 2013). In addition, a rise in property taxes negatively affects output (see Alpanda and Zubairy, 2016; Funke et al., 2013). These studies show that small changes in the tax rate significantly impact a closed economy. In contrast, this impact decreases to a certain extent in a small, open economy.

There is a rapidly expanding body of research on the interaction among standard monetary policy, augmented monetary policy and macro-prudential policy reactions to financial variables (see for example, Agenor et al., 2013; Bailliu et al., 2015; Lambertini et al., 2013; Kannan et al., 2012; Angeloni and Faia, 2013). These studies generally conclude that augmented monetary policy may strengthen financial and macroeconomic stability. Such stabilisation has added benefits when monetary policy interacts with macro-prudential policy. Lui and Molise (2019) establish that combining monetary and macro-prudential policies within a general equilibrium framework featuring heterogeneous borrowers from distinct sectors, promotes financial and macroeconomic stability, especially when monetary policy does not react to financial conditions. In contrast, Funke et al. (2018) found that coordination of the two policies causes financial and macroeconomic instability.

This chapter contributes to the literature by investigating the effect of historical shock decompositions on selected variables. It also investigates the effects of the LTV ratio and stamp duty taxes on the housing sector and the effect of forward guidance of macro-prudential policy. Finally, the interaction of monetary and macro-prudential policy is analysed. Most studies focus on the LTV ratio (quantity restrictions) as a macro-prudential instrument for the housing sector (see, for example, Kannan et al., 2012; Bailliu et al., 2015). A limited number of studies use stamp duties (price restrictions) as a macro-prudential policy. For example, Funke et al. (2018) employ both instruments to investigate their effectiveness in affecting house prices, the channels transmitting such policies and the adverse effects on the macroeconomy. It should be noted that Funke et al.'s (2018) study focuses on an advanced economy, New Zealand.

Furthermore, much of the literature examines the combination of the two policies and the impact of macro-prudential policy on the housing sector in a closed economy (see Lui and Modise, 2019; Agenor et al., 2013; Angeloni and Faia, 2013). To the best of our knowledge, no study has been conducted on an emerging African economy. Given that emerging economies in general and African countries in particular do not have the same characteristics as advanced economies, there is need to conduct a similar study on South Africa from which the country's policy implications can be drawn. This is one of the motivations for this study.

We adopt a small open economy DSGE framework estimated with Bayesian methods to conduct our analysis. First, the modelling framework adopts the work of Iacoviello (2005) and Moneacelli (2009). Next, following Gali and Monacelli (2005), we use a small, open economy framework that merges housing cycles in a DSGE model. In addition, we assume that the rest of the world impacts South Africa, while the opposite is false. Using Bayesian methods, the model is estimated using data from South Africa covering the period from 2000Q1 to 2018Q4.

Following the estimations, the variance decomposition shows that monetary policy shocks are not a significant contributor to house prices, contrary to existing findings in South Africa. A further observation is that borrowing-constrained households are a significant mechanism for the effectiveness of the monetary policy on output. The LTV ratios target household borrowings and affect the efficacy of monetary policy.

Among other macro-prudential policy tools, this study focuses on the impact of LTV policies. We find that a one per cent increase in the LTV ratio, a tight macro-prudential policy, leads to increasing house prices, with significant effects on CPI inflation. Therefore, LTV restrictions may be used to affect house prices while rendering monetary policy less effective. The study also discusses the role of long-term LTV restrictions versus transitory LTV restrictions. The results show that long-term LTV restrictions are more effective in mitigating house price inflation. A one per cent increase in property tax lowers house prices, and through the collateral channel, credit decreases. Using monetary policy and macro-prudential policy simultaneously yields relatively small gains. The results show that policy authorities face a trade-off between price and financial stability.

The remainder of the chapter is organised as follows: Section 5.2 presents the Literature review, section 5.3 DSGE model, and section 5.4 discusses the Bayesian estimation and describes the model's dynamics. Section 5.5 presents the results of macro-prudential policies, while section 5.6 concludes the chapter.

5.2 Literature review

Ample research has been conducted to investigate the interaction of housing-related macroprudential policies and monetary policy. The macroprudential instruments are most likely customized according to the challenges that a particular country has to face (Claessens, 2015). Most studies adopt Iacoviello's (2005) DSGE model with a housing market to address the interaction of both macroprudential and monetary policies. There are, however, some limitations of using the DSGE model in a study of macroprudential policy. While using DSGE models to analyse monetary policy is in line with the monetary policy transmission mechanism found in the data, application of the model for analyzing macroprudential policy is still in its infancy. Moreover, macroprudential investigation are most likely linked to vulnerability of the financial system to particular events related to disequilibrium which cannot be captured within a DSGE model. In addition DSGE models are infinite horizon models and as a result they are unable to incorporate state contingency in a meaningful way. Therefore, DSGE models tend to have challenges of modelling financial intermediation and frictions (Bean, 2009). Another challenge, is the absence of lags identification when using a DSGE model with Bayesian estimation (An and Schorfheide, 2007). As a result, Koop et al. (2014) proposed two Bayesian identification indicators. Even though there are drawbacks, DSGE models are mostly used for macroprudential analysis because they have many advantages that make them superior to simple time series models.

First, DSGE models are derived from microeconomic foundations of constrained decision-making, implying that they describe general equilibrium allocations and prices in the economy where all agents dynamically maximise their objectives subject to resource constraints (Tovar, 2008). This also makes these models suitable for the study of welfare issues (Brazdik et al., 2012). Secondly, DSGE models are not, at least in principle, vulnerable to the Lucas Critique, unlike the more traditional macroeconomic forecasting models (Woodford, 2003). Following the estimation of deep parameters in a DSGE framework, it is possible to avoid the Lucas Critique, where only models in which the parameters that do not vary with policy interventions are suited to evaluate the impact of a policy change (Tovar, 2008). Third, DSGE models are structural, implying that each equation has an economic interpretation that allows clear identification of policy interventions and their transmission mechanisms (Peiris and Saxegaard, 2007). Fourth, DSGE models are forward looking in the sense that agents optimise model-consistent forecasts about the future evolution of the economy. And Fifth, DSGE models allow for a precise and an unambiguous investigation of random disturbances. This is facilitated by the stochastic design of the models.

DSGE models can be compared against a benchmark. They also allow many sources of shocks that can be employed to investigate different trajectories. Furthermore, DSGE models depend on general equilibrium analyses and are appropriate for simulations to investigate the impact of new policy instruments. In addition, calibrated parameters may be adjusted to test for different policy scenarios.

There is near consensus that the 2007/2008 global financial crisis emanated from real estate booms and busts. Accordingly, many studies focus on the effects of macroprudential tools on the housing sector (Lui and Molise, 2020; Rubio and Yao, 2020; Ravn, 2016; Brzoza-Brzezina et al., 2015; Mendicino and Punzi, 2014; Rubio and Carrasco-Gallego, 2014; Quit and Rabanal, 2014; Angelini et al., 2014; Lambertini et al., 2013). These studies investigate the key element of the real estate sector, namely the Loan-to-Value (LTV) ratio that serves as a macroprudential tool to improve financial stability. Some studies consider non-bank lending in the form of real estate funds that are a significant contributor of financial resources that are not subject to regulatory LTV limits. Munoz (2020), for instance investigates the effectiveness of countercyclical LTV ratios that limit the real estate funds borrowing capacity in smoothing house price and credit cycles. The study found that optimized LTV rules limiting the borrowing capacity of such funds are more effective in smoothing business and credit cycles and house prices compared to affecting indebted households borrowing limits. In South Africa, however, real estate funds are excluded from the non-banking sector (SARB, 2016).

Some studies argue that LTV regulation delivers more stability economically and financially and improves social welfare (Broza-Brzezina et al., 2015; Mendicino and Punzi, 2014; Garbers and Lui 2018; Quit and Rabanal, 2014). Garbers and Lui (2018), for example, use a small open-economy DSGE framework to assess the impact of LTV and capital requirements on the transmission channels of each instrument and their comparative effectiveness in dealing with foreign interest rate shocks. The study found that LTV regulation has the largest foreign interest rate shock attenuation benefits. Taking into account zero lower bound interest rates in a DSGE model, Rubio and Yao (2020) confirm that LTV leads to macroeconomic and financial stabilization and improves social welfare. Ravn (2016) only differs by incorporating endogenous credit standards in the model. Other shocks such as positive housing demand shocks and financial shocks can be moderated by a decrease of LTV during credit booms (Rubio and Carrasco-Gallego, 2014; Angelini et al., 2014). News-shock-driven cycles, on the other hand, can be reduced by a social welfare maximizing policy which uses countercylial LTV policy in addition to an interest rate response to credit growth (Lambertini et al., 2013). Other studies investigate the effectiveness of countercyclical LTV that targets two types of household borrowers and two types of intermediate goods (Punzi and Rabitsch, 2018; Funke et al., 2018). Lui and Molise (2021) use a DSGE model to examine borrower specific countercyclical capital regulation in a model where different types of borrowers from distinct sectors of the credit market co-exist. The study shows that both generic and sector specific LTV ratios are effective in improving macroeconomic and financial stability.

5.3 The model

The study employs a small, open economy DSGE model with macro-housing linkages. The model has two intermediate goods producers (non-housing and housing goods) and two types of households (savers and borrowers). Contrary to the Mora-Sanguintti and Rubio (2014) model, which introduces tenants who consume from hand to mouth, consuming their net income in all periods, our model presumes that houses are owner-occupied. In South Africa, most consumers are homeowners, which explains the fact that 53 per cent of the loans are mortgages (SARB, 2019). The intermediate goods firm operates in a monopolistic competitive market and supplies goods and services that serve as inputs for final goods producers. The assumption is that the output of final housing goods producers is non-tradable, while non-housing goods trade internationally. The two groups of households consume both housing goods and non-housing goods. Housing goods can be consumed instantly or used as collateral in the mortgage market. The binding collateral constraint on borrowers introduces credit market frictions, meaning that only people with houses can purchase houses. The conduct of final goods firms and intermediate goods firms is founded on standard monopolistic competition with Calvo pricing. Estimation, simulation, and solution of the model involve log-linearisation around the steady-state with volatile results from several shocks (see log-linearisation in Appendix C).

Households (savers and borrowers) consume non-housing and housing goods where they derive their utility. Housing goods may be consumed immediately or utilised as collateral for mortgage loans. Hence, the level of credit to borrowers is constrained by their collateral. The SARB's monetary policy is captured by the standard Taylor rule, which functions through nominal interest rates to control CPI inflation. The implication is that the nominal exchange rate is floating. Not only is the traditional Taylor rule used as a policy tool, but property taxes (stamp duties) and the LTV constraint are added as policy instruments (Crowe et al., 2013).

Akin to Iacoviello (2005) and Funke and Paetz (2013), the study introduces housing cycles within a small, open economy DSGE model (Gali and Monacelli, 2005). Following Monacelli (2009) and Funke and Paetz (2013), it models capital accumulation to reproduce the salient features of business cycles, particularly the financial and banking sector into DGSE models (see Gertler and Kiyotaki, 2010). In this model, however, the banking sector is left out because we focus on macro-prudential policy. We also assume that South Africa is a small, open economy that is affected by the rest of the world, while the opposite is false. An asterisk represents variables from the countries around the world while one foreign country is represented by the superscript i.

Following Kiyotaki and Moore (1997), the assumption is that two categories of agents are split by their discount factors, ω and $(1-\omega)$. ω denotes the number of borrowers and $(1-\omega)$ represents the number of savers in the small, open economy. b and s denote the number of borrowers and the number of savers, respectively, in line with Aoki et al. (2004). Apart from the discount factors, it is assumed that households are entirely symmetric. Non-housing goods and housing goods are represented by subscripts C and D, respectively. A borrowing constraint is faced by borrowers (impatient households) when taking a loan. The study incorporates a LTV ceiling by permitting borrowers to borrow a fraction of the value of new housing acquisitions. Furthermore, it is assumed that the government imposes property taxes on house purchases following the current literature strand presented by Alpanda and Zubairy (2016). The study assumes that the government runs a balanced budget using lump-sum transfers to households to make sure that the balance is respected in every period.

5.3.1 Impatient Households (Borrowers)

There are two types of households in the economy, patient and impatient. These households can be differentiated by a discount factor that is higher for patient households and lower for impatient ones (see Gupta and Sun, 2018; Angelini et al., 2014; Gerali et al., 2010). The heterogeneity in households' discount factors offers a simplified means to produce financial flows in equilibrium: patient households (savers) buy a positive amount of saving assets and never take loans. Impatient households are the only borrowers in the economy. The discount factor for the impatient household is lower than the discount factor for patient households because it ensures that the households' borrowing constraint is binding around the steady-state.

We assume that the impatient representative household has an infinite planning horizon and maximises the expected discounted utility given by:

$$maxE_0 \sum_{t=0}^{\infty} \beta_b^t \left[\frac{1}{1-\sigma} X_t^{b^{1-\sigma}} - \frac{v_b}{1+\varphi}\left(N_{j,t}^b\right)^{1+\varphi}\right] \tag{5.1}$$

which is a function of the consumption bundle X_t^b; and $N_{j,t}(j = C, D)$ denotes the labour supply in sector j. Parameters σ and φ denote intertemporal elasticities of substitution in relation to consumption and labour, respectively. The borrowers' discount factor is represented by β_b. In line with Monacelli (2009), the welfare-relevant consumption index is a weighted average of the flow of the stock of housing and non-housing consumption expenditure:

$$X_t^b = \tilde{C}_t^{b\left(1-\gamma\varepsilon^{D,b}\right)} D_t^{b\gamma\varepsilon^{D,b}} \tag{5.2}$$

where the flow of composite housing service consumption (equivalent to the stock of housing) and a composite index of non-housing consumption is represented by D_t^b and $\tilde{C}_t^b = C_t^b - h_c C_{t-1}^b$ respectively. $\varepsilon^{D,b} = \exp\left(e^{D,b}\right)$ is a housing preference shock that impacts the marginal rate of substitution between housing goods and non-housing goods, γ is the share of housing in consumption and h_c measures the degree of habit formation in non-housing consumption. The housing preference shock captures changes in institutional and social norms that shift preferences towards housing.

Following Darracq Paries and Notarpietro (2008), impatient households trade nominal riskless bonds, but they cannot tap global markets to finance their expenditure. Household borrowing in South Africa is mainly funded by commercial banks (SARB, 2018). As a result, they encounter a sequence of budget constraints given by:

$$C_t^b + Q_t(1+\tau_t^D)I_{D,t}^b - B_{H,t}^b = -R_{t-1}\frac{B_{H,t-1}^b}{\prod_{c,t}} + \frac{W_t N_t^b}{P_{c,t}} + T_t^b \qquad (5.3)$$

where $\prod_{c,t+1} = \frac{P_{c,t+1}}{P_{c,t}}$ is the CPI based inflation rate, $B_{H,t}^b$ is the stock of real domestic debt (denominated with the domestic non-housing price index), and Q_t are the real housing prices. R_{t-1}, is the nominal interest rate (the lending rate on a loan contract issued in $t-1$), $I_t^b = D_t^b - (1-\delta)D_{t-1}^b$ defines a housing investment and $W_{j,t}$ is the sector-specific nominal wage. In South Africa, the mortgage contract is an adjustable-rate mortgage (Bah et al., 2018). It is assumed that property tax τ^D is constant, ε_t^τ denotes the property shock, and δ represents the depreciation rate of the housing stock. Every time a household buys a house, the proportional transaction tax is applied. The main reason for this rule of thumb is that a certain percentage of house prices is generally paid as an incidental expense. Transaction costs were initially studied by Flemmin (1969) in a deterministic model and by Grossman and Laroque (1990) in a stochastic context. Government lump-sum transfers are represented by T_t^b. Impatient households never save and are confined by a borrowing constraint as follows:

$$R_{t-1}B_{H,t}^b \leq (1-X)(1-\delta)E_t Q_{t+1} D_t^b \prod_{C,t+1} \varepsilon_t^{LTV} \qquad (5.4)$$

where X denotes the fraction of the value of housing goods that cannot be used as collateral. Therefore, the LTV constraint is represented by $1-X$. Equation (5.4) refers to a borrower's payment in the subsequent period to the expected future value of durable stocks (adjusted for depreciation and the LTV ratio). For South Africa, the LTV ratio is binding because we assume that borrowers can only access domestic mortgage markets. We also disregard international investors. The impatient household maximises equation (5.1) subject to equations (5.3) and (5.4). The first-order conditions for this optimisation problem are expressed as:

$$\frac{W_t}{P_{c,t}} = \frac{\left(X_t^b\right)^{\sigma} N_t^{s\varphi} \tilde{C}_t^{s\gamma\varepsilon^{D,s}}}{(1-\gamma\varepsilon^{D,s}) D_t^{s\gamma\varepsilon^{D,s}}} \tag{5.5}$$

$$(1+\tau_t^D)Q_t = \left(\frac{\gamma\varepsilon^D}{1-\gamma\varepsilon^D}\right)\frac{\tilde{C}_t^b}{D_t^b} + (1-X)(1-\delta)\psi_t Q_{t+1} E_t \prod_{C,t+1} + \beta_b(1-$$

$$\delta)E_t\left(\frac{1-\gamma\varepsilon_{t+1}^D}{1-\gamma\varepsilon_t^D}\right)\left(\frac{X_t^b}{X_{t+1}^b}\right)^{\sigma}\left(\frac{D_{t+1}^b}{\tilde{C}_{t+1}^b}\right)^{\gamma\varepsilon_{t+1}^D}\left(\frac{\tilde{C}_t^b}{D_t^b}\right)^{\gamma\varepsilon_t^D} Q_{t+1}(1+\tau_{t+1}^D) \tag{5.6}$$

$$R_t\psi_t = 1 - \beta_b E_t\left(\frac{1-\gamma\varepsilon_{t+1}^D}{1-\gamma\varepsilon_t^D}\right)\left(\frac{X_t^b}{X_{t+1}^b}\right)^{\sigma}\left(\frac{D_{t+1}^b}{\tilde{C}_{t+1}^b}\right)^{\gamma\varepsilon_{t+1}^D}\left(\frac{\tilde{C}_t^b}{D_t^b}\right)^{\gamma\varepsilon_t^D}\frac{R_t}{\prod_{c,t+1}} \tag{5.7}$$

where ψ_t and $\lambda_t\psi_t$ denote the marginal value of borrowing and the Lagrangian multiplier on the borrowing constraint, respectively (see Monacelli, 2005). If $\psi_t = 0$, equation (5.7) reduces to the standard New Keynesian Euler equation. Therefore an increase in ψ_t leads to a tightening of the collateral constraint. The first condition represents the standard labour-leisure trade-off, equating the marginal disutility of an additional unit of labour to the marginal utility received from additional consumption. Equation (5.6) equates the marginal utility of non-durable consumption to the shadow value of durable services. The last equation is a consumption Euler equation adjusted to capture the borrowing constraint.

5.3.2 Patient Households (Savers)

Intertemporal decisions are made in a standard way by patient households. The representative patient saver is expected to maximise an intertemporal utility function given by

$$\max E_0 \sum_{t=0}^{\infty} \beta_S^t \left[\frac{1}{1-\sigma} X_t^{s^{1-\sigma}} - \frac{v_S}{1+\varphi}\ (N_t^s)^{1+\varphi}\right] \tag{5.8}$$

Subject to

$$C_t^s + Q_t(1+\tau_t^D)I_{D,t}^s - B_{H,t}^s - \mathfrak{E}_t B_{F,t}^s = -R_{t-1}\frac{B_{H,t-1}^S}{\Pi_{C,t}} - R_{t-1}^* \frac{\mathfrak{E}_t B_{F,t}^S}{\Pi_{C,t}} + \sum_{j=C,D} \frac{F_{j,t}}{P_{C,t}} + T_t^s \tag{5.9}$$

where $B_{F,t}^S$, R_t, E_t, and $F_{j,t}$ represent foreign bond holdings, foreign interest rates, nominal exchange rates, and profits earned by savers from owning intermediate goods firms, respectively. The rest of the variables' definitions are similar to those of the borrowers. Optimisation of equation (5.8) subject to equation (5.9) yields:

$$\frac{W_t}{P_{c,t}} = \frac{\left(X_t^b\right)^{\sigma} N_t^{s\varphi} \tilde{C}_t^{s\gamma\varepsilon^{D,S}}}{(1-\gamma\varepsilon^{D,S}) D_t^{s\gamma\varepsilon^{D,S}}} \tag{5.10}$$

$$(1+\tau_t^D)Q_t = \left(\frac{\gamma\varepsilon^D}{1-\gamma\varepsilon^D}\right)\frac{\tilde{C}_t^s}{D_t^s} + \beta_s(1-\delta)E_t\left(\frac{1-\gamma\varepsilon_{t+1}^D}{1-\gamma\varepsilon_t^D}\right)\left(\frac{x_t^s}{x_{t+1}^s}\right)^{\sigma}\left(\frac{D_{t+1}^s}{\tilde{C}_{t+1}^s}\right)^{\gamma\varepsilon_{t+1}^D}\left(\frac{\tilde{C}_t^s}{D_t^s}\right)^{\gamma\varepsilon_t^D} Q_{t+1}(1+\tau_t^D) \tag{5.11}$$

$$1 = \beta_s E_t \left(\frac{1-\gamma\varepsilon_{t+1}^D}{1-\gamma\varepsilon_t^D}\right)\left(\frac{x_t^s}{x_{t+1}^s}\right)^{\sigma}\left(\frac{D_{t+1}^s}{\tilde{C}_{t+1}^s}\right)^{\gamma\varepsilon_{t+1}^D}\left(\frac{\tilde{C}_t^s}{D_t^s}\right)^{\gamma\varepsilon_t^D}\frac{R_t}{\Pi_{C,t+1}} \tag{5.12}$$

$$1 = \beta_s E_t \left(\frac{1-\gamma\varepsilon_{t+1}^D}{1-\gamma\varepsilon_t^D}\right)\left(\frac{x_t^s}{x_{t+1}^s}\right)^{\sigma}\left(\frac{D_{t+1}^s}{\tilde{C}_{t+1}^s}\right)^{\gamma\varepsilon_{t+1}^D}\left(\frac{\tilde{C}_t^s}{D_t^s}\right)^{\gamma\varepsilon_t^D}\frac{\mathfrak{E}_{t+1}}{\mathfrak{E}_t}\frac{R_t}{\Pi_{C,t+1}} \quad (5.13)$$

Identical to the case of borrowers, equation (5.10) equates the real wages in units of non-durables to the saver's marginal rate of substitution between leisure and consumption. Furthermore, since savers are not subject to a borrowing constraint, the equations emulate those of borrowers for $\psi_t = 0$. Equation (5.11) equalises the durable goods purchase price to pay-off (the marginal rate of substitution between non-durable and durable consumption) plus the anticipated resale value. Equations (5.12) and (5.13) are conventional Euler equations adjusted for housing in the consumption index.

5.3.3 Tradable goods sector

Following Funke et al. (2018), durable and non-durable consumption indices are given by:

$$C_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}\frac{\eta-1}{\eta} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \quad (5.14)$$

where

$$C_H \equiv \left[\int_0^1 C_H(k)^{\frac{\epsilon_{C-1}}{\epsilon_C}} dk\right]^{\frac{\epsilon_C}{\epsilon_{C-1}}}$$

$$C_F \equiv \left[\int_0^1 C_{i,t}(k)^{\frac{\varsigma-1}{\varsigma}} di\right]^{\frac{\varsigma}{\varsigma-1}}$$

$$C_{i,t} \equiv \left[\int_0^1 C_{i,t}(k)^{\frac{\epsilon_{C-1}}{\epsilon_C}} dk \right]^{\frac{\epsilon_C}{\epsilon_{C-1}}}$$

We define η as the intertemporal elasticity of substitution between foreign and domestic goods, α is the degree of openness, and ϵ_C is the intertemporal elasticity of substitution between differentiated goods that are tradable in a country and those that are non-tradable. ς is the intertemporal elasticity of substitution between goods produced in the rest of the world and those produced locally. Therefore, the price indices are given by:

$$P_{C,t} = \left[(1-\alpha)P_{C,H,t}^{1-\eta} + \alpha P_{C,F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}} \qquad (5.15)$$

The sector-specific bilateral terms of trade between the domestic country and country i represent the price of country i's goods in terms of domestic goods and is given by $S_{i,t} = \frac{P_{C,i,t}}{P_{C,H,t}}$ (the price of country i's goods). Therefore the price of country i's goods in terms of domestic goods (i.e., effective terms of trade) is given by $S_{i,t} = \frac{P_{C,F,t}}{P_{C,H,t}} = \left(\int_0^1 s_{i,t}^{1-\varsigma}\right)^{\frac{1}{1-\eta}}$, which can be approximated by $s_t = log(S_T) \approx \int_0^1 s_{i,t}\, di$. In addition, log linearising the domestic price indices under the assumption of a symmetric steady-state satisfying the PPP provides a relationship between the inflation of goods produced locally and the sectorial terms of trade in the consumption goods sector. The latter is denoted by

$$\hat{\pi}_{C,t} = \hat{\pi}_{C,H,t} + \alpha \Delta \hat{s}_t \qquad (5.16)$$

The study assumes that the law of one price (LOOP) holds at the brand level and that aggregation across all tradable products and countries leads to $P_{C,F,t} = \mathfrak{E}P^*_{C,F,t}, P_{C,H,t} = \mathfrak{E}P^*_{C,H,t}$ and $P_{C,t} = \mathfrak{E}P^*_{C,t}$. Log-linearising $P_{C,F,t}$ around a symmetric steady-state yields

$$\hat{p}_{C,F,t} = \int_0^1 (\widehat{e_{\iota,t}} + \hat{p}_{C,i,t})di = \hat{e}_t + \hat{p}^*_{C,t} \tag{5.17}$$

where the log world price index of tradable goods is denoted by $\hat{p}^*_{C,t}$

5.3.4 International risk-sharing

The study assumes that patient households can share country-specific risks internationally via the trading of bonds in complete security markets, while impatient households are constrained. The equalisation of domestic and foreign optimality conditions in relation to consumption and linearising the results around a symmetric steady-state assuming symmetric initial conditions yields:

$$\left(\frac{X_t^{s^*}}{X_t^s}\right)\left(\frac{\tilde{C}_t^{s,\varepsilon_t^D}}{\tilde{C}_t^{s^*,\varepsilon_t^{D^*}}}\right)^{\gamma}\left(\frac{D_t^{s,\varepsilon_t^D}}{D_t^{s^*,\varepsilon_t^{D^*}}}\right)^{\gamma} = \mathcal{R}_t \tag{5.18}$$

where $\mathcal{R}_t$, $D_t^{s^*}$, $\hat{C}_t^{s^*}$ represent the consumer price based real effective exchange rates, the index of non-durable consumption, and the composite index of foreign savers' non-durable consumption accounting for habit persistence. Moreover, $X_t^{s^*}$ is the index of foreign savers' total consumption and $\varepsilon_t^{D^*}$ denotes foreign counterparts to domestic shocks.

5.3.5 Firms

This subsection focuses on the microstructure of firms. The study assumes that there is a two-stage production process in each sector constituting the production of intermediate goods (wholesale sector) and final goods (retailer sector).

Final Goods Firms (Retailers)

There is a continuum of intermediate goods firms that produce differentiated goods. A separate set of firms (final goods firms) operating in the retail sector bundles these goods into final goods Y_t using the following production function (Dixit-Stiglitz aggregator):

$$Y_{j,t} = \left(\int_0^1 Y^{\frac{1}{\mu_{tj}}} (k) dk \right)^{\mu_{tj}} \tag{5.19}$$

where aggregate output is represented by $Y_{j,t}$. Intermediate goods firm k produces inputs $Y^{\frac{1}{\mu_{tj}}}$(both expressed in per capita terms) and μ_{tj} represents a time-varying sector-specific price mark up over marginal cost in the wholesale sector. Considering that the retailers are price takers, each produces the optimal number of final goods to maximise their profits:

$$Max P_{j,H,t} Y_{j,t} - \int_0^1 P_{j,H,t}(k) Y_{j,t}(k) dk \tag{5.20}$$

Subject to equation (5.20), we get the standard downward-sloping demand curve for product k given by:

$$Y_{j,t}(k) = \left(\frac{P_{j,H,t}(k)}{P_{j,H,t}} \right)^{-\epsilon_j} Y_{j,t} \tag{5.21}$$

Intermediate Goods Firms (Wholesale Sector)

The assumption is that there is a continuum of monopolistically competitive intermediate goods firms. Each firm is assumed to follow a stochastic constant return to scale production function $Y_{j,t}(k) = A_{j,t}N_{j,t}(k)$, where $A_{j,t}$ and $N_{j,t}$ represent sector-specific labour productivity and labour input, respectively. Each sector's real marginal cost is derived from each sectorial firm's cost minimisation problem. Thus, the latter is given by:

$$Min\ W_tN_{c,t}(k) \tag{5.22}$$

subject to the following constraint:

$$A_{c,t}N_{c,t}(k) \geq \left(\frac{P_{c,H,t}(k)}{P_{c,H,t}}\right)^{-\epsilon_c} Y_{C,t} \tag{5.23}$$

And

$$MinW_tN_{D,t}(k) \tag{5.24}$$

subject to

$$A_{D,t}N_{D,t}(k) \geq \left(\frac{P_{D,H,t}(k)}{P_{D,H,t}}\right)^{-\epsilon_D} Y_{D,t} \tag{5.25}$$

given by $\frac{\left(\frac{w_t}{P_{H,j,t}}\right)}{MPN_{j,t}}$ where $MPN_{j,t}$ denotes the marginal product of labour in each sector. The aggregate optimal labour-leisure decisions of savers and borrowers, the real marginal cost in each sector is given by:

$$MC_{C,t} = \frac{X_t^b N_t^{b^{\varphi}} c_t^{b^{\gamma \varepsilon_t^D}} s_t^{\alpha}}{(1-\gamma \varepsilon_t^D) D_t^{b \gamma \varepsilon_t^D} A_{c,t}} \tag{5.26}$$

$$MC_{D,t} = \frac{X_t^b N_t^{b^{\varphi}} c_t^{b^{\gamma \varepsilon_t^D}}}{(1-\gamma \varepsilon_t^D) D_t^{b \gamma \varepsilon_t^D} A_{D,t} Q_t} \tag{5.27}$$

5.3.6 Price setting

The intermediate goods producer is monopolistically competitive and adjusts prices by assuming that they follow Calvo pricing's diverse characteristic in line with Gali and Gertler (1999). A fraction of the firms selected randomly in each period $(1-\theta_j)$ adjusts prices, whereas the remaining proportion θ_j does not. Following Justiniano and Preston (2010), it is assumed that producers that do not reoptimise in the current period adjust their prices in line with the following rule:

$$logP_{H,C,t}(i) = logP_{H,C,t-1}(i) + l_j \prod_{H,C,t-1} \tag{5.28}$$

$$logP_{D,t}(i) = logP_{D,t-1}(i) + l_j \prod_{D,t-1} \tag{5.29}$$

where the index of the past period's inflation is denoted by $0 \leq l_j \leq 1$. This assumption yields the conventional markup rule. Thus, producers set the price as a mark-up over the current and future real marginal costs subject to a price index. Consequently, the usual New Keynesian Phillips curve comprises forward-looking and backward-looking elements. Taking first-order log-linear approximations around the steady-state produces:

$$(1 + \beta_s l_c)\hat{\pi}_{H,C,t} = \beta_s E_t \hat{\pi}_{H,C,t} + l_c \hat{\pi}_{H,C,t-1} + k_c \widehat{mc}_{C,t} + \varepsilon_t^{\mu_c} \quad (5.30)$$

$$(1 + \beta_s l_D)\hat{\pi}_{D,t} = \beta_s E_t \hat{\pi}_{H,C,t} + l_D \hat{\pi}_{D,t-1} + k_D \widehat{mc}_{D,t} + \varepsilon_t^{\mu_D} \quad (5.31)$$

where the slope of the New Keynesian Phillips curve is represented by $k_j = \frac{(1-\theta_j)(1-\theta_j\beta_s)}{\theta_j}$, $\widehat{m}c_{j,t}$ is the real marginal cost in log-deviation from the steady-state and $\varepsilon_t^{\mu_j}$ denotes a cost-push shock similar to Smets and Wolters (2007).

5.3.7 Market clearing

Aggregate goods market-clearing for each good k in each sector j requires

$$Y_{c,t}(k) = C_{H,t}(k) + \int_0^1 C_{H,t}^i(k)di \quad (5.32)$$

$$Y_{D,t}(k) = I_t(k) \quad (5.33)$$

The aggregate consumption of both housing stock and non-durable goods is given by:

$$C_t = \omega C_t^b + (1-\omega)C_t^s \quad (5.34)$$

$$D_t = \omega D_t^b + (1-\omega)D_t^s \quad (5.35)$$

And

$$I_t = D_t + (1-\delta)D_{t-1} \quad (5.36)$$

$$A_t = A_{c,t} = A_{D,t} \tag{5.37}$$

Equations (5.32) and (5.33) approximate around a symmetric steady-state by

$$\hat{y}_{c,t} = (1-\alpha)\widehat{c_t} + \alpha\hat{c}_t^* + \alpha v\hat{s}_{c,t} \tag{5.38}$$

$$\hat{y}_{D,t} = \hat{l}_{D,t} \tag{5.39}$$

where $v = \varsigma + \eta(1-\alpha)$. The $P_{H,t}Y_t = P_{C,H,t}Y_{C,t} + P_{D,H,t}Y_{D,t}$ is fulfilled by the aggregate real output denominated with the aggregate producer price index $P_{H,t}$. Therefore,

$$T_t^b = T_t^s = 0 \tag{5.40}$$

5.3.8 Monetary policy

The study assumes a Taylor-type rule, that is:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_\tau} \left[\left(\frac{\prod_{C,t}}{\prod_C}\right)^{\Phi_\pi} \left(\frac{Y_t}{Y_{t-1}}\right)^{\Phi_\alpha}\right]^{1-p_r} \varepsilon_t^m \tag{5.41}$$

where ρ_τ is the degree of policy rate smoothing, and Φ_π and Φ_α measure the interest rate's response to inflation and output growth, respectively. Equation (5.41) is the Taylor rule that enables us to examine conventional monetary policy's effectiveness specifically for rising house prices.

5.3.9 Exogenous processes

Local solution methods are used to solve the model by linearising all the equilibrium conditions using a first-order Taylor approximation. As a result, all the variables are put forward as log deviations from their steady-state levels. Six exogenous processes define the model's dynamics to capture the reasons for moving exogenous to the model. The functional forms are presented as:

$$a_{j,t} = \rho_a a_{j,t-1} + v_{j,t}^{a} \quad (5.42)$$

$$\epsilon_t^m = v_t^m \quad (5.43)$$

$$\hat{c}_t^* = \rho^* \hat{c}_{t-1}^* + v_t^* \quad (5.44)$$

$$\epsilon_t^{\mu_i} = \rho_{\mu_j} \epsilon_{t-1}^{\mu_i} + v_t^{\mu_i} \quad (5.45)$$

$$\epsilon_t^{\gamma} = \rho_{\gamma} \epsilon_{t-1}^{\gamma} + v_t^{\gamma} \quad (5.46)$$

$$\epsilon_t^{LTV} = \rho LTV \epsilon_{t-1}^{LTV} + v_t^{LTV} \quad (5.47)$$

$$\epsilon_t^{\tau} = \rho_{\tau} \epsilon_{t-1}^{\tau} + v_t^{\tau} \quad (5.48)$$

where $v_t^i \sim N(0, \sigma_i^2)$. Equation (5.42) describes a standard stochastic process for technology in sector j, while equation (5.43) is the monetary policy shock. Equation (5.44) is foreign demand for locally produced tradable goods, which is an autoregressive process of order one and is subject to random disturbances represented by $\hat{c}_t^*$. Equation (5.45) is the sector-specific cost-push shock. The model also enables an exogenous perturbation to the marginal rate of substitution between the consumption of non-tradable goods and the consumption of tradable goods in the utility function in the form of a housing preference shock represented in equation (5.46). The impact of macro-prudential tools, namely the positive LTV shock and negative stamp duty tax shock for stabilising house prices, are denoted by equations (5.47) and (5.48), respectively.

5.4 Calibration and estimation

The study uses quarterly data for South Africa from 2000Q1-2018Q4, which covers the inflation-targeting period. We use six observable variables that include real consumption per capita, CPI inflation, real GDP per capita, employment, the overnight interbank cash rate and house price inflation. We discuss this data in detail in Appendix D. Real output per capita, employment, consumption and real housing investment are detrended using the one-sided Hodrick-Prescott filter while house price inflation and the CPI are only demeaned. The overnight cash rate is in a monthly frequency. It is transformed into quarterly data to match the frequency of the rest of the variables and hence the set-up of the DSGE model. All the data, except for house price inflation, employment, and real house investment, were obtained from the SARB. House price inflation was obtained from ABSA bank, while employment and real house investment were obtained from the World Bank and IMF's International Financial Statistics, respectively. Policy models geared towards assessing actual macro-prudential policy challenges need to match the data moments and allow for policy simulation and analysis. The calibration of steady-state ratios and values is determined by parameters using a Bayesian approach. The posterior distribution of the parameter is estimated using a Metropolis-Hastings algorithm.

5.4.1 Calibration

Table 5.1 reports on the parameter values for the small, open economy. The parameters $\beta_s = 0.995$, and $\beta_b = 0.87$ are discount factors for savers and borrowers, respectively. The selection of these values is in line with the literature on borrowing constraints (see Iacoviello, 2005; Gerali et al., 2010; Gupta and Sun, 2018). The rate of housing stock depreciation, δ, is set at 0.02, giving an annual depreciation rate of 2 per cent. The LTV ratio is 0.75, according to the cross country evidence in the IMF statistics (2011). The elasticities of substitution between goods produced locally and those produced in a foreign country are somewhat challenging to estimate due to their relation to sector-specific degrees of openness. Therefore, following Funke and Paetz (2013), the model is kept tractable and set at **ς**= η=2. Following Gupta and Sun (2018), the degree of openness, α is set to 0.3 to match the South African imports in GDP. For both the durable and non-durable sectors, the substitution elasticity is 6, which produces a mark-up value of 1.2. Purchasing real estate in South Africa comes at an ancillary cost (land registry costs, notary fees, etc.), which is based on a property tax set at 0.05. The steady-state of housing investment to aggregate production matches the share of housing consumption in the utility function. Finally, both types of households have the same hours worked preference parameter, one-third of their time in the steady-state.

Table 5.1: Calibrated parameters

Parameter	Symbol	Value
Discount factor of savers	β_s	0.995
Discount factor of borrowers	β_b	0.87
Elasticity of substitution between differentiated non-durable goods	ϵ_C	6
Elasticity of substitution between differentiated durable goods	ϵ_D	6
Depreciation of residential stock	δ	0.02
LTV ratio	$1-x$	0.75
share of housing in utility	γ	0.4
Property tax	τ	0.05
Degree of openness	α	0.2
Elasticity of substitution between goods produced in different foreign countries	**ς**	2
Elasticity of substitution between domestic and foreign goods	η	2

5.4.2 Prior and posterior distribution

Table 5.2 presents the prior distribution, standard deviation and mean for all the estimated parameters, while the shock parameters are shown in Table 5.3. Priors are crucial for Bayesian estimation; hence, their selection is guided by the DSGE literature on South Africa. Most of the parameters are consistent with previous studies (see Iacovillo and Neri, 2010; Gupta and Sun, 2018). The assumption is that the degree of habit persistence follows a beta distribution with a mean of 0.4 and a standard deviation of 0.05. The borrower's share is assumed to follow a beta distribution with a mean of 0.4. In the Taylor rule, the interest rate smoothing parameter is assumed to follow a beta distribution with a mean of 0.7 and a standard deviation of 0.05. The assumption is that output and inflation have gamma and beta distributions with means of 1.57 and 1.84, respectively, and a standard deviation of 0.1. In addition, house price inflation and tradable goods inflation are forward- and backward-looking, respectively. The posterior mean of the monetary policy rule's output growth coefficient implies that the reserve bank focuses on inflation stability rather than output growth smoothing.

Table 5.2 structural parameter estimate

Description	Parameter	Posterior mean	90% interval	Prior mean	Density	St.dev
elasticity of substitution of labour	$(\boldsymbol{\sigma})$	1.00	(1.35,1.2)	1.49	gamma	0.05
elasticity of substitution of consumption	$(\boldsymbol{\varphi})$	2.00	(1.85,1.67)	2.02	gamma	0.10
degree of habit information	$(\boldsymbol{h})$	0.40	(0.89,0.84)	0.93	beta	0.05
share of borrowers	$(\boldsymbol{\omega})$	0.40	(0.08,0.06)	0.10	beta	0.05
interest rate smoothing parameter	$(\boldsymbol{\rho_r})$	0.50	(0.64,0.36)	0.70	beta	0.05
policy rate to inflation	$(\boldsymbol{\Phi_\pi})$	2.00	(1.25,1.01)	1.57	gamma	0.10
policy rate to output	$(\boldsymbol{\Phi_y})$	0.20	(0.94, 0.04)	1.84	gamma	0.10
Calvo(non-housing goods)	$(\boldsymbol{\theta_d})$	0.80	(0.86,0.81)	0.91	beta	0.05
calvo (housing goods)	$(\boldsymbol{\theta_c})$					
forward-looking tradable goods	$(\boldsymbol{l_c})$	0.50	(0.67,0.49)	0.84	beta	0.10
backward-looking tradable goods	$(\boldsymbol{l_d})$	0.50	(0.31,0.09)	0.56	beta	0.10
Autocorr. Technology (housing)	$(\boldsymbol{\rho_{a_C}})$	0.50	(0.44,0.35)	0.54	beta	0.05
Autocorr. Technology (housing)	$(\boldsymbol{\rho_{a_D}})$	0.50	(0.94, 0.91)	0.97	beta	0.05
World price index	$(\boldsymbol{\rho}^*)$	0.50	(0.74,0.68)	0.79	beta	0.05
Autocorr. Cost push	$(\boldsymbol{\rho_{\mu_C}})$	0.50	(0.52, 0.44)	0.44	beta	0.05
Autocorr. Cost push	$(\boldsymbol{\rho_{\mu_D}})$	0.50	(0.54,0.38)	0.70	beta	0.05
Autocorr. House preference	$(\boldsymbol{\rho_\gamma})$	0.50	(0.55,0.46)	0.64	beta	0.05

The posterior distribution is estimated using a Metropolis-Hastings (MH) Markov-Chain Monte Carlo (MCMC) algorithm. Counterfactually, the total number of Markov-Chains draws per chain is 200 000. Fifty per cent of the draws burn-in. To confirm that the acceptance rate is approximately 26 per cent, the study parameterises the MH with a scale factor of 0.45.

5.5 Model properties

In this section, we assess the properties of the model for our baseline scenario, specifically by evaluating the model's ability to replicate the actual data by comparing volatility and the correlation of the variables predicted by the estimation model and those of the real data. Most of the variables reported in Table 5.4 show that the relative standard deviations of both the model and the data are less volatile. However, according to the DSGE housing literature, house investment and house prices tend to be excessively unstable in the model compared to the data.

Table 5.5 shows the correlation of both the data and the model. The model performs well since the estimated correlations are close to those observed in the data. The model replicates the co-movements of output, consumption, house prices and housing investment. These variables are the main focus of macro-prudential policy. The variance decomposition analyses in Table 5.6 reveal the contribution of different shocks to these variables. The table shows that the variance decomposition of technology shocks (housing industry) has a potent effect on output. While the technology shock (consumption) has a marginal impact on output, it accounts for less than 15 per cent of technology fluctuations throughout the period under analysis. Foreign demand shocks make a relatively more significant contribution to output. In contrast, monetary policy shocks account for less than 10 per cent of the fluctuations in house prices.

Table 5.4: Relative Standard Deviations

		Relative standard deviations
	Data	Model
Output	1.00	1.00
Interest rate	0.39	0.05
CPI inflation	0.49	0.05
Property price inflation	1.98	0.28
consumption	0.97	0.22
Housing investment	8.12	16.61
Employment	7.91	0.71

Table 5.5: Correlations

Correlations	**Data**	**Model**
$\boldsymbol{y, \pi_D}$	-0.43	0.34
$\boldsymbol{y, i_D}$	0.59	0.95
$\boldsymbol{R, \pi_c}$	0.71	0.40
$\boldsymbol{R, c}$	-0.35	-0.32
$\boldsymbol{\pi_C, c}$	-0.47	-0.11
$\boldsymbol{\pi_D, R}$	0.01	0.07
$\boldsymbol{\pi_C, i_D}$	0.01	0.39
$\boldsymbol{n, \pi_C}$	-0.00	-0.34
$\boldsymbol{n, R}$	-0.09	0.29

Table 5.6: Variance decomposition

Variable	Horizon	Technology Shock (cons)	Technology Shock (house)	Monetary Policy shock	Foreign Demand shock	Cost Push Shock (cons	Cost Push Shock (cons)	House Pref shock
$\boldsymbol{y}$	1	0.14	0.52	0.08	0.00	0.10	0.15	0.00
	2	0.10	0.44	0.06	0.00	0.06	0.34	0.00
	4	0.09	0.44	0.05	0.00	0.06	0.35	0.00
	8	0.09	0.46	0.05	0.00	0.06	0.34	0.00
	∞	0.08	0.45	0.05	0.00	0.07	0.35	0.00
$\boldsymbol{\pi_c}$	1	0.01	0.00	0.39	0.26	0.29	0.05	0.00
	2	0.01	0.02	0.26	0.18	0.44	0.10	0.00
	4	0.01	0.06	0.22	0.14	0.45	0.11	0.00
	8	0.01	0.08	0.21	0.14	0.45	0.12	0.00
	∞	0.01	0.08	0.20	0.13	0.45	0.13	0.00
$\boldsymbol{\pi_D}$	1	0.01	0.68	0.07	0.00	0.06	0.17	0.00
	2	0.01	0.68	0.07	0.00	0.06	0.17	0.00
	4	0.01	0.68	0.08	0.00	0.07	0.17	0.00
	8	0.01	0.67	0.07	0.00	0.07	0.18	0.00
	∞	0.01	0.67	0.07	0.00	0.07	0.18	0.00
$\boldsymbol{c}$	1	0.00	0.02	0.27	0.04	0.30	0.04	0.32
	2	0.00	0.02	0.24	0.04	0.44	0.01	0.24
	4	0.00	0.03	0.18	0.02	0.61	0.01	0.14
	8	0.00	0.09	0.10	0.01	0.65	0.08	0.06
	∞	0.00	0.55	0.04	0.00	0.31	0.08	0.02

5.6 Historical decomposition

The historical shock decomposition of CPI inflation, consumption and house price inflation is over the estimated sample period 2000Q1-2018Q4. Figure 5.1 shows that monetary policy shocks mainly influence CPI inflation. In 2000 South Africa implemented inflation targeting, and the data used in this study begins from that period. However, the variance decomposition (see Table 5.6) shows that cost-push shock (consumption) factors account more for fluctuations in CPI inflation than monetary policy shocks.

Figure 5.1 CPI inflation

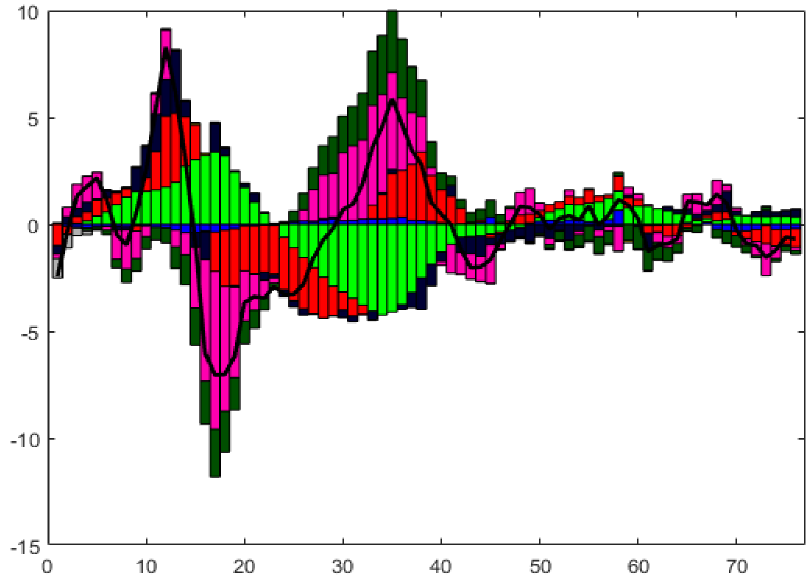


Figure 5.2 Housing inflation

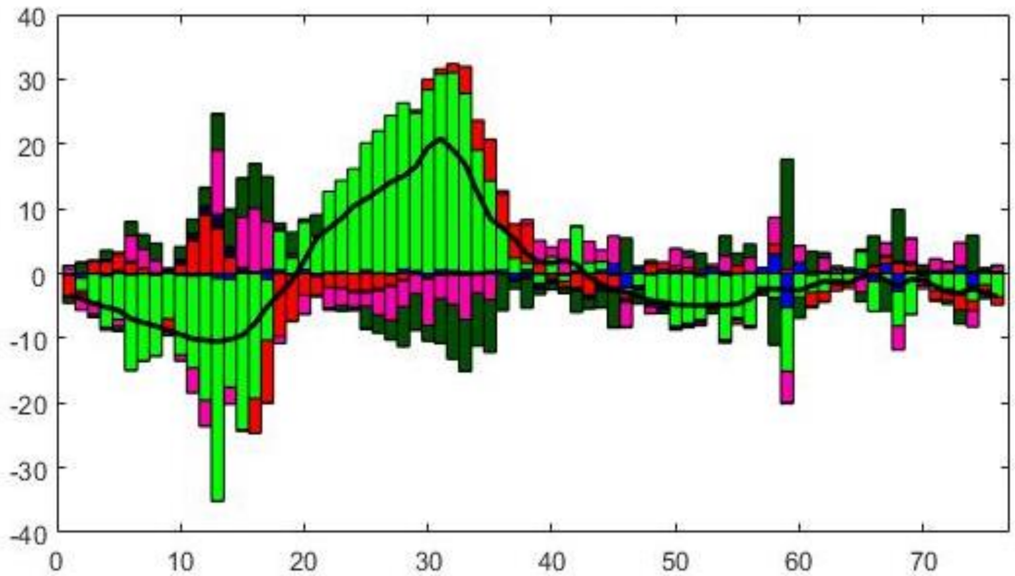


Figure 5.3 Consumption

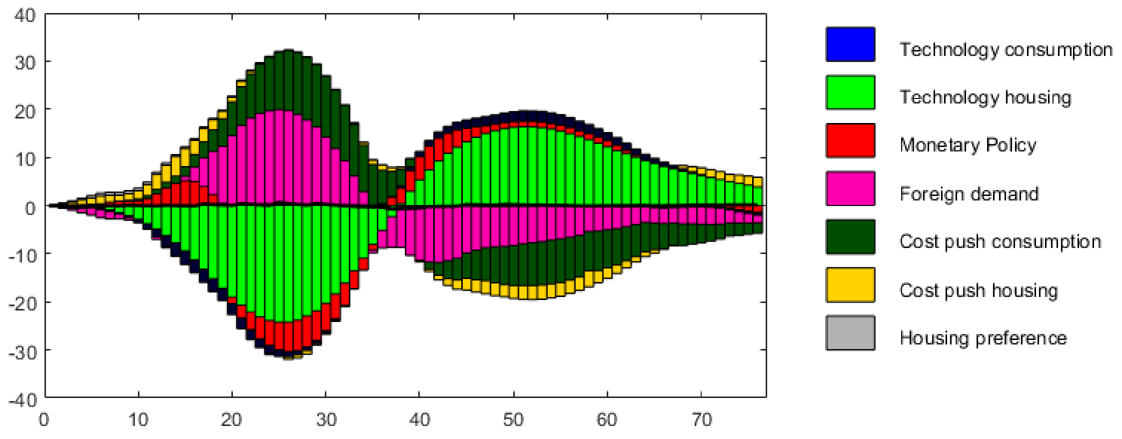


Figure 5.2 shows that house price inflation is mainly driven by technology shocks (housing supply shocks) that might also be referred to as mortgage supply shocks. Following Mian et al. (2017), mortgage supply shocks contribute significantly to business cycles. The authors establish that the relationship between consumption and debt makes a major contribution to this channel. The domination of mortgage supply shocks confirms the fact that 53 per cent of the retail sector's lending is for residential mortgages in South Africa (SARB, 2019). Figure 5.3 shows that the housing sector affects the economy through the consumption channel (Iacoviello and Neri, 2010). LTV regulation also uses this channel because it regulates how credit-constrained households limit consumption when responding to low house prices (Mian et al., 2013). Figure 5.3 further shows that consumption is primarily dominated by the housing industry and consumption shocks (technology shocks), and the variance decomposition results confirm this (see Table 5.6). The foreign demand shock increases demand for non-tradable goods. Hence, house prices fall due to the shift in consumption to non-tradable goods. This narrative fits well with the influence of the 2007/2008 global financial crisis. Consumption in 2018 was negative and house prices were positive. The historical decomposition suggests that housing technology shocks, have the same effect in increasing house prices and consumption.

This further supports consumption as a channel for macro-prudential policy targeting house debt and house prices.

5.7 Impulse response analysis

The model's dynamic properties are presented in this section that sets out the impulse response functions of how housing preference shocks, monetary policy shocks, and technology shocks impact selected variables. Figure 5.4(a) shows the effects of house preference shocks (representing housing demand) on output, consumption, housing stock, the nominal interest rate, inflation, house prices, house investment, employment, and trade terms. The figure reveals that house preference shocks significantly increase real house prices and housing investment (representing housing). Therefore, consumption decreases since consumers substitute their demand for consumption with investment. The impact on CPI inflation increases due to the slow reaction of growing demand for housing supply. High demand for houses increases their prices. Hence, policymakers raise the nominal interest rate. A housing preference shock results in a decline in employment, consumption and output and transient moves from other economic sectors.

Figure 5.4(a): Impulse responses to a one-standard-deviation House preference shock in the housing sector

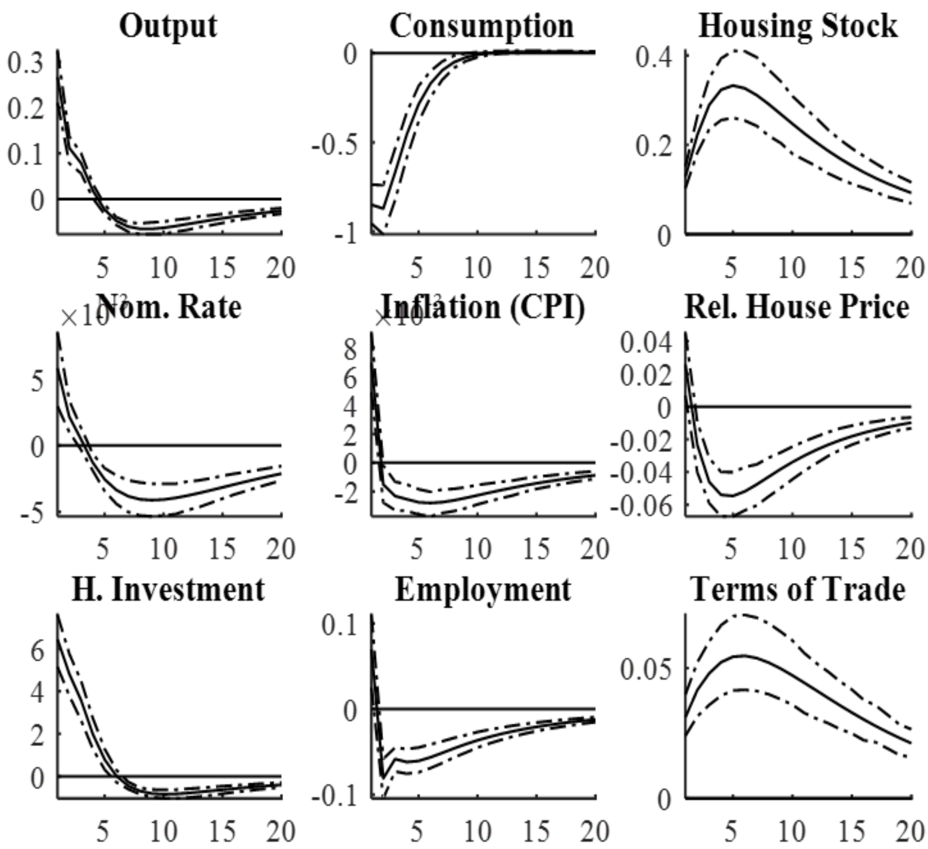


Figure 5.4(b) shows the impact of a tight monetary policy on output, consumption, housing stock, the nominal interest rate, inflation, house prices, house investment, employment, and terms of trade. The figure reveals that high nominal interest rates affect borrowers more than savers because it impacts their debt levels. The decrease in real house prices lowers the real value of borrowers' collateral, which encourages them to reduce their debt, intensifying the adverse effect on their house prices and housing demand. Output decreases due to the drop in consumption while aggregate demand shrinks, and CPI inflation decreases because of the lower prices of imported goods which amplify the real exchange rate.

Figure 5.4(b): Impulse responses of a Contractionary Monetary Policy shock

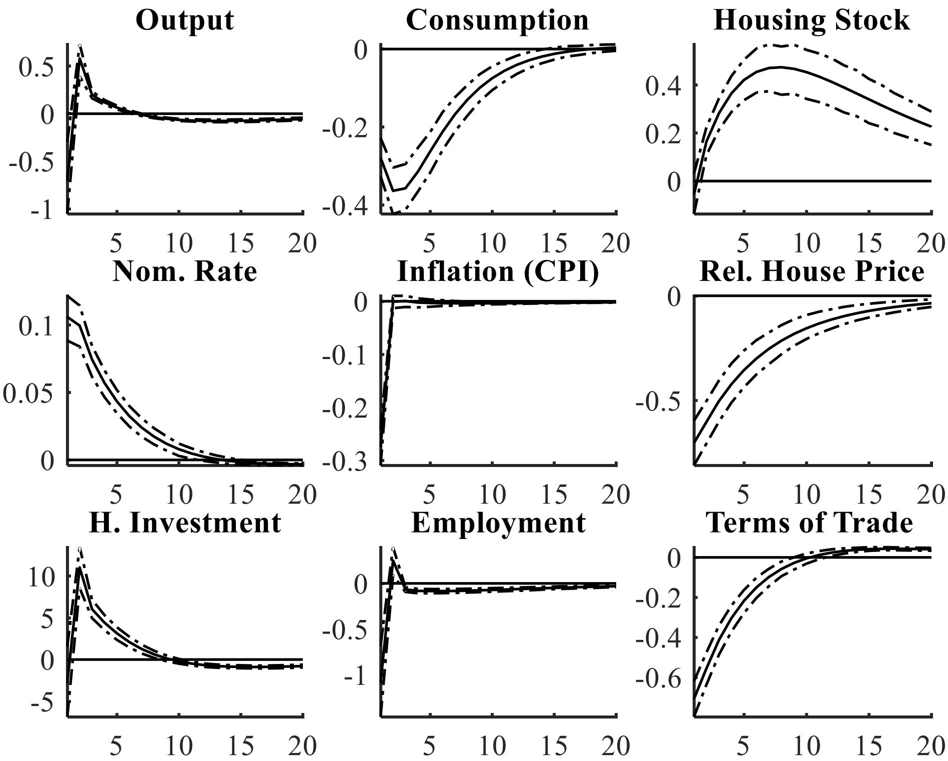
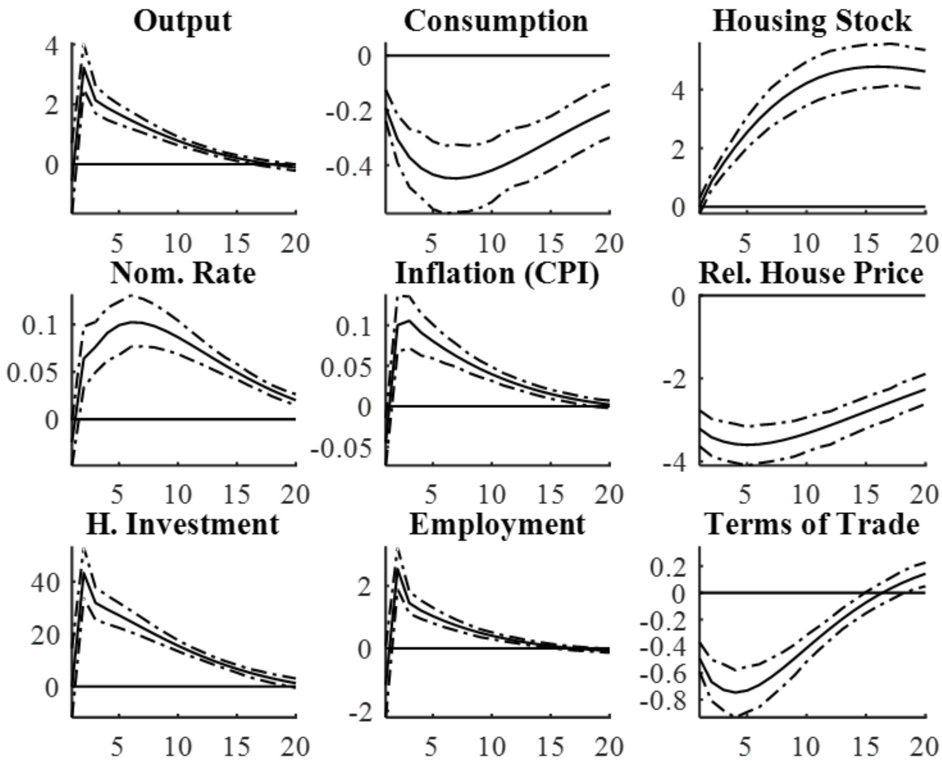


Figure 5.4 (c) illustrates the impact of technology shocks in the housing sector. The results show that housing investment and output rise following a technology shock. House prices decrease, encouraging consumers to divert their demand from non-durable goods to housing. Policymakers respond by increasing nominal interest rates. Therefore, the domestic currency appreciates. Such appreciation negatively impacts foreign demand for local non-durable goods and, consequently, the current account.

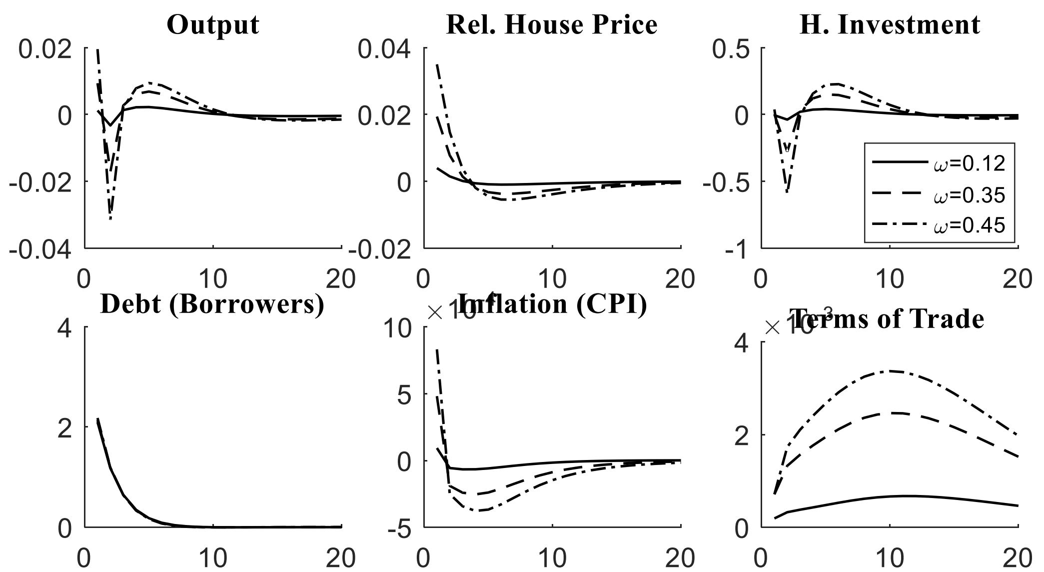
Figure 5.4(c): Impulse Responses to a technology shock



Macro-prudential policy analysis

In South Africa, residential mortgages account for the largest proportion of loans in the banking sector. Households have to pay an instalment to ensure that the LTV ratio continues to be lower than the threshold. Following Iacoviello (2015), the exogenous fluctuations of the LTV ratio are an example of macro-prudential policy loosening or tightening household borrowing capacity. The LTV ratio constraints' objective is to prevent households from exposing themselves to excessive real estate borrowing and excessive risk-taking. Figure 5.5 shows the impulse responses for a one per cent rise in the LTV constraint: an expansion of macro-prudential policy on output, inflation, house prices, house investment, borrowers and terms of trade. In this model, the exogenous parameter is a share of borrowers. Thus, the estimates surround the intensive borrowing margin. The figure shows that the extensive margin generates an additional channel whereby changes in the LTV may affect house prices. A high (low) LTV ratio permits more (few) borrowers to obtain a loan; therefore, the fraction of borrowers ω rises (falls). A high (limited) number of borrowers can make a down payment for housing. As a result, demand for housing increases (decreases). This channel complements and intersects with the intensive mortgage credit channel. Figure 5.5 shows the economy's response to a one per cent increase in the LTV ratio shock for diverse shares of borrowers to investigate the extensive channel. Unexpectedly, a relaxed LTV policy makes borrowers indifferent to their debt level. In other words, the ratio's effectiveness depends on how vital access to financing is for house prices. Following a high LTV regime, savers demand consumption goods instead of housing and as a result, the CPI increases. Under the lowest LTV regime, the opposite occurs, and borrowers demand less of both goods. Therefore, house prices decrease. High real estate prices lead to an increase in the collateral value that borrowers are required to pledge to secure a mortgage, which tends to have a negative effect on their ability to borrow.

Figure 5.5: Impulse response of a one-per cent rise in the LTV ratio.



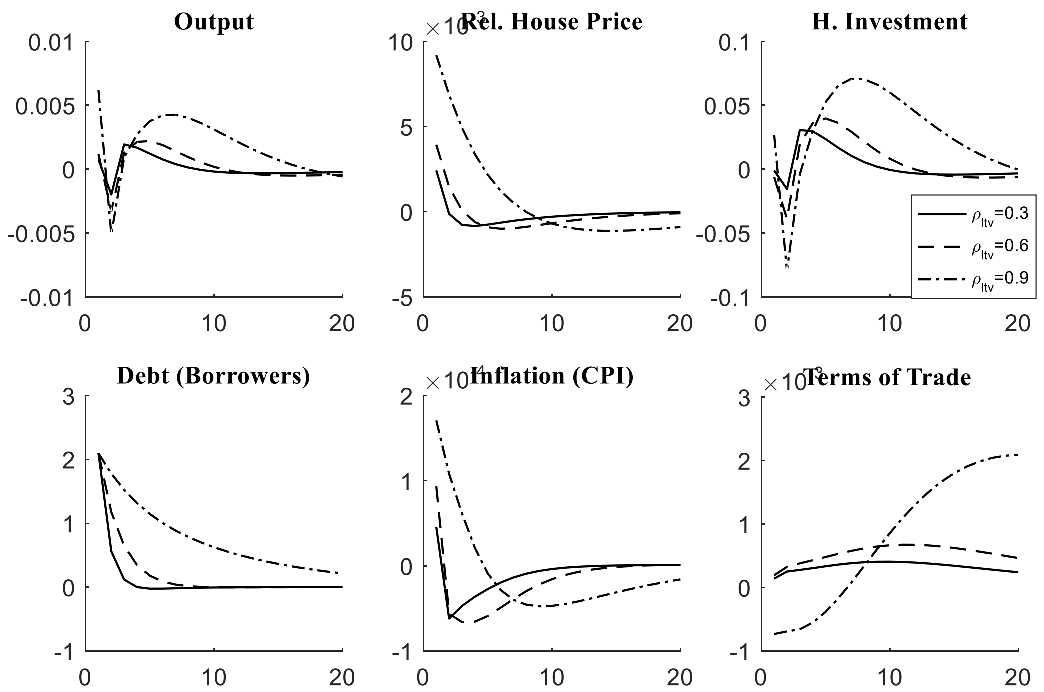
Contrary to Darracq Paries and Notarpietro's (2008) findings, the LTV ratio shock does not increase the funds available to borrowers. The decline in house investment decreases the user cost of housing for savers and leads to high demand for residential investment and consumption. The rise of inflation requires policymakers to increase policy rates, leading to appreciation of the real exchange rate and current account deterioration in the short term. The highest LTV regime reduces the terms of trade and generates a positive spill-over on foreign output.

Forward guidance

The effectiveness of the LTV ratio also depends on the improved predictability of macro-prudential policy. Transparency is enhanced through the Central Bank communicating its key assumptions underlying macroeconomic variables' forecasts. Therefore, the study compares a long-term LTV to a more transitory one in order that communication of the macro-prudential policy reaction process through forward guidance can describe the future policy path. In its communication on forward guidance, the Central Bank may insist that forward guidance stimulates the economy by reducing nominal long-term interest rates. The Central Bank may efficiently sustain the economy by showing that it will keep short interest rates in place for a longer time than previously projected. This will positively affect anticipated financial stability and the expected forthcoming behaviour of macro-prudential policy. Transitory LTV is discretionary as the economy responds to small macro-prudential policy changes to discern the appropriate policy adjustment.

Figure 5.6 shows the effects of business cycles under more persistent and transitory LTV shocks. Relaxing the LTV policy enables borrowers to increase their debt level, allowing them to demand more housing. Thus, this shock generates a surge in house prices in comparison to a transitory LTV policy. Consumer Price Index inflation also increases because patient households reduce their housing investment and increase goods consumption. The attenuation of a persistent LTV shock results from lower house prices. Consequently, its impact on the stability of house prices is strong compared to consumer price stability. In other words, a credibly announced LTV policy complements the standard Taylor rule to achieve price stability, particularly for real estate prices.

Figure 5.6: Impulse response functions of a percentage increase in the LTV ratio: forward guidance.

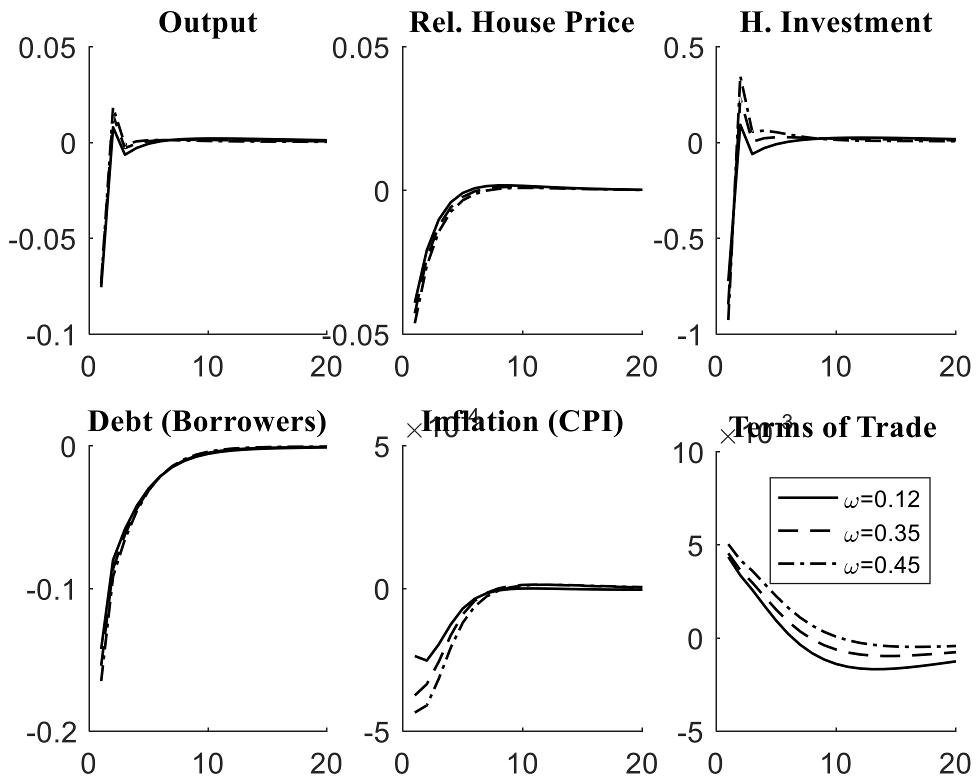


Stamp duty tax

This section discusses alternative macro-prudential policy tools such as property tax. Figure 5.7 presents the effects of a percentage rise in the property tax rate on house prices and the rest of the economy. The figure reveals that high stamp tax duty causes a substitution effect from house investment to non-durable goods. The positive response of non-durable goods is due to the collateral channel; by issuing less debt made possible by lowering house prices on the existing mortgage. Borrowers reduce their consumption, dampening house investment and thus output. This evidence suggests that stamp duty taxes positively affect homeowner households, have a small impact on output, and smooth out the policy's impact through saving and borrowing. Figure 5.7 demonstrates that policymakers respond by decreasing interest rates and CPI inflation below the steady-state, enhancing the terms of trade and leading to real exchange rate depreciation. For a small, open economy, this positively impacts foreign demand for domestic goods and prevents the reduction of aggregate output to some degree.

The effects of changes in property tax are different for savers and borrowers. An increase in property tax increases the effective cost of housing for savers and borrowers. For borrowers, the rise in the cost of holding housing results in a fall in their demand for housing, while a decline in house prices and a fall in credit supply from savers reduce the real value of borrowers' collateral.

Figure5.7: Impulse responses of a one-per cent point rise in the stamp duty rate

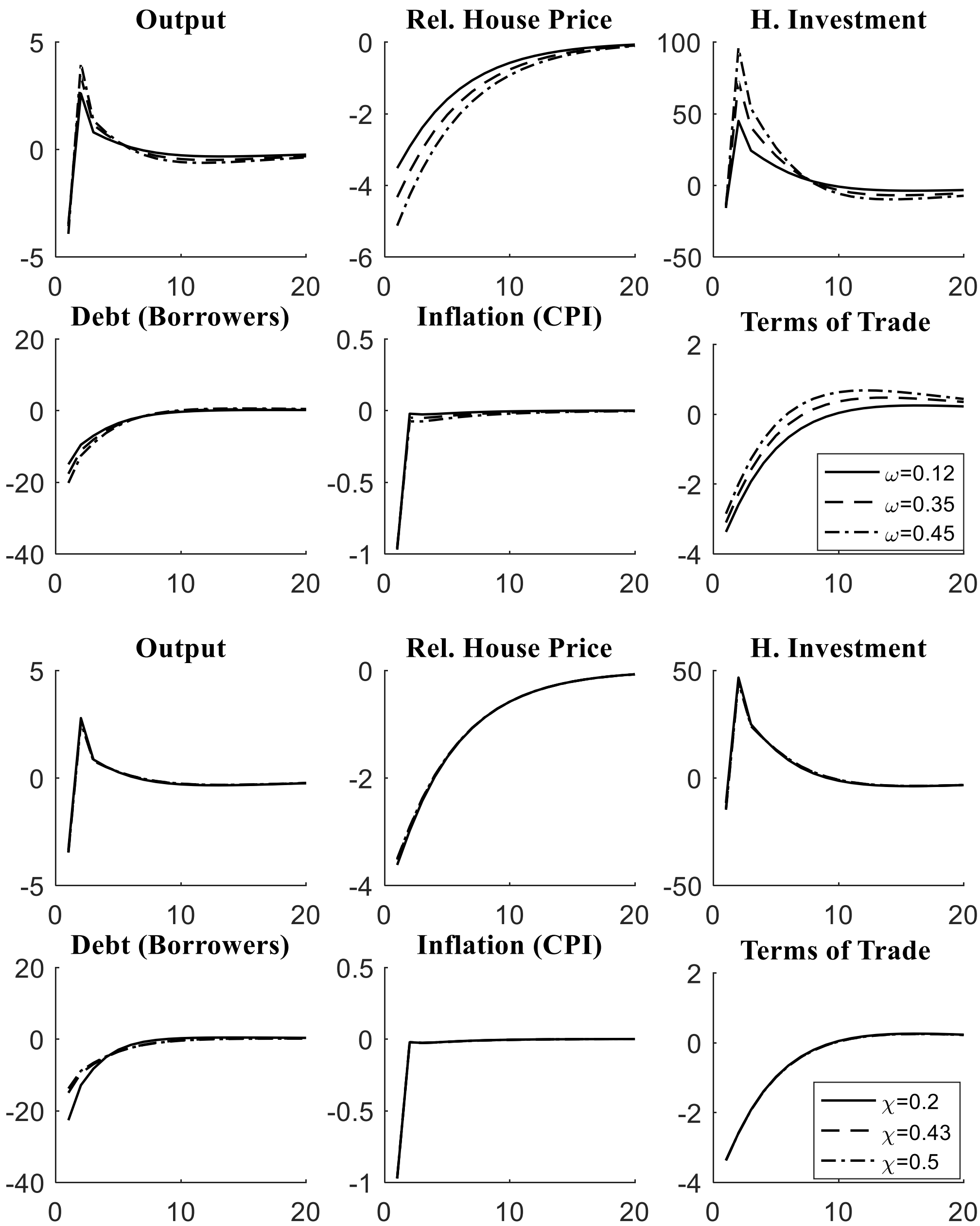


For savers (patient households), consumption increases in the short run and decreases investment in housing. Their savings drop due to the rise in real interest rates. These findings concur with Alpanda and Zubiary (2016) and Funke et al. (2018) who show that an increase in property tax decreases both house prices and output.

Policy interaction

The introduction of the Basel III LTV ratio regulation can affect the credit market since its main objective is to counteract significant increases in household debt that are also affected by monetary policy. Therefore, it is of great concern that macro-prudential policy may limit monetary policy efficacy by weakening monetary policy transmission channels. For example, borrowers respond via consumption, which is an imperative monetary policy channel (Hedlund et al., 2016; Iacoviello and Minetti, 2008). While indirectly, two channels of macro-prudential policy alter the share of borrowers, ω, and their borrowing constraint levels, X, that might also affect the economy's levels of leverage and debt. To examine these challenges, Figure 5.8 shows the impulse responses of a monetary policy shock under different values of X and ω (macro-prudential regimes). The results show that interest rate shocks have small effects on debt levels and house prices, rendering the monetary policy channel less effective since it only experiences an insignificant reduction. The effectiveness of the monetary policy in terms of the economy mainly emerges from sticky prices, which might change relative prices and real interest rates and, consequently, production and consumption choices. The macro-prudential policy's effects are nearly the same, as demonstrated by the coherence of the impulse responses of CPI inflation and output. The changes in interest rates have a smaller effect on debt levels and house prices, further indicating that macro-prudential policy can help to limit the effects of monetary policy spill-overs on debt and house prices. These findings suggest that the benefit of monetary policy and macro-prudential policy coordination is small. The macro-prudential policy serves as a target of house prices and levels of leverage and indebtedness.

Figure 5.8: tight interest rate shocks under macroprudential regimes (different values of ω and x).

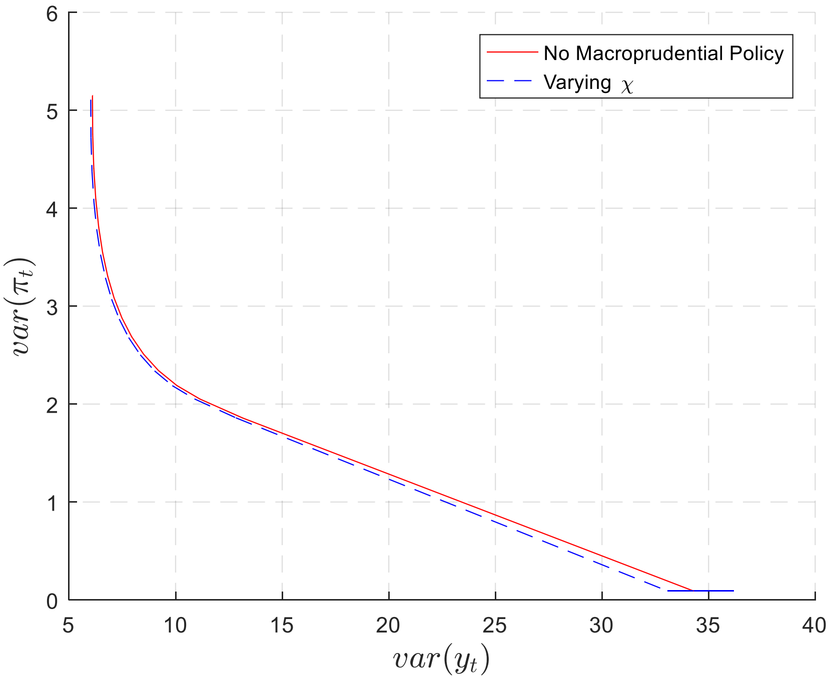


5.8 Policy frontier

Shocks that originate from the supply side cause Central Banks to confront a trade-off between output and CPI inflation (Levin et al., 1999; Iacoviello, 2005). This forces policymakers to choose whether to stabilise output or inflation. Illustrating these trade-offs, the study uses Taylor curves (efficiency policy frontier). The Taylor curve shows the locus of the volatility of output and CPI inflation. The output-inflation frontier is calculated using a coefficient of the Taylor rule. The coefficients are computed by solving a weighted sum minimum of the unconditional variances combined at different weights (Levin et al., 1999). The values that are considered are only those with a unique rational expectation equilibrium. All the shocks in the estimation of the model are considered. The first case, monetary policy, is used as a stabilising tool for inflation and output by not considering financial stability. We substitute the independent monetary policy with the macro-prudential policy by directly including the LTV ratio in the Taylor-type rule for policy rates. The analysis is not about Taylor's rule targeting asset prices or Taylor's rule and macro-prudential policy. Instead, it is about whether a macro-prudential policy is conducted in the economy. Therefore, the second case, policymakers, varies the steady-state LTV ratio. Policies designed for output stability and inflation stability may not signify financial stability.

Figure 5.9 shows the Taylor curves on the unconditional variance of CPI inflation against the unconditional variance of output. The curves that are nearer to the origin indicate a more efficient policy outcome. The findings indicate that the introduction of macro-prudential policy moves the Taylor curves to the left, suggesting a more efficient policy outcome (i.e., it lowers inflation and output variability). This is because reducing the steady-state LTV ratio (macro-prudential policy) has a diminishing effect on borrowing and output and house prices. Specifically, Figure 5.9 shows that macro-prudential policy (decreasing LTV ratio) improves monetary policy trade-offs.

Figure 5. 9 efficient policy frontier: inflation vs output



5.9 Robustness Check

This section analyses two different subsets of the data for small open economy DSGE parameters to test the robustness of the main results. The first subsample of the data period is from 2000 to 2007 and the second subsample is from 2008-2018. To further confirm the robustness of the results, a Chow-type test for parameter stability is conducted.

5.9.1 Chow parameter stability test

When using time series data it is possible that there are structural changes in the relationship between the dependent and independent variables. Structural change can be defined as a significant shift in the values of the parameters of a model, usually caused by major economic developments. An Example would be the 2007-2008 global financial crisis. Therefore, it is important to use the chow test to test if the parameters are stable through the study period. The data from this paper are divided into two subsamples periods 2000-2007 and 2008-2018. Effectively, the two sub-samples separate the period before (2000-2007) and after (2008-2018) the global financial crisis. There are three possible regressions given by:

(i) Time period 2000-20007:

$$y_t = \lambda_1 + \lambda_2 n_t + \lambda_2 \pi_{Dt} + \lambda_3 \pi_{ct} + \lambda_4 X_t^b + \lambda_5 \rho_{\tau t} + \lambda_6 I_t^b + +\mu_{1t} \quad n_1 = 28$$

(ii) Time period 2008-2018:

$$y_t = \gamma_1 + \gamma_2 n_t + \gamma_2 \pi_{Dt} + \gamma_3 \pi_{ct} + \gamma_4 X_t^b + \gamma_5 \rho_{\tau t} + \gamma_6 I_t^b + +\mu_{1t} \quad n_2 = 40$$

(iii) Time period 2000-2018:

$$y_t = \alpha_1 + \alpha_2 n_t + \alpha_2 \pi_{Dt} + \alpha_3 \pi_{ct} + \alpha_4 X_t^b + \alpha_5 \rho_{\tau t} + \alpha_6 I_t^b + +\mu_{1t} \quad n = 76$$

We test the following hypothesis:

H_o: There is no significant improvement in fit from running two regressions.

The Chow test is an F-test with the following F-statistic

$$F = \frac{(RSS_P - RSS_A - RSS_B)/_k}{(RSS_A + RSS_B)/(n - 2k)}$$

where RSS_A is defined as the residual sum of squares (RSS) using only subsample A; RSS_B is defined as the RSS using only subsample B; RSS_P is defined as the RSS using the entire (pooled) sample

Table 5.7: Chow test parameter stability

F value	Critical value
1.984705	2.145475

Table 5.7 displays the Chow-type parameter stability results. The results shows that we fail to reject the null hypothesis of parameter stability since the F-value is not greater than the critical F-value. The comparison of the entire sample together with the subsamples can be depicted by impulse response functions. Figures 5.10a, 5.10b and 5.10c, for instance show the economy's response to a one percent rise in the LTV ratio, forward guidance and property taxes before the financial crisis. The impact of high, and low LTV ratios, property taxes and interest rate shocks coincide with those in the consolidated model (the pooled sample data). Overall, for the subsample before the financial crisis, the impulse response functions are highly similar to those of the entire sample and a few are worth mentioning. The results show that implementing LTV restrictions and stamp duty taxes can be used to mitigate excessive house prices. In addition, the efficient policy frontier analysis used in the study shows that a policy combination of standard monetary policy and macroprudential policy is the most efficient policy regime to enhance both output and price stabilities.

Figures 5.11a, 5.11b, 5.11c in the Appendix D.1 plots the subsample from the financial crisis period, compared to the period prior to the financial crisis. It is evident that both imply identical responses, which, similar to the first robustness parameters, would lead to a coherent conclusion when compared to the entire sample. Overall, these findings show that the gains from coordinating monetary and macroprudential policies are small. Furthermore, macroprudential policy can be employed to reduce the volatility of house prices and debt. At the same time, the policy could limit the spillover effects from monetary policy into debt and house prices. Therefore, the effectiveness of the macroprudential policy on debt and house prices can be done separately from the monetary policy without hindering price stability.

5.10 Summary and Conclusion

The 2007/2008 global financial crisis highlighted the need to understand the financial and macroeconomic linkages that require the addition of macro-prudential policy to monetary policy and micro-prudential regulation. Although studies have been conducted on the efficacy of macro-prudential policy in terms of economic outcomes, there is a limited body of literature on how macro-prudential policy (the LTV ratio and stamp duty taxes) influence house prices. This study employed a small, open DSGE framework estimated with Bayesian methods to investigate how various shocks, prices of houses and macro-prudential policies, and their interaction with monetary policy affect the economy. It found that monetary policy has large spill-over effects on house prices. Hence, it is not the primary driver of house prices. The study also revealed that LTV restrictions and stamp duty taxes can be adopted to mitigate excessive house prices. In addition, the efficient policy frontier analysis used in the study showed that a combination of standard monetary policy and macro-prudential policy is the most efficient policy regime to enhance both output and price stabilities. In light of these findings, it is concluded that the gains accrued from coordinating monetary and macro-prudential policies are small. Furthermore, the study found that macro-prudential policy can be employed to reduce the volatility of house prices and debt. At the same time, it could limit the spill-over effects from monetary policy into debt and house prices. Therefore, the effectiveness of the macro-prudential policy on debt and house prices can be achieved separately from the monetary policy without hindering price stability.

CHAPTER 6

IMPLEMENTATION OF MACRO-PRUDENTIAL POLICY AND MONETARY POLICY IN SOUTH AFRICA

6.1 Introduction

Chapter five demonstrated that macro-prudential policy can reduce house prices that are one of South Africa's financial stability risk indicators. More importantly, we found an efficient policy frontier to be a conduit through which inflation and output stabilise. This chapter explores how Basel III-type rules interact with monetary policy to achieve financial and economic stability. In particular, the study considers the corporate risk indicator of financial stability. The corporate sector provides a perspective on how low demand for South African goods due to the slowdown of global growth could hinder borrowers' debt-servicing capacity and, in turn, negatively impact banks' asset quality.

Following the global financial crisis of 2007/2008, it was clear that financial regulations, limits on lending, and higher borrowing costs directly impact credit markets and cause financial imbalances in the real economy. Subsequently, near consensus has emerged on the need to adopt macro-prudential tools to manage and prevent a build-up of financial imbalances, since monetary policy appears to be insufficient (see, for example, Smets, 2014; Claessens, 2017; BIS, 2008). In this context, the Basel Committee on Banking Supervision (BCBS) developed the Basel III Accord. The aim is to focus not only on micro-prudential policy (Basel II) which exacerbates procyclicality in both the real and financial sector (see Liu and Seeiso, 2012; Covas and Fujita, 2010; Angeloni and Faia, 2013) but also macro-prudential policy (Basel III). The

Basel III Accord requires banks to hold countercyclical bank capital buffers, raise the quality of assets, set loan loss provisions, and promptly increase the capital adequacy ratio before credit risk emerges (BCBS, 2010). Fulfilment of these requirements strengthens the banking sector and promotes financial stability through macro-prudential policy.

However, there might be coordination issues with regard to macro-prudential and monetary policies. The 'Tinbergen principle' states that the policy authorities require at least one independent policy tool for any individual policy goal (Tinbergen, 1952). Monetary policy uses interest rates to achieve price stability while macro-prudential policy needs another instrument to attain financial stability. However, each policy tool does not affect the economy in isolation (Schoenmaker and Wierts, 2011). Therefore, if implemented independently, the policies may offset each other. A question thus arises regarding coordination of macro-prudential and monetary policies.

The literature has widely acknowledged the need to coordinate the macro-prudential policy and monetary policy. However, it is unclear how financial and macroeconomic stability will be achieved. The existing literature considers the interaction of monetary policy and macro-prudential regulation in DSGE models (Rubio and Carrasco-Gallego, 2016; Angeloni and Faia, 2013; Quint and Rabanal, 2014; Kannan et al., 2012). The overall conclusion in these studies is that the extent to which the interaction of Basel III-type countercyclical rules and a credit-augmented Taylor rule effectively enhances financial stability and macroeconomic stability depends on the type of shock. In contrast, Angelini et al. (2014) and Liu and Molise (2020) investigate the combination of monetary policy and macro-prudential policy within a framework in which non-financial corporate borrowers and households coexist. These authors found that a simultaneous deployment of macro-prudential policy and an augmented Taylor rule enhances both output and financial stability.

Moreover, Lui and Molise (2020) consider a wide range of financial shocks and show that monetary policy is only suitable for price stability, while macro-prudential policy focuses on financial stability. Another study that focuses exclusively on the degree to which Basel III-type rules mitigate fluctuations in credit and housing markets and promote macroeconomic and financial stability is Liu and Molise (2019). The results show that countercyclical capital requirements effectively address volatility in the credit and housing market and prevent bubbles.

The other strand of the literature shows that macro-prudential policy directly affects financial market conditions and has a smaller effect on prices than monetary policy (see, for example, Turdaliev and Zhan, 2019; Svensson, 2017, 2012; Suh, 2014; Gelain et al., 2013). These studies advocate that policymakers should separate the responsibilities of monetary and macro-prudential policy. They add that achieving price stability and financial stability might be exclusively assigned to monetary policy and macro-prudential policy, respectively. In contrast, Adrian and Liang (2018), Verona, Martins and Drumond (2017), and Gambacorta and Signoretti (2014) establish that monetary policy needs to broaden its objective to attain both financial and price stability.

This chapter contributes to the rich body of macroeconomic-finance literature by fostering further understanding of the relationship between macro-prudential and monetary policy. More studies investigate the relationship between the two policies within a New Keynesian Dynamic Stochastic General Equilibrium (NKDSGE) modelling with endogenous financial frictions (see Lui and Molise, 2020; Angelini et al., 2014). However, this study adopts a DSGE framework with endogenous risk forming at both the bank capital level and firms. This approach fills the knowledge gap on trade-offs and key policy transmission channels within the economy, providing more information for policymakers. The linkages between the credit market and the financial system are explained using the borrowing cost channel which links loan rate behavior to the price inflation rate and the real marginal costs. This borrowing cost channel has three additional channels that directly impact the cost of borrowing: (i) the risk premium channel resulting from the positive likelihood of default in firms. This leads the commercial bank to charge a premium over the borrowing cost from households. (ii) The bank capital default channel emerges from the introduction of bank capital risk. Bank capital is subject to risk, and households demand a higher return for holding this asset such that a no-arbitrage condition betwixt bank capital and deposits prevails. (iii) The risk weight channel, determined by the bank capital-loan ratio; as a result, it is driven by the cyclical behaviour of the probability of default. The borrowing cost channel introduces a rationale for bank capital. Financial risk shocks have their origins in the banking system, ex-ante default costs in the banking sector, a credit spread-augmented type Taylor rule and the countercyclical bank capital regulation. Tayler and Zilberman's (2016) work is part of the scanty studies that investigate the relationship between macro-prudential policy and monetary policy using a framework in which risk at firm and bank capital levels coexist. In this model, the borrowing cost channel is intensified by different credit frictions, a rich banking environment, and regulatory requirements, which explains the relationship between inflation, the real business cycle, and the financial sector.

This study investigates an increase in credit risk in loan books and declining profits in the corporate sector. Our approach is relevant in the South African context because credit risk in the banking sector is high in the corporate sector, with a default ratio of 13.12 per cent (SARB, 2019). In South Africa, credit risk is exacerbated by extended periods of sluggish economic growth that can negatively affect financial stability using different channels, including limited ability to service debt among corporates and households and a high unemployment rate (SARB, 2019). As a result, banks' profitability is low, negatively impacting their assets.

To the best of our knowledge, this is the first study to model the interaction between countercyclical regulation, bank capital, and the function of an augmented and standard Taylor rule in the South African context. In addition, most of the literature (see, for example, Agenor et al., 2014; De Fiore and Trstani, 2013; De Paoli and Paustian, 2013) uses DSGE models with a borrowing cost channel adjusted through meaningful endogenous financial imperfections modelled for advanced countries. Limited research has been conducted on emerging countries (see for example, Unasl, 2013; Liu and Molise, 2020, 2019). Among the few studies carried out in South Africa, Unsal (2013) investigated whether macro-prudential measures could help monetary policy to stabilise the economy under different types of shocks; Lui and Molise (2020) examined the efficacy of monetary and macro-prudential policies in fostering financial stability and macroeconomic stability; and Liu and Molise (2019) investigated how well the Basel III-type rules mitigate volatility in housing and credit markets and promote macroeconomic and financial stability. No study that we are aware of in an emerging economy has investigated the endogenous risk forming at both the bank capital levels and firms in relation to monetary policy and the macro-prudential roles of bank capital regulation in fostering macroeconomic and financial stability. Furthermore, no research has been conducted on whether rule-based Basel III bank capital regulation can restrain the adverse spill-overs (when financial stability measures use credit risk and credit spreads) into the real economy coming from the financial sector. It is in this context that mitigation of the output and inflation volatility that Central Banks face can be understood. This study was, therefore, motivated by the need to fill this gap in the literature.

This chapter investigates CCyBs' ability to restrain the negative adverse spill-overs in the real economy coming from the financial sector, hence promoting overall macroeconomic and price stability. The study measures financial stability using credit spreads and credit risk, while the price and macroeconomic stability are measured using the volatility of inflation and output consistent with Tayler and Zilberman (2016) and Rubio and Carrasco-Gallego (2014). We consider a benchmark policy and two other policy regimes. Policy I is the benchmark in which the monetary authorities follow a standard Taylor rule and banks are under a Basel II-type rule. The benchmark policy is compared with the other two policy regimes, II and III. The first policy regime (Policy II) is an Optimal Taylor rule. A countercyclical capital requirement represents the macro-prudential policy instrument. Countercyclical capital requirements relate to deviations of the bank capital requirements ratio and loan-output ratio from their steady-state level in line with Angelini et al. (2012) and Meh and Moran (2010). The second policy regime (Policy III) combines an optimal Taylor rule with countercyclical capital requirements. An optimal Taylor rule is a strong anti-inflation monetary policy. In this context, the study also examines the efficacy of monetary policy in attaining output and price stability when regulatory requirements and credit frictions exist. The study employs a DSGE model that features firms, households, banks, macro-prudential policy and monetary policy in line with Tayler and Zilberman (2016). The model has endogenous credit frictions which affect loan rate behaviour through various channels. Adjustments in the borrowing cost affect macroeconomic stability through the borrowing cost channel that links price inflation and the lending rate. Finally, the countercyclical bank capital regulations (macro-prudential policy) are incorporated.

The study uses optimal simple rules to compare the model's behaviour under three regimes following financial and supply shocks. We find that when there is a borrowing cost channel, mainly driven by financial friction, the Central Bank should reduce the reaction of inflation in the monetary pollicy despite higher inflationary pressures. The simultaneous deployment of optimal monetary policy and macro-prudential policy addresses volatility of wages, output and the credit market. The introduction of the macro-prudential policy rule allows banks to supply credit. It also mitigates rapid deleverage during periods of economic contraction, driven by negative financial and supply shocks. In this way, countercyclical capital regulation can restrain the adverse spill-overs emanating from the financial sector to the real sector. The findings show that the Policy III regime is more beneficial than Policy II at the cost of price instability. Simultaneously, the monetary authorities face a trade-off between financial and monetary stability objectives when the optimal Taylor rule policy rate responds to credit growth.

Finally, we conduct a Taylor curves analysis to evaluate the efficacy of Basel II and Basel III. We show that Basel III alleviates the fluctuations of output, price inflation and wage inflation. The Taylor curves analysis suggests that Basel III is a significant addition to monetary policy since it improves output and price stability. The approach also shows that countercyclical capital regulations help provide better trade-offs between the Central Bank's price and financial stability.

The remainder of the chapter is structured as follows: Section 6.2 explains the model, while section 6.3 outlines the equilibrium properties and parameterisation of the model. Section 6.4 investigates the optimal simple policy rules that are implementable. Section 6.5 studies the simultaneous deployment of optimal macro-prudential and monetary policies under two alternating policy regimes and compares their efficacy in promoting macroeconomic and financial stability. The comparison analysis entails two dimensions, model dynamics and efficient policy frontiers. Section 6.6 concludes the chapter.

6.2 The Model

Assume there are five economic agents, namely, final goods-producing firms, households, intermediate goods producing firms, commercial banks and a Central Bank. The Central Bank serves as a financial regulator. After observing aggregate shocks at the start of a period, households bring deposits to the commercial bank, which also issues bank capital. In the model, the bank capital is presented as bank debt as opposed to equity. According to Basel terms, the bank capital is modelled using “tier 2’ capital and not “tier 1” capital.

Furthermore, the bank choose the loan rate following the refinance rate, the risk premium, bank capital requirements, and the likelihood of collecting intermediate goods firms' collateral in the event of defaults. For a specific loan rate, the intermediate goods firm determines the employment rate, sets prices and determines how much to lend. In parallel, households decide on the level of deposits, bank capital and consumption considering their aggregate earnings. Thereafter, defaulting firms and idiosyncratic shocks are exposed. If there is a default, the bank takes hold of the output (debt-servicing capacity) that served as collateral from the intermediate goods firms. During this difficult time, there is a probability that break-even banks will not recoup the output and may end up making a loss. On an aggregated basis, bank capital covers these losses, that are also endogenously connected to the firm's credit risk. Households act as bank capital holders who know the economic climate and can forecast banking sector losses. Households demand higher returns on bank capital to account for these default costs. Therefore, households are indifferent between holding bank capital and risk-free deposits.

6.2.1 Households

Assume there is a continuum of infinitely lived households represented by $i \epsilon (0,1)$. A representative household i aims to maximise its utility function given by:

$$U_T = E_{i,t} \sum_{s=0}^{\infty} \beta^s \left\{ \frac{[C_{t+s}]^{1-\delta^{-1}}}{1-\delta^{-1}} - \frac{H_{i,t+s}^{1+\gamma}}{1+\gamma} \right\} \tag{6.1}$$

where $E_{i,t}$ is the expectations operator, influenced by the i^{th} household information presented at period t, with the discount factor indexed by $\beta \epsilon (0,1)$; C_t represents consumption at period t; $H_{i,t}$ is the number of working hours by household i; δ represents the elasticity of intertemporal substitution in consumption; and γ is the inverse of the Frisch labour supply elasticity.

At the beginning of time *t*, the household holds real cash balances M_t. The household earns a wage bill $(1+\tau_\omega)\left(W_{i,t}/P_t\right)H_{i,t}$, in the form of cash paid by the employer, the intermediate goods firm, with $W_{i,t}$, τ_ω and P_t representing the nominal wage, subsidy rate, and the price of final goods, respectively. The household's financial assets are partly held as real deposits, D_t, in commercial banks, and partly as investments in bank capital, V_t. The household's net cash balances of $M_t + (1+\tau_\omega)\left(W_{i,t}/P_t\right)H_{i,t} - D_t - V_t$ are used to buy goods and services. We assume the cash-in-advance constraint, $C_t \leq M_t + (1+\tau_\omega)\left(W_{i,t}/P_t\right)H_{i,t} - D_t - V_t$ holds. In the previous period, the household collects real profit income from the financial intermediation process (J_t^{FI}), and all profits from the intermediate goods firm ($J_t^{IG} = \int_0^1 J_{j,t}^{IG}\, dj$). The final goods firm's profit is equal to zero. Additionally, the household receives gross interest on bank capital and deposits, represented by $(1-\xi_t^V)R_t^V$ and R_t^D respectively. The bank risk premium is represented by ξ_t^V and is taken, as stated in the household optimisation problem. The real cash value is carried over to time $t+1$,

$$M_{t+1}\frac{P_{t+1}}{P_t} = M_t + (1+\tau_\omega)\frac{W_{i,t}}{P_t}H_{i,t} - C_t - D_t - V_t + R_t^D D_t + (1-\xi_t^V)R_t^V V_t + J_t^{FI} + \int_0^1 J_{j,t}^{IG}\, dj \qquad (6.2)$$

with a non-negative deposit interest rate ($R_t^D > 1$), and taking prices and income as specified. The first-order conditions (FOC) with respect to C_t, D_t and V_t (taking prices and rate of returns as given) result in the following:

$$C_t^{-\frac{1}{\delta}} = \beta E_t R_t^D \frac{P_t}{P_{t+1}} C_{t+1}^{-\frac{1}{\delta}} \qquad (6.3)$$

$$R_t^V = \frac{R_t^D}{(1-\xi_t^V)} \tag{6.4}$$

Equation 6.3 determines the optimal consumption path, and it is the standard Euler equation. Equation 6.4 is an arbitrage-free condition related to the rate of return on bank capital to the deposit with zero risks. In equilibrium, the bank capital interest rate is set as a default premium over the interest rate on deposits as a result of the ex-ante default costs in the banking sector (ξ_t^V). The banking sector's anticipated default costs determine the deposit rate spread and bank capital endogenously in relation to the bank capital to loan ratio and the firm's level risk of default.

6.2.2 The wage decision

Following Erceg et al. (2000) and Christaino et al. (2005), it is assumed that households i supplies differentiated labour $(H_{i,t})$ with $i \epsilon (0,1)$. A competitive labour contractor then groups all the categories of workers into a one identical worker (N_t) using the standard Dixit-Stiglitz (1977) aggregator expressed as,

$$N_t = \left(\int_0^1 H_{i,t}^{\frac{\lambda_\omega - 1}{\lambda_\omega}}\right) \tag{6.5}$$

where $\lambda_\omega > 1$ represents the constant elasticity of substitution between the diverse categories of labour. The labour demand curve of the i^{th} household is given as:

$$H_{i,t} = \left(\frac{W_{i,t}}{W_t}\right)^{-\lambda_\omega} N_t \tag{6.6}$$

where W_t represents the aggregate nominal wage for each component of labour. The zero-profit condition for the labour grouping produces the economy's wage equation, $W_t = \left[\int_0^1 W_{i,t}^{1-\lambda_\omega} di\right]^{\frac{1}{1-\lambda_\omega}}$. Calvo (1983) assumes that nominal rigidities of the wage-setting at each time is a constant fraction of $1 - \lambda_\omega$ labourers who can re-optimise their income whereas a fraction ω_ω index their income in line with the previous rate of inflation $(\pi_t - 1)$. Therefore, the non-re-optimising households set their income in line with $W_{i,t} = \pi_{t-1} W_{i,t-1}$. Furthermore, if income remained unset since time t, then at time $t + s$ the real relative income of the i household turns into $\frac{W_{i,t+s}}{W_{t+s}} = \frac{\prod s W_{i,,t+s}}{W_{t+s}}$ where $\prod s = \pi_t \ X \ \pi_{t+1} \ X \ ... X \ \pi_{t+s-1}$.

As a result, the labour demanded in time $t + s$ is $H_{i,t+s} = \left(\frac{\prod s W_{i,,t+s}}{W_{t+s}}\right)^{-\lambda_\omega} N_{t+s}$. In equilibrium, every re-optimising household selects a similar wage (W_t^*) and the optimal relative wage in a log-linearised form (represented by a hat) is given by $\widehat{\left(\frac{W_s^*}{W_t}\right)} = \left(\frac{\omega_\omega}{1-\omega_\omega}\right)\widehat{\pi_t^W}$ with $\widehat{\pi_t^W} \equiv \widehat{W_t} - \widehat{W_{t-1}}$ denotes the wage inflation. When there are no wage rigidities $(\omega_\omega = 0)$, the real income equals the income mark-up $\frac{\lambda_\omega}{\lambda_\omega - 1}$ multiplied by the marginal rate of substitution between consumption and leisure MRS_t. Particularly, $\frac{W_t}{P_t} = \frac{\lambda_\omega}{\lambda_\omega - 1} MRS_t$ with $MRS_t = N_t^\gamma C_t^{\frac{1}{\delta}}$ and $N_t = H_t$. Finally, similar to Erceg et al. (2000), the wage-prices equation is given by

$$\widehat{\pi_t^W} = \beta E_t \widehat{\pi_{t+1}^W} + \frac{(1-\omega_\omega)(1-\beta\omega_\omega)}{(\omega_\omega)(1-\gamma\lambda_\omega)}\left[\widehat{MRS_t} - \widehat{\left(\frac{W_t^R}{P_t}\right)}\right] \tag{6.7}$$

with real wages evolving according to,

$$\widehat{W_t^R} \equiv \widehat{\left(\frac{W_t}{P_t}\right)} = \widehat{\left(\frac{W_{t-1}^R}{P_{t-1}}\right)} + \widehat{\pi_t^W} - \widehat{\pi_t^P} \tag{6.8}$$

where $\widehat{\pi_t^P} \equiv \widehat{P_t} - \widehat{P_{t-1}}$ denotes the log-linearised CPI that that shifts from equilibrium. There are three incentives for including sticky wages in the model. First, sticky wages are essential for identifying the slow and continuous nature of real wages detected in data. They are imperative for attaining a constant reaction of prices without depending on debatable values of staggering prices (Christiano et al., 2005). Secondly, wage rigidities are necessary for acquiring attainable optimal policy rules in response to supply shocks, which would alternatively yield extremely high optimal inflation coefficient weights in the Taylor rule (see Schmitt-Groche and Uribe, 2007). As a result, this study investigates the use of optimal policy guidelines and how they interact. It is necessary to have a target optimal price coefficient within a boundless rational interval. Finally, in the literature, the approximation of the actual household welfare function is enhanced by having a Central Bank loss function that incorporates a nominal wage inflation gap rather than a simple standard inflation-output-gap-based objective (Debortoli et al., 2015; Tayler and Zilberman, 2016).

6.2.3 Final Goods Firm

A perfectly competitive final goods firm gathers a range of intermediate goods $\left(Y_{j,t}\right)$ with $j\epsilon(0,1)$, to manufacture final goods (Y_t) employing standard Dixit-Stiglitz (1977) technology,

$$Y_t = \left(\int_0^1 Y_{j,t}^{\frac{\lambda_p - 1}{\lambda_p}} dj \right)^{\frac{\lambda_p - 1}{\lambda_p}} \tag{6.9}$$

where $\lambda_p > 1$. Given the intermediate goods price $\left(P_{j,t}\right)$. Each intermediate good demand function is

$Y_{j,t} = Y_t \left(\frac{P_{j,t}}{P_t}\right)^{-\lambda_p}$ with the aggregate price index $P_t = \left[\int_0^1 P_{j,t}^{1-\lambda_p} dj\right]^{\frac{1}{1-\lambda_p}}$

6.2.4 Intermediate Goods Firms

The producer of each intermediate good, represented by $j \in (0,1)$, employs the same labour provided by the labour contractor, and is subject to a linear production function given by,

$$Y_{j,t} = Z_{j,t} N_{j,t} \tag{6.10}$$

The terms $Z_{j,t}$ and $N_{j,t}$ show the aggregate productivity shock anticipated by firm j and the number of workers employed, respectively. Furthermore, it is assumed that the $Z_{j,t}$ shock evolves according to the following process:

$$Z_{j,t} = Z_{t-1}^{s^2} exp(\alpha_t^Z) \tag{6.11}$$

where A_t is a standard economy's technology shock which adopts the $AR(1)$ process, $A_t = (A_{t-1})^{\delta^A} exp(\alpha_t^A)$, where δ^A and α_t^A are the autoregressive coefficient and a normally distributed random shock with constant variance and a zero mean, in that order. $\varepsilon_{j,t}^F$ denotes an idiosyncratic shock with a homogenous constant variance distributed over the interval $\left(\underline{\varepsilon^F}, \overline{\varepsilon^F}\right)$. Following Faia and Monacelli (2007), this distribution permits a closed-form expression for credit risk.

Commercial banks lend money to the intermediate goods firm j for wages paid in advance to households. Precisely, let $L_{j,t}$ be the loan taken by the firm j. Then the financing limitation will be equal to

$$L_{j,t} = W_t^R N_{j,t} \tag{6.12}$$

6.2.5 The default space

Funding working capital needs bears risk, and in case of default, the banks expect to seize the firm's output $(Y_{j,t})$ with a probability of x_t. During these bad times, it is likely that $(1 - x_t)$ banks cannot retrieve the intermediate goods firm's collateral (Jerman and Quadrini, 2012). Assuming that x_t follows the $AR(1)$ process, $x_t = (x)^{1-\delta^x}(x_{t-1})^{\delta^x} exp(\alpha_t^x)$, where $x \in (0,1)$ represents the steady-state value of this probability, δ^x is the degree of persistence and α_t^x is a constant variance and a random shock with normal distribution. A shock to the likelihood of retrieving collateral (x_t) denotes a credit (financial) shock in the model, as it directly affects the value of the collateral the commercial banks can recover in default cases, as well as the firms' credit risk.

During good times firms do not default, and commercial banks get their loaned money back with interest. According to the willingness to pay method in debt contracts, default arises if the amount that needs to be reimbursed to the lender is greater than the anticipated value of seizable output $(x_t Y_{j,t})$ in the last period: $x_t Y_{j,t} < (1 + i_t^L) L_{j,t,}$ where i_t^L represents the interest rate on loans provided to intermediate goods firms. In line with Agenor and Aizenman (1998), for simplicity, the assumption is that no intermediate goods firm defaults if the economy is growing and the output level is large enough to service the loan. Assume $\varepsilon_{j,t}^{F,M}$ is the threshold value below which the intermediate goods firm defaults. Using equations 6.12 and 6.13, the threshold state is given by,

$$\varepsilon_{j,t}^{F,M} = \frac{1}{x_t A_t}(1 + i_t^L) W_t^R \tag{6.13}$$

Thus, the cut-off value is linked to real wages, the prime rate and total technology shocks and is homogenous in all firms. Similar to Tayler and Zilberman (2016), we assume that the loan rate depends on the finance premium, the risk-free rate, the likelihood of the commercial banks recovering collateral, the bank capital loan ratio and the rate of return on bank capital. Therefore, both the likelihood of default and the loan rate are impacted by the type of regulatory regime.

6.2.6 Intermediate Goods price setting

The intermediate goods firm solves a two-stage pricing decision problem when the total shocks in time t are realised. In stage one, each intermediate goods firm reduces the cost of labour, given its real effective costs $\left((1 + i_t^L)W_t^R\right)$. This minimisation problem produces the real marginal cost,

$$mc_{j,t} = (1 + i_t^L)W_t^R \frac{1}{Z_{j,t}} \tag{6.14}$$

In stage two, each intermediate goods firm decides the optimal price for the goods. We assume Calvo (1983) type contracts where a percentage ω_p of producers keep their prices unchanged while the remaining percentage $1 - \omega_p$ of producers adjust their prices optimally taking into consideration the existing marginal cost and the lending rate at the beginning of the period. The firm's problem is to maximise the following anticipated discount value of current and future real profits depending on the demand function for individual good (equation 6.10) and taking the marginal costs as given:

$$max_{P_{j,t+s}} E_t \sum_{s=0}^{\infty} \omega_P^s \, \Delta_{s,t+s} \left[\left(\frac{P_{j,t+s}}{P_{t+s}}\right)^{1-\lambda_p} Y_{t+s} - mc_{t+s} \left(\frac{P_{j,t+s}}{P_{t+s}}\right)^{-\lambda_p} Y_{t+s} \right] \tag{6.15}$$

with the total discount factor represented by $\Delta_{s,t+s} = \beta^s \left(\frac{C_{t+s}}{C_t}\right)^{\delta^{-1}}$

whereP_t^* is the optimal price level chosen by individual producers at period t. The first-order conditions of the firm's maximisation problem with respect to P_t^* produces the profit-maximising price equation

$$Q_t = \frac{P_t^*}{P_t} = \left(\frac{\lambda_p}{\lambda_p - 1}\right) \frac{E_t \sum_{s=0}^{\infty} \omega_P^S \beta^s C_{t+s}^{-\frac{1}{\delta}} Y_{t+s} mc_{t+s} \left(\frac{P_{t+s}}{P_t}\right)^{\lambda_p}}{E_t \sum_{s=0}^{\infty} \omega_P^S \beta^s C_{t+s}^{-\frac{1}{\delta}} Y_{t+s} \left(\frac{P_{t+s}}{P_t}\right)^{\lambda_p - 1}} \tag{6.16}$$

where $Q_t = \frac{P_t^*}{P_t}$ is the relative price selected by firms adjusting their prices at time t and $pm = \left(\frac{\lambda_p}{\lambda_p - 1}\right)$ denotes the mark-up price. Finally, applying the total price equation (6.11) with the Calvo staggered price assumption and linearising the logged equation (6.16) produces a New Keynesian Phillips Curve (NKPC)

$$\widehat{\pi_t^P} = \beta E_t \widehat{\pi_{t+1}^P} + \frac{(1-\omega_p)(1-\omega_p \beta)}{\omega_p} \widehat{mc}_t \tag{6.17}$$

In this model, a bank's loan rate is a factor that drives the marginal cost from equation (6.14). Thus, the regulatory regime, credit risk, monetary policy, and bank capital affect the loan rate and directly affect the marginal cost and accordingly, the wage inflation, price inflation rate, and output. The borrowing channel is represented by the interaction between the loan rate, output, marginal cost and CPI.

6.2.7 The banking sector

Balance sheet identity

A range of banks represented by $k\epsilon(0,1)$ operate in a perfectly competitive environment, where they raise finance through issuing bank capital (V_t), mobilising deposits (D_t) and a liquidity injection (X_t) from the monetary authorities to finance loans $(L_{t)})$ to a range of firms. Therefore, the balance of a representative bank in real terms is given by:

$$L_t = D_t + V_t + X_t \tag{6.18}$$

Where $L_t \equiv \int_0^1 L_{j,t} dj$ denotes aggregate lending to intermediate goods firms.

Lending rate decision

A representative individual bank k anticipates breaking even from its intermediation activity so that the anticipated income from lending to a range of intermediate goods firms is equivalent to the aggregate costs of lending deposits and bank capital from households, and the cost of receiving liquidity from the Central Bank,

$$\int_{\varepsilon_{j,t}^{F,M}}^{\overline{\varepsilon^F}} \left[R_t^L L_{j,t}\right] f\left(\varepsilon_{j,t}^F\right) d\varepsilon_{j,t}^F + \int_{\underline{\varepsilon}^F}^{\varepsilon_{j,t}^{F,M}} \left[X_t Y_{j,t}\right] f\left(\varepsilon_{j,t}^F\right) d\varepsilon_{j,t}^F = R_t^V V_t + R_t^D (D_t + X_t) + cV_t \tag{6.19}$$

where $f\left(\varepsilon_{j,t}^F\right)$ represents the probability density function of $\varepsilon_{j,t}^F$. The left-hand side of equation (6.19) is the refund to the bank in the non-payment state denoted by $\int_{\varepsilon_{j,t}^{F,M}}^{\overline{\varepsilon^F}} \left[R_t^L L_{j,t}\right] f\left(\varepsilon_{j,t}^F\right) d\varepsilon_{j,t}^F$, while $\int_{\underline{\varepsilon}^F}^{\varepsilon_{j,t}^{F,M}} \left[X_t Y_{j,t}\right] f\left(\varepsilon_{j,t}^F\right) d\varepsilon_{j,t}^F$ is the anticipated return to the bank non-payment state accounting for the likelihood of seizing collateral (X_t). The expression $R_t^V V_t + R_t^V (D_t + X_t)$ is the aggregate return to households and the monetary authorities for supplying funds to the bank. Moreover, the bank is subject to a linear cost function when issuing bank capital, indexed by cV_t, with $c > 0$. These expenses do not rely on economic conditions and show steady administrative costs related to issuing or underwriting brochures, for example. They can also be explained as the added tax on bank capital resembling a tax advantage of debt over equity, which increases the spread between the deposits rate (R_t^D) and the total capital costs $(R_t^V + c)$. The lending rate is given by,

$$\int_{\varepsilon_{j,t}^{F,M}}^{\overline{\varepsilon^F}} [R_t^L L_{j,t}] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F \equiv \int_{\underline{\varepsilon}^F}^{\overline{\varepsilon^F}} [R_t^L L_{j,t}] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F - \int_{\varepsilon_{j,t}^{F,M}}^{\overline{\varepsilon^F}} [R_t^L L_{j,t}] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F \tag{6.20}$$

where $\int_{\underline{\varepsilon}^F}^{\overline{\varepsilon^F}} [R_t^L L_{j,t}] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F \equiv [R_t^L L_{j,t}]$. Hence, using the bank's balance sheet equation (6.18) and substituting equation (6.16) for $x_t(A_t \varepsilon_{j,t}^{F,M}) N_{j,t} = R_t^L L_{j,t}$ and adopting the value of output from the production function (equation 6.12) yields

$$[R_t^L L_{j,t}] - \int_{\underline{\varepsilon}^F}^{\varepsilon_{j,t}^{F,M}} [\varepsilon_{j,t}^{F,M} - \varepsilon_{j,t}^F] X_t A_t N_{j,t} f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F = (R_t^V + c) V_t + R_t^D D_t (L_{j,t} - V_t) \tag{6.21}$$

Equation (6.21) can be divided by $L_{j,t}$ to give:

$$R_t^L = (R_t^V + c)\left(\frac{V_t}{L_{j,t}}\right) + (R_t^D)\left(1 - \frac{V_t}{L_{j,t}}\right) + (i_t^L)\left(1 - \frac{V_t}{L_{j,t}}\right) + \frac{[\varepsilon_{j,t}^{F,M} - \varepsilon_{j,t}^F] X_t A_t N_{j,t} f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F}{L_{j,t}} \tag{6.22}$$

The number of workers hired and real wages are the same for individual firms, and consequently, the amount of lending by single banks is also identical. Thus, the subscript j is dropped. Defining $\Delta_t = V_t / L_t$ (aggregate capital-loan ratio) reduces equation (6.22) to:

$$R_t^L = v_t[(\Delta_t)(R_t^V + c) + (1 - \Delta_t)(R_t^D)] \tag{6.23}$$

where $v_t \equiv \left[1 - \frac{\int_{\underline{\varepsilon}^F}^{\varepsilon_t^{F,M}} \left[\varepsilon_{j,t}^{F,M} - \varepsilon_{j,t}^F\right] f\left(\varepsilon_{j,t}^F\right) d\varepsilon_{j,t}^F}{\varepsilon_t^{F,M}}\right]^{-1} > 1$ is the finance premium.

To obtain an explicit term for the likelihood of default, the assumption is that ε_t^F has a uniform distribution over the interval $\left(\underline{\varepsilon}^F, \overline{\varepsilon}^F\right)$. Thus, the probability density is $1/\left(\overline{\varepsilon}^F - \underline{\varepsilon}^F\right)$ and its mean $\mu_\varepsilon = \left(\overline{\varepsilon}^F - \underline{\varepsilon}^F\right)/2$. The probability of default is, therefore, written as:

$$\Phi_t = \int_{\underline{\varepsilon}^F}^{\varepsilon_t^{F,M}} f\left(\varepsilon_{j,t}^F\right) d\varepsilon_{j,t}^F = \frac{\varepsilon_t^F - \underline{\varepsilon}^F}{\overline{\varepsilon}^F - \underline{\varepsilon}^F} \tag{6.24}$$

Equation (6.24) states that default's likelihood relies on the series of evenly distributed and idiosyncratic shock cut-off values.

The Bank Capital Risk Premium Rate

The premium rate on a unit of bank capital (ξ_t^V) determines the mark-up of the bank capital rate over the zero-risk deposit rate in the household's arbitrage-free condition (equation (6.4)). As elucidated previously, banks chose the lending rate each time they anticipate a break-even level. This indicates that loan prices are determined by the bank capital and cost of deposits, adjusted for the bank capital-loan ratio and the risk premia. Moreover, a fraction $(1 - x_t)$ of banks incur losses because they are unable to seize collateral from defaulting firms.

Households have information about the total level of firm default and can calculate ex-ante bank losses. Accounting for bank capital defaults emerging from bank losses guarantees that deposits are a safe asset. Therefore, households decide to calculate the bank capital ex-ante rate of default so that the arbitrage-free condition in equation (6.4) is satisfied:

$$\xi_t^V R_t^V V_t = (1 - x_t)\left[\int_{\underline{\varepsilon}^F}^{\varepsilon_t^{F,M}} \left[X_t Y_{j,t}\right] f\left(\varepsilon_{j,t}^F\right) d\varepsilon_{j,t}^F\right] \tag{6.25}$$

Equation (6.25) ensures that aggregate losses on bank capital ($\xi_t^V R_t^V V_t$) are equivalent to the value of collateral the defaulting bank anticipated earning if it could recoup $X_t Y_{j,t}$ in the default regime. Substituting equations (6.12), (6.13), and (6.14) in equation (6.25) yields,

$$\xi_t^V V_t = (1 - x_t) x_t A_t \frac{L_t}{W_t^R}\left[\int_{\underline{\varepsilon}^F}^{\varepsilon_t^{F,M}} \varepsilon_{j,t}^F f\left(\varepsilon_{j,t}^F\right) d\varepsilon_t^F\right]$$

Applying the features of the uniform distribution and reordering, we get the risk premium for retaining bank capital,

$$\xi_t^V = (1 - x_t) \frac{L_t}{V_t} \frac{R_t^L}{R_t^V} \left(\frac{\varepsilon_t^{F,M} + \underline{\varepsilon}^F}{2\varepsilon_t^{F,M}}\right) \Phi_t \tag{6.26}$$

The premium rate of bank capital is a function of the cost of default, $(1 - x_t) \frac{R_t^L}{R_t^V} \left(\frac{\varepsilon_t^{F,M} + \underline{\varepsilon}^F}{2\varepsilon_t^{F,M}}\right) \Phi_t$ which emerges from the likelihood of banks accruing losses in the regimes where firms fail to repay their loans. The risk premium of bank capital is also adversely affected by the bank capital loan ratio, which in turn is also determined by the regulatory requirements. Therefore, bank capital regulation aims to address market failure connected with default expenses in the banking sector.

Bank capital adequacy and countercyclical rule

Each bank is subject to the lowest risk sensitivity bank capital requirements executed by the monetary authorities and in line with the Basel Accords. Initially, the bank issues an amount of capital that is guided by a certain per cent of its loans to intermediate goods firms. As elucidated previously, borrowing intermediate goods firms are risky. The risk weight on loans is denoted by ϑ_t. The bank capital requirements constraint in real terms is presented as

$$V_t = p_t \vartheta_t L_t \tag{6.27}$$

where p_t is the total bank capital-loan ratio. In the Internal Ratings Based (IRB) method of Basel II (which does not change under Basel III), the credit risk weight (ϑ_t) can be associated with the probability of defaulting firms projected by the commercial banks as it is observed as a measure of credit risk. The assumption is that the probability of firms defaulting is incurred by the bank's risk weight on loans as expressed in the following equation

$$\vartheta_t = \left(\frac{\Phi_t}{\Phi}\right)^q \tag{6.28}$$

where $q > 0$ denotes the risk weight elasticity in relation to shifts in the likelihood of default (Φ_t) from its steady-state value (Φ). There is consensus in the literature that Basel II-type risk-sensitive bank capital requirements might intensify the procyclical effects previously inherent in the financial system (see Angeloni and Faia, 2013; Liu and Seeiso, 2012; Covas and Fujita, 2010). To address the procyclical issue, the Basel Committee reformed Basel II by using a countercyclical regulatory rule (BCBS, 2011). Then the "overall" capital ratio (p_t) is defined as follows

$$p_t = p^D p_t^C \tag{6.29}$$

The minimum capital adequacy requirements (Cooke Ratio) are indexed $p^D \epsilon(0,1)$, whereas p_t^C denotes the countercyclical component. For Basel II, the total capital ratio is set by p^D with no effect from the cyclical component. Therefore, under Basel II, $p_t = p^D$ and $p_t^C = p^D = 1$. However, for Basel III, the alteration of the cyclical component can be associated with shifts in the loan-output ratio from its steady-state (Meh and Moran, 2010; Angelini et al., 2012). Specifically,

$$p_t^C = \left(\frac{L_t/Y_t}{L/Y}\right)^{\vartheta^c} \tag{6.30}$$

where $\vartheta^c > 0$ represents an adjustment coefficient. Therefore, during times of expansion in the economy together with increasing lending activity, macro-prudential regulations like equation (6.30) constrain bank capital requirements so that the cost of credit increases equation (6.31). The increase in the credit rate can also alleviate the financial sector procyclical effects on the real economy.

The risk transmission channels and bank capital on the credit rate

Using equations (6.28), (6.29), (6.30), and (6.31) and the features of the normal distribution, the loan rate expressed in equation (6.27), we obtain,

$$R_t^L = R_t^D + \left[p^D \left(\frac{L_t/Y_t}{L/Y}\right)^{\theta^C} \left(\frac{\phi_t}{\phi}\right)^q\right](R_t^V - R_t^D + c) + \left(\frac{X_t A_t}{W_t^R}\right) \frac{(\bar{\varepsilon}^F - \underline{\varepsilon}^F)}{2\varepsilon_t^{F,M}} \phi_t^2 \tag{6.31}$$

where the term $\left(\frac{X_t A_t}{W_t^R}\right) \frac{(\bar{\varepsilon}^F - \underline{\varepsilon}^F)}{2\varepsilon_t^{F,M}} \phi_t^2$ denotes the financial premium. The financial premium is a positive function of the loan rate from equations (6.17) and (6.28) (see Appendix D.2).

Equation (6.31) states that the loan rate is positively correlated with the bank capital issuance cost, the bank capital deposit rate spread, the interest rate on deposits, and the finance premium. The cost of issuing bank capital and the bank capital-deposit rate spread are set as a proportion of the bank capital-loan ratio, which is determined by the Cooke Ratio, and the risk weight on loans. For Basel III, the loan rate uses the same guidelines as Basel II for risk-weighted assets but has tighter capital requirements, and its countercyclical rule is defined by equation (6.30).

There are several channels through which the probability of defaults affects the loan rate. The first is the bank capital default, which emanates from combining the arbitrage-free condition and a positive level of default costs on bank capital in relation to the rate of bank capital, the rate of deposit and the bank capital risk premium rate (ε_t^V). The bank capital risk premium is also negatively related to the bank capital loan ratio and positively related to the risk of defaults at the intermediate goods firm level (see equations 6.4 and 6.26). The second channel is the finance premium channel, which stems from a positive relationship between the finance premium and the default risk that directly influences credit expenses. The third is the bank requirements channel for both Basel II and Basel III. The sign determines the direction of adjustment in bank capital ϑ^c in equation (6.30).

In the model, the impact of the bank capital loan ratio on the loan rate is ambiguous. At the same time, tightening bank capital regulation raises the cost of credit through the direct positive relationship between i_t^L and $\frac{V_t}{L_t} = f\left(\vartheta_t(\phi_t)\right)$ (the risk weight channel). Furthermore, an increase in the bank capital-loan ratio minimises the risk premium on bank capital, thus, reducing the loan rate through the bank capital default channel (see equation (6.30)). With increasing bank capital requirements, there is a higher equity base to absorb bank losses which leads to a mitigating effect on the cost of credit, the bank capital premium rate and the bank capital-deposit rate spread (see Barth et al., 2004; Coleman et al., 2006).

A decrease in the bank capital risk premium as a result of a higher capital ratio is in line with the logic of the Modigliani and Miller (1958) theorem and is supported by the empirical literature (see Kashyap et al., 2010; Barth et al., 2004; Coleman et al., 2006). Furthermore, Admati and Hellwig (2014) argue that the bank capital cost is low and reduces the risk premium on equity, resulting in fewer distortions in lending decisions and better-performing banks. In this model, the conflicting effects of bank capital regulation on the loan rate largely offset each other in steady-state and reduce the role of time-varying regulation in the model dynamics. When small issuance costs of bank capital are added, dynamic capital requirements' effectiveness is restored (Covas and Fujita, 2010; Gerali et al., 2010). The tax advantage of debt over equity increases the weighted average cost of capital and the loan rate due to an increase in bank capital into a reasonable empirical range (Hanson et al., 2011).

A main element in this setting is that the probability of default is a function of the lending rate, while the bank capital rate is a function of the bank's losses (from the arbitrage-free condition) and the default risk. Therefore, a negative shock related to declining levels of output (collateral) leads to high financial risk, which increases the bank capital rate and regulatory requirements (in the benchmark Basel II case where $\vartheta^c > 0$). A rise in bank capital expenses, in turn, increases the loan rate, thus exerting upward pressure on the bank capital premium rate and the risk of default and respectively amplifying the original rise in the loan rate. Thus, the probability of default, via its correlation with regulatory requirements, the borrowing costs and the bank capital rate, exacerbate the effect on the economic and financial variables. These frictions lead to significant financial accelerator effects, in line with the consensus in the literature that banking activities are procyclical (Basel II). Consequently, in Basel III, $\vartheta^{c} < 0$ is used to combat the effects of the borrowing cost channel and financial sector procyclicality on the real economy.

6.2.8 Monetary Policy

The monetary authorities set interest rates (i_t^R) using the Taylor rule. The following is the log-linearised Taylor rule equation,

$$\widehat{\iota_t^R} = \widehat{\phi \iota_{t-1}^R} + (1-\phi)\left[\phi_\pi \widehat{\pi_t^P} + \phi_Y \widehat{Y_t} + \phi_{L/Y}\left(\widehat{L_t} - \widehat{Y_t}\right)\right] \qquad (6.32)$$

where $\widehat{\pi_t^P} \equiv \pi_t^P - \pi^{P,T}$represents inflation shifts from its range value ($\pi^{P,T}$), $\widehat{Y_t}$ refers to output deviations from its equilibrium (output gap), $\phi \in (0,1)$ is the degree of policy rate smoothing and $\phi_\pi,\ \phi_Y > 0$ are parameters calculating the relative weights on inflation and output gap, respectively, in the Taylor Rule.

The standard Taylor rule has an added new variable given by $\phi_{L/Y}\left(\widehat{L_t} - \widehat{Y_t}\right),$ where $\phi_{L/Y} > 0$. Hence, the monetary authorities set their interest rates taking into account the shift of the credit spread from steady-state level (Curdia and Woodford, 2010). Consequently, adverse shocks produce a trade-off between output-inflation stabilisation, the loan rate and the probability of default increase, and lead to a decline in lending and an increase in credit spreads. Therefore, interest rates decrease and mitigate the original spike in the loan rate, thus reducing the contraction in credit and GDP and at the same time easing inflation pressure. However, a high output gap followed by low interest rates may apply more inflationary pressure through the borrowing cost channel.

6.3 Parameterisation

Similar to the cost channel literature and allowing for the clearing of the goods market, we assume that the size of the liquidity injection plus the real wage subsidy is $X_t + \int_0^1 \tau_\omega \frac{W_{i,t}}{P_t} H_{i,t} di = M_{t+1} \frac{P_{t+1}}{P_t} - M_t$. Following the financial intermediation process, the monetary authorities collect $R_t^D X_t + cV_t = J_t^{FI}$, which is repaid in a lump-sum to households. In a symmetric equilibrium ($P_{j,t} = P_t, H_{j,t} = H_t, L_{j,t} = L_t$), we substitute the intermediate goods firm's profits and aggregate profits from the financial intermediation process, the equilibrium condition in the market for credits ($W_t^R H_t = D_t + V_t + X_t$), the arbitrage-free condition (4), and the size of the wage subsidy plus the liquidity injection in identity (2) to acquire the basic market clearing condition ($Y_t = C_t$).

The model is solved by log-linearising the behavioural equations and the resource constraints around the non-stochastic, zero-inflation steady-state and taking the percentage deviations from their counterparts under flexible wages and prices. The model is calibrated, where applicable, within the range of the parameters suggested by Smets and Wouters (2007), Steinbach, Mathuloe and Smit (2009), Lui and Gupta (2007) and Christiano, Eichenbaum and Evans (2006). The baseline calibrated values are summarised in Table 6.1.

Table 6.1: Calibrated Parameter Values

Parameter	Value	Description
β	0.99	Discount factor
ς	1.06	Intertemporal substitution in consumption
γ	3.0	Inverse of the Frisch Elasticity of Labour Supply
λ_ω	1	Labour demand elasticity
ωm	0.8	Wage Mark-up
ω_ω	0.5	Proportion of workers that do not adjust wages between any two periods
λ_p	28.6	Elasticity of Demand Intermediate Goods
pm	0.25	price indexation
ω_p	1.15	Degree of price stickiness
A	0.8	Average productivity parameter
ε^{F}	1.36	Idiosyncratic Productivity Shock Upper Range
$\underline{\varepsilon}^{\mathrm{F}}$	1	Idiosyncratic productivity shock lower range
X	0.88	Probability of banks recovering collateral
p	0.08	Capital Adequacy ratio
θ^{c}	0.05	Adjustment parameter in countercyclical rule
q	0.02	Elasticity of Risk Weight regarding non-repayment loans
c	0.1	Administrative Cost of issuing Bank capital
ϕ	0.5	Degree of persistence in Interest rate rule
ϕ_π	1.389	Reaction of interest rates to Inflation Deviations
ϕ_Y	0.625	Reaction of interest rates to output Deviations
$\phi_{L/Y}$	0.00	Reaction of interest rates to credit spreads
ξ^{A}	2	Degree of Persistence - Supply Shock
ξ^{x}	0.8	Degree of persistence - Credit Shock

The idiosyncratic productivity shock's upper limit is 1.36, the lower limit is 1, and the steady-state probability of the bank recouping collateral (X) is 88 per cent. Furthermore, (p) is set to 0.08, indicating the Basel II floor value. All these values, as well as a price mark-up of 1.10, produce a steady-state credit risk of 3.1 per cent, a long-run value for the bank capital return of 2.4 per cent and a lending rate of 11.4 per cent. These estimations are in line with values from emerging economies.

Countercyclical regulations θ^c and the reaction of interest rates to credit spread $\phi_{L/Y}$ are set at 10.1 and 0.01, respectively. These values are optimally determined within a grid search. The elasticity of the risk weight in relation to the probability of default (q) is set to 0.05 as estimated by Covas and Fujita (2010).

The persistence parameter and standard deviations related to supply and financial shocks approximately correspond to the standard deviations of output, inflation and loan rates in the South African data, from 2000Q1 to 2016Q4. The selection of the prior distribution is similar to Liu and Molise (2020). For supply shocks, ξA=0.95 while the financial shock ξx =0.90 and the standard deviation is 0.25 for each shock.

6.4 Optimal simple policy rules

The study analyses the optimal combination of macro-prudential policy tools and the conventional Taylor rule. Using a second-order approximation, the Central Bank's objective function is derived around the efficient steady-state of the household's forecast expected utility written in gap form,

$$\sum_{t=0}^{\infty} \beta^t U_t \approx U - \frac{1}{2} U_c C \mathbb{E}_0$$

$$\sum_{t=0}^{\infty} \beta^t \left[\frac{\lambda_p}{k_p} var\ (\hat{\pi}_t^P) + (\varsigma^{-1} + \gamma) var\left(\hat{Y}_t^g\right) + \frac{\lambda_w}{k_w} var\ (\hat{\pi}_t^W) \right] \tag{6.33}$$

where $k_p = \frac{(1-\omega_p)(1-\omega_p\beta)}{\omega_p}$, $k_w = \frac{(1-\omega_p)(1-\beta\omega_\omega)}{\omega_\omega(1+\gamma\lambda_\omega)}$ and $\hat{Y}_t^g = \hat{Y}_t - \hat{Y}_t^e$ is the welfare relevant gap between the efficient and natural level of output. The expression $\hat{Y}_t^e = [(1+\gamma)/(\varsigma^{-1}+\gamma)]\hat{Z}_t$ is the effective level of GDP selected by the social planner who can subdue the financial and nominal volatility of the economy. Consistent with Ravenna and Walsh (2006), the existence of the borrowing cost channel produces an output gap given by $\hat{Y}_t^e - \hat{Y}_t^n = [1/(\varsigma^{-1} + \gamma)]\hat{R}_t^{L,n}$, where $\hat{Y}_t^n$ and $\hat{R}_t^{L,n}$ represent the actual level (indexed by exponent n) of output, and the lending rate dominates in accordance with wage and price flexibility. Following Taylor and Zilberman (2016), the existence of the different financial frictions gives rise to fluctuations $\hat{R}_t^{L,n}$ creating a wedge between $\hat{Y}_t^n$ and $\hat{Y}_t^e$. The study has different optimal policy rules that minimise the loss function elements for the welfare function.

We compute the optimal combination of policy parameters (ϕ , $\phi L/Y$, θ^c) in equations (6.32), (6.30) which minimizes equation (6.33). To find the optimal parameters that minimise the welfare loss function, we search the grid of the following parameters numerically: ϕ = [1:10], $\phi L/Y$ =[0:1] and θ^c= [-50:1] with a step of 0.01.

6.5 Optimal simple rules analysis

This section presents the optimal simple policy analysis: the standard deviations measured in terms of the theoretical moments. Table 6.2 shows the standard Taylor rule (Policy I), Policy II (optimal Taylor rule) and the combination of optimal monetary policy and a macro-prudential policy (Policy III). The study conducts the optimal policy investigation dependent on a distinct shock hitting the economy. These shocks include credit shocks (column 2) and supply shocks (column 3). The selection of these shocks is driven by the literature's conclusion that financial and supply shocks are imperative in explaining the dynamics of real variables (see Meh and Moran, 2010; Christiano et al., 2014; Jermann and Quadrini, 2012).

The results in table 6.2 show that optimal monetary policy features a modest response to inflation in the range of 1.1 to 1.5, which is less than the estimated value of 1.7. This means that using an aggressive response to inflation is not optimal when the monetary authorities pursues both financial and price stability objectives using two policy instruments. These results are similar to the two shock scenarios.

Table 6.2: Optimal simple policy rules and standard deviations

	Credit shock		Supply shock	
Policy I	$\phi_\pi = 2$ $\phi_{L/Y} = -$ $\theta^c = 0.05$	$s.d(\hat{\pi}_t^P) = 0.0087$ $s.d(\hat{Y}_t^g) = 0.0328$ $s.d(\hat{\pi}_t^W) = 0.0038$	$\phi_\pi = 2$ $\phi_{L/Y} = -$ $\theta^c = 0.05$	$s.d(\hat{\pi}_t^P) = 0.0496$ $s.d(\hat{Y}_t^g) = 0.1062$ $s.d(\hat{\pi}_t^W) = 0.0224$
Policy II,	$\phi_\pi = 1.3$ $\phi_{L/Y} = -$ $\theta^c = 0.05$	$s.d(\hat{\pi}_t^P) = 0.0087$ $s.d(\hat{Y}_t^g) = 0.0288$ $s.d(\hat{\pi}_t^W) = 0.0035$	$\phi_\pi = 1.7$ $\phi_{L/Y} = -$ $\theta^c = 0.05$	$s.d(\hat{\pi}_t^P) = 0.0516$ $s.d(\hat{Y}_t^g) = 0.0814$ $s.d(\hat{\pi}_t^W) = 0.0232$
Policy III	$\phi_\pi = 1.3$ $\phi_{L/Y} = 0.00$ $\theta^c = 0.05$	$s.d(\hat{\pi}_t^P) = 0.0087$ $s.d(\hat{Y}_t^g) = 0.0288$ $s.d(\hat{\pi}_t^W) = 0.0035$	$\phi_\pi = 1.7$ $\phi_{L/Y}$ $= 0.00$ $\theta^c = 0.05$	$s.d(\hat{\pi}_t^P) = 0.0516$ $s.d(\hat{Y}_t^g) = 0.0814$ $s.d(\hat{\pi}_t^W) = 0.0232$

6.6. Impulse Response Results

This section presents the interaction of monetary policy with a macro-prudential policy in the impulse response functions of selected variables following financial and supply shocks. We contrast Policy I (the benchmark policy) with two alternative policy regimes in which we have an optimal Taylor rule (Policy II) and an optimal Taylor rule and countercyclical capital regulation (Policy III). To conduct this analysis, we use the optimal values reported in Table 6.2.

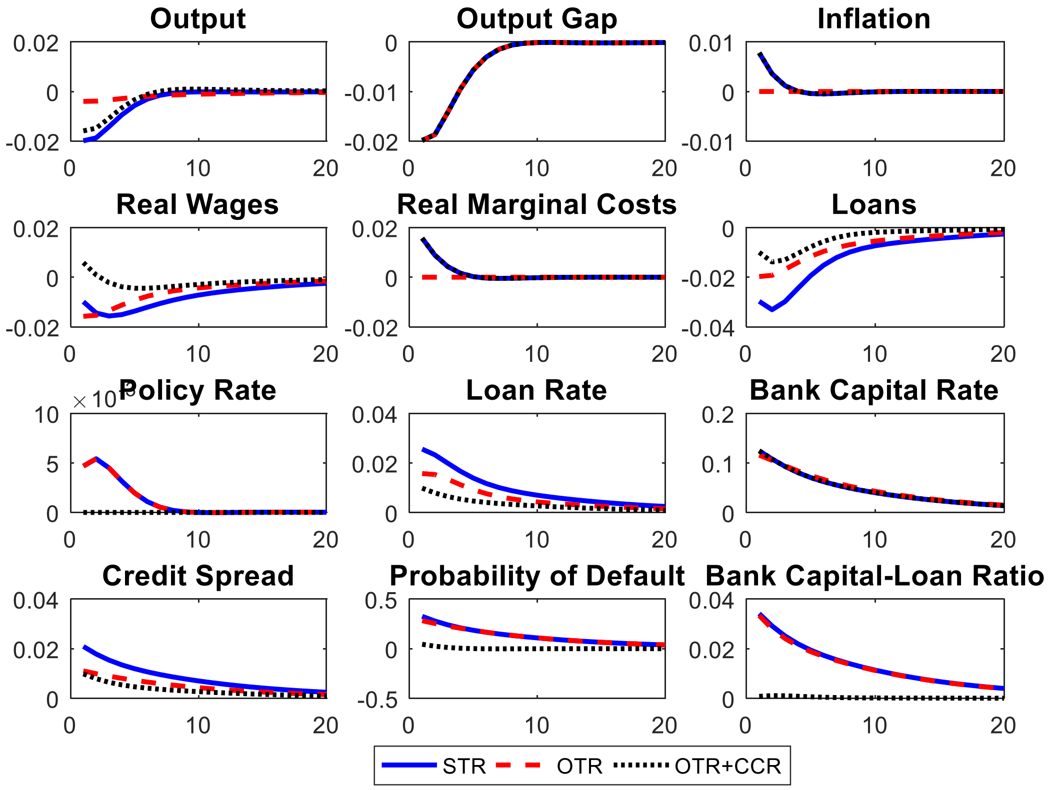
Figure 6.1 presents the impulse responses of selected variables following an adverse financial shock. The figure shows that under Policy I, the benchmark case where there is only the standard Taylor rule, the financial shock has a contractionary effect on the economy following a negative financial shock. The contractionary impact results in a rise in the probability of default, and therefore, the loan rate increases through the finance premium channel. Since this regime operates under Basel II, bank capital requirements rise, inducing an amplification effect on credit risk and borrowing cost. The increase in bank loan losses together with a rise in the loan rate increases the real marginal cost, raises inflation, and prompts the monetary authorities to raise the policy rate (nominal interest rates).

The rise in the policy rate generates an added upward shift in the loan rate and bank capital, fuelling a decrease in aggregate lending and demand. This finding indicates that there is a trade-off between output and inflation volatility in response to credit shocks, as indicated by Tayler and Zilberman (2016), Liu and Molise (2019) and Lui and Molise (2020). The marginal fall in real wages due to high inflation, low demand for labour, and low output moderates the rise in marginal cost because the credit shock hits directly at credit spreads.

The bank's perceived risk generates upward pressure on the bank capital rate through the bank capital default channel, resulting in banks charging a higher loan rate. Moreover, the bank is subject to risk-sensitive bank capital requirements. The risk weight on loans increases with a rise in the probability of default, further amplifying the effects on the borrowing cost.

When the authorities adopt a policy regime that has an optimal Taylor rule (Policy II), both output and inflation stabilise. Compared to Policy I, Policy II relatively improves output due to low inflationary pressure. Improved production also shows that an optimal Taylor rule reduces the procyclicality of wages and financial variables.

Figure 6.1. Negative financial shock with optimal policy rules.



As the bank capital to loan ratio increases, the Central Bank responds by raising the policy rate similar to the standard Taylor rule, mitigating the decrease in output. Furthermore, the increase in the policy rate marginally reduces the increase in the loan rate, which initially acts to attenuate inflation's response through the borrowing cost channel. However, as inflation stabilises, real wages decrease, which stabilises the marginal costs.

Turning to the implications of the augmented Taylor rule combined with the countercyclical rule, in Figure 6.1, we observe that the shock increases inflation volatility despite mitigating output losses. The output level increases due to the low policy rate as a result of high credit spreads through an intertemporal substitution effect and reduces the rise in the loan rate through the monetary policy cost channel. The marginal rise in output can also be due to the low refinance rate that translates into an increase in price inflation via the standard demand channel of monetary policy transmission. Of the two types of channels, the latter dominates, and as a result, low policy rates tend to be inflationary.

Following an adverse credit shock, the bank capital loan ratio falls. Consequently, bank capital requirements loosen to mitigate the loan rate reaction. The low loan rate increases demand for loans. An observed, the rise in price inflation and marginal costs is less pronounced than in Policy I, caused by a decrease in the refinance rate that fuels high inflation via the interest rate channel of monetary policy. The lower policy rate under Policy III in comparison to Policy II demonstrates that Policy III directly affects financial conditions that have a small impact on monetary policy versus prices. As a result, interest rates fall, and this prompts firms to increase demand for loans following the shock.

We turn next to the impact of a negative supply shock. Figure 6.2 shows the impulse response functions of the selected variables following a negative supply shock. Under Policy I (solid blue line), the shock decreases output and raises inflation through the NKPC equation. As GDP levels decrease, collateral falls via the finance premium channel, increasing both the loan rate and the probability of default similar to Agenor, Bratsiotis and Pfajfar (2013). The decline in collateral increases the risk perceived by the bank. It generates upward pressure on the bank capital rate through the bank capital default channel, resulting in banks charging a higher loan rate. The high loan rate and the credit spread are further amplified through Basel II and the bank capital default channel.

Figure 6.2. Negative supply shock with optimal policy rules.

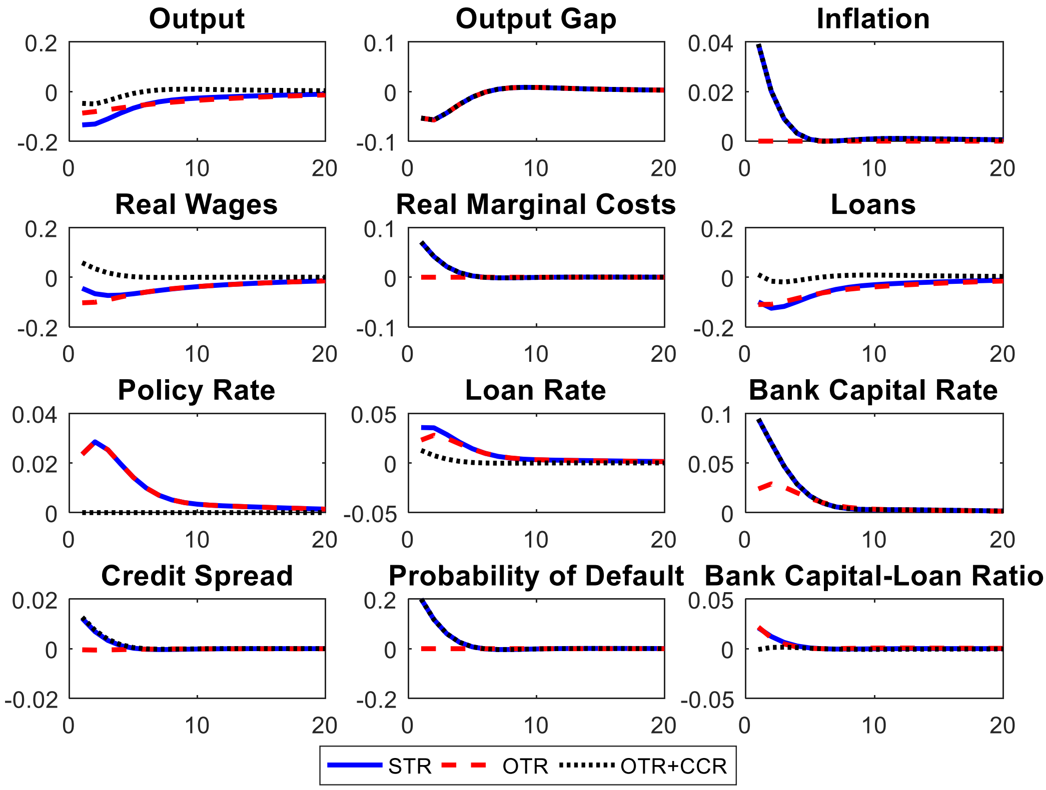


Figure 6.2 also reveals that as a direct impact, negative supply shocks raise the loan rate that amplifies the price of inflation and the real marginal cost. At the same time, output deteriorates through the borrowing cost channel. This generates an upward shift in the bank capital rate and loan rate and lowers output through the intertemporal substitution in consumption.

As illustrated by the adverse financial shock, deployment of the optimal Taylor rule stabilises inflation. Under Policy II, the Central Bank increases the interest rate when the bank capital-loan ratio rises. The negative supply shock lowers real wages, which leads to a mitigating effect on the probability of default and consequently, on the loan rate and the borrowing cost channel.

Figure 6.2 further shows that under Policy III, the shock increases firms' borrowing capacity as a result of low loan rates. High borrowing capacity exerts upward inflationary pressure through the borrowing cost channel that produces higher output compared to Policy II and Policy I. Thus firms demand more loans.

The negative supply shock lowers capital requirements so that banks significantly reduce the bank capital-loan ratio, thus containing the increase in the loan rate. The reduction in the bank-capital loan ratio produces no change in the policy rate, thus balancing the declining output with a rise in inflation. The increase in the borrowing cost and loan rate, and the fall in production reduce demand for loans. Concurrently, as demand for credit falls, so does the amount of capital the bank needs to issue in each period to satisfy regulations. The decline in bank capital activates the adjustment cost channel, attenuating the procyclical effects in the financial system through its impact on the bank capital rate.

The bank capital-loan ratio is independent of the probability of default. Thus, as the perceived risk increases following a negative supply shock, the bank capital-loan ratio stabilises, resulting in a fall in the loan rate. The loan rate and the probability of default are negatively related. Hence, a fall in the cost of loans directly increases the likelihood of default for firms and, consequently, the expected increase in the bank capital loan ratio.

6.7 Efficient Policy Frontier

In this section, we compare the outcomes of Basel II and Basel III in terms of three-dimensional Taylor curves on output, wages and inflation variabilities. These are the trade-offs between output stabilisation, wage stabilisation and inflation stabilisation that the monetary authorities face when shocks hit the economy. To illustrate these trade-offs graphically, we use Taylor curves or efficiency policy frontiers.

The coefficients of the Taylor rule vary to produce a wide range of points on the output-wage-inflation frontier. The study follows Levin et al. (1999) in computing the efficiency frontiers by finding the weighted sum minimum of the unconditional variances of output, wage rate, and inflation for diverse weights' values. The only points considered are those from a unique rational expectations equilibrium. The investigation uses the financial shock and the supply shock to examine the two scenarios.

Figure 6.3(a) shows the trade-offs the model produces between the unconditional inflation, wage, and output variance when the economy faces a negative financial shock. Curves that are closer to the origin signify the preferred (efficient) policy regime in terms of reducing the volatilities of inflation, output, and wages. The efficiency policy frontier under Basel II (benchmark case) presents a clear trade-off between output, wage rate and inflation. The results show that under Basel III, the Taylor curves shifts to the right, suggesting a more effective policy outcome with respect to lower inflation-output volatilities compared to the benchmark case. This means that macro-prudential regulation on its own can stabilise the economy, while monetary policy under a financial shock plays a small role.

Figure 6.3 (a) Efficient policy frontier: all dimensions, Financial shock.

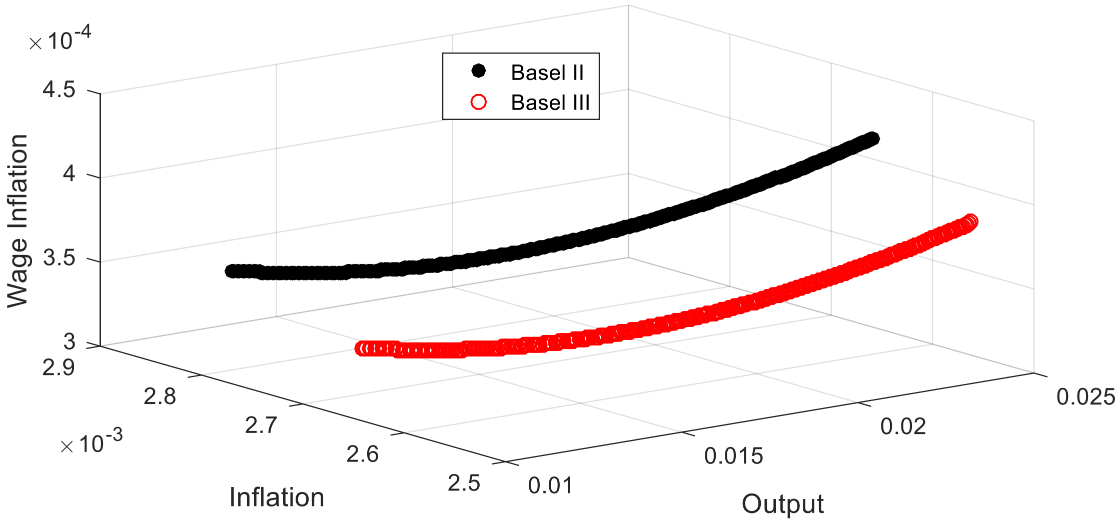
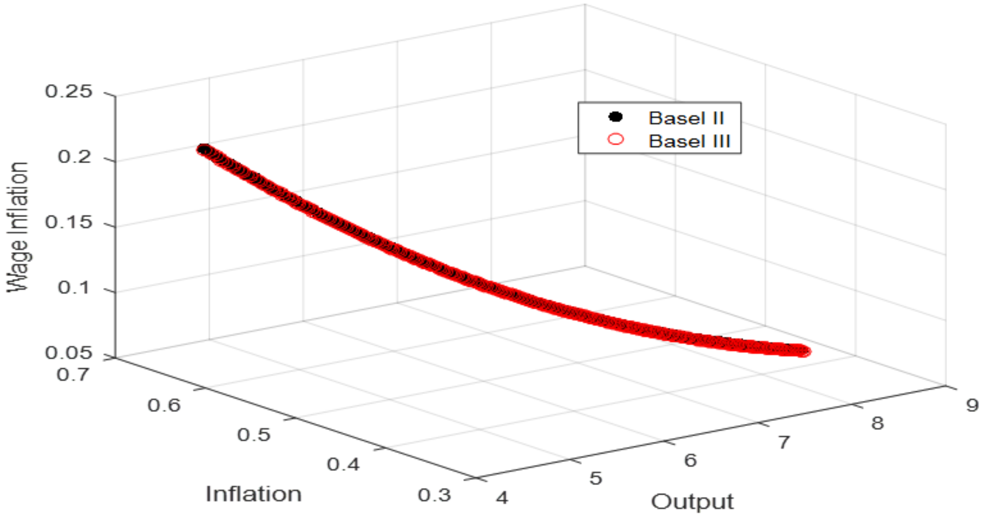


Figure 6.3 (b) shows that following a supply shock, the higher the wage volatility, the closer the output and inflation unconditional variances are to the origin (less volatility of output and inflation). Comparing Basel II with Basel III shows that both regulations only promote output stability and are less efficient in promoting inflation and wage inflation stability consistent with the findings of Liu and Molise (2019).

Figure 6.3 (b) Efficient policy frontier: all dimensions, supply shock.



6.8 Summary and Conclusion

Despite the significance of the relationship between macro-prudential policy and monetary policy, it is one of the least investigated issues in South Africa. The macro-prudential policy framework requires banking institutions to continue providing financial services and products without interruption regardless of the changes in the economic environment that came into effect in 2007/2008. This chapter evaluated the monetary policy and the macro-prudential role of bank capital regulation in fostering macroeconomic and financial stability.

The study examined the relationship between the two policies within a framework. There is a non-financial corporate borrower in a borrowing cost channel model featuring endogenous credit friction and nominal rigidities. The endogenous financial frictions are defined by bank losses, credit risk and bank capital costs, and the borrowing cost channel connects the financial sector to the real economy. The study considered two alternative policy regimes, namely, an optimal monetary Taylor rule and a regime where the optimal Taylor rule and a countercyclical rule are jointly implemented against a benchmark policy in which there is a standard Taylor rule.

The study found that the combination of optimal monetary policy and macro-prudential policy following a financial shock only fosters financial stability. For supply shocks, simultaneously deploying macro-prudential policy with optimal monetary policy stabilises output at the cost of compromising price stability and financial stability. Efficient policy frontier analysis showed that Basel III-type regulations can restrain the negative spill-overs coming from the financial sector to the real economy. Our findings suggest that macro-prudential policy can eliminate the output-inflation trade-off faced by policy authorities during periods of financial distress without using both the standard and optimal monetary policy.

CHAPTER 7

SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Summary and Conclusions

The monetary policy framework is mainly concerned with achieving price stability. Price stability has been shown to be insufficient to achieve financial stability and instability in the financial system may have major adverse feedback effects on price stability. This raises important questions such as: (i) does monetary policy play any significant role in the post-global financial crisis? (ii) how does the new macro-prudential framework affect the real economy? The 2007/2008 global financial crisis has clearly shown that banking regulation and financial sector volatility translate to substantial real macroeconomic effects. Moreover, incorporating credit market friction and financial risk into standard macro models is crucial in explaining the behaviour of real business cycles. The financial frictions are indications of the level of disturbance to the normal operations of financial institutions, markets or infrastructure where facilitation of smooth financial flows among lenders and investors is weakened (Hakkio and Keeton, 2009). During such times, the financial system is in a period of financial distress.

This study noted that South Africa has been frequently affected by stress regimes that manifested before and after the 2007/2008 financial crisis. This has raised concerns on the procyclical nature of Basel II that has negative implications for financial stability and macroeconomic stability. The procyclicality of financial shocks through the financial sector and macroeconomy led this study to examine the issue in a nonlinear framework. In objective one, the study built on the work of Sims et al. (2008) by adopting a MSVAR model with Bayesian estimations. The model assessment was done using the goodness-of-fit criteria that relate to the properties of the model, marginal data densities and the model's ability to explain financial stress regimes. The study used an FCI constructed by Kabundi and Mbelu (2017). This index used a time-varying factor model employing 39 monthly financial variables from January 2000 to April 2017. Objective one explored how high financial stress interacts with the economy. The nonlinear linkages between financial stress and economic dynamics were also investigated using the bridge sampling method. The study found that the relationship between financial stress and the economy is not time-invariant. Therefore, linear models are likely to provide misleading results. It also found that the shifting of regimes allows for variance switching and coefficient switching that explain the variance of structural shocks and economic behaviour during stressful times.

Furthermore, the results show that after financial shocks, interest rates respond negatively during financial distress regimes and tranquil times. As a result, credit growth increased during tranquil times and financial distress regimes. However, the response of output growth was initially sluggish before it fell in response to high financial stress. The decline in output shows that credit is mainly for mortgages which is not accounted for in GDP transactions. Subsequently, inflation decreases in response to financial shocks during the financial distress regimes. The findings imply that monetary policy is less efficacious in times of financial distress due to factors other than interest rates and lending risk functions that influence the effectiveness of monetary policy.

Objective two presented housing cycles in small, open DSGE model and also investigated the effects of different housing-related macro-prudential policies on house prices and their interaction with monetary policy. The housing-related macro-prudential policies included the LTV ratio (quantity restrictions) and stamp duties (price restrictions). The study found that stamp duty taxes are effective policy instruments when dealing with volatility emanating from the real estate market, and that they decrease output. The study also compared a credibly announced long-term LTV policy with a more transitory LTV policy. The findings reveal that a credibly announced longer-term LTV policy complements monetary policy towards maintaining price stability. A lower LTV ratio in the form of expansionary macro-prudential policy tightens lending standards and therefore reduces house prices, then mildly raises the volatility of household debt. Furthermore, price and inflation stabilities objectives are achieved when the low LTV shock generates a adverse relationship between household prices and house debt. While this seems beneficial from a financial stability viewpoint, it comes at the expense of increasing house debt. Under a high LTV ratio in the form of expansionary monetary policy, the opposite occurs because it has a significant effect on inflation. This implies that it might be used while affecting the efficacy of monetary policy. In this case, the policy authorities can employ the interest rate to address house price volatility. The coordination between interest rates and macro-prudential policy, as indicated by the impulse response analysis, tight interest rates shocks have a small effect on debt levels and house prices. The small effects of interest rates on debt and house prices show that macro-prudential policy might limit the spill-over effects of monetary policy on debt and house prices.

The results suggest that the use of different macro-prudential tools can improve their efficacy. This also helps to address the weaknesses of a single policy tool and enables modification of the general policy reaction to different risk characteristics while limiting for circumvention. Moreover, the estimates of the impact of LTV policy contraction affect house prices, with a primarily small effect on inflation. Consequently, the macro-prudential policy targets house prices directly and mitigates the impact of monetary policy on house prices with a small impact of monetary policy on inflation. The macro-prudential policy reduces the effectiveness of monetary policy by weakening the monetary policy transmission channels. The efficient policy frontier analysis demonstrates that macro-prudential policy added value to monetary policy, and this may help to ensure improved outcomes as measured by lower fluctuations in output and inflation in comparison with only employing monetary policy.

In objective three the study identified the interaction between the real business cycle and the credit markets. It examined monetary policy and macro-prudential roles of bank capital regulation in promoting macroeconomic and financial stability. The study employed a DSGE framework with an endogenous formation of risk at both firm and bank capital levels. The linkages between the real business cycle and the financial system in the model were explained through the borrowing cost channel (introduced by Ravenna and Walsh, 2006), which connects the loan rate behaviours and the real marginal costs and hence the inflation rate. However, the study's borrowing cost channel has three additional channels that directly impact borrowing costs. The first is the risk premium channel determined by the positive probability of default at the firm level which leads the commercial bank to charge a premium over the cost of borrowing from households, similar to Agenor et al. (2013). The second is the bank capital default channel resulting from the introduction of bank capital risk. The probability of default on bank capital creates an endogenous spread between the interest rates on deposits and the rate of return on bank capital. The final channel is the risk weight channel, stemming from the bank capital-loan ratio, which is driven by the cyclical behaviour of the probability of default. The risk weight channel is observable in the Foundation IRB approach of Basel II and III, whereas the bank capital default channel and risk premium channel prevail irrespective of the regulatory regime.

The study examined two alternative policy regimes in where there is only an optimal monetary policy, and macro-prudential policy that is jointly implemented with an optimal monetary policy. It compared their efficacy in fostering macroeconomic stability and financial stability against a benchmark policy, the standard monetary policy. The study found that a combination of monetary and macro-prudential policies following a supply shock stabilises output at the cost of compromising price and financial stability. For a financial shock, combining macro-prudential policy with optimal monetary policy only promotes financial stability. The efficient policy frontier analysis showed that Basel III is the most effective policy on its own with regard to improving both financial stability and macroeconomic stability.

7.2 Policy implications and Recommendations

An investigation of the efficacy of the South African monetary policy in the presence of macro-prudential policy and how both policies bring about stability in the economy is beneficial for policy purposes. Several policy implications emerge from the study's results.

Firstly, the findings suggest that policymakers should exercise prudence when permitting monetary policy to respond to financial stress. Monetary policy needs to consider other policies like macro-prudential policies in times of high financial stress.

Secondly, monetary policy seems not to have a significant influence on house prices. Therefore, the monetary authorities may not be concerned about rising house prices as long they are not driven by unsustainable debt levels. Against low interest rates, policymakers need to introduce macro-prudential policies that can contain rising house prices.

Thirdly, the findings suggest that policymakers should not increase the inflation response despite high inflationary pressure when the borrowing cost channel is mainly lead by financial frictions. They highlight the importance of recognising the origins of economic instabilities for the formulation of monetary policy and macro-prudential policy. Furthermore, monetary policy should be coordinated with macro-prudential policy (countercyclical capital regulation) when promoting financial and price stability. Simultaneous pursuit of financial stability and macroeconomic stability by each objective helps to improve the policy outcome by focusing exclusively on the primary objectives.

7.3 Limitations of the study

Using data from South Africa, this study set out to: (i) investigate how financial stress affects South Africa's economy, (ii) examine the relationship between macro-prudential and monetary policies, and house prices in an open economy, and (iii) evaluate monetary policy and the macro-prudential role of bank capital regulation in fostering financial and economic stability in South Africa. While these objectives were achieved, the study encountered a few limitations. For instance, the FCI used is limited to banks and omits non-banks which have been a major source of credit since the implementation of macro-prudential measures. The model does not allow households to switch from being borrowers to savers and vice versa as a result of macro-prudential policies. Therefore, the counterfactual model shows how macro-prudential policies affect house prices and credit at the intensive margin instead of the extensive margin. Previous studies on business cycles and housing are built on DSGE models with limited heterogeneity. Therefore, the calibrated policy simulations attempted to capture this indirectly. Thus, we recommend that future studies should incorporate more heterogeneity.

7.4 Suggestions for further research

Research in this area should be ongoing. Based on our findings, future studies could extend the FCI, which functions as a measure of financial stability to include the non-bank sector. This would make further research more reliable and effective in dealing with risks emerging from market-based financing. Furthermore, capturing both the bank and non-bank sectors would enhance policy reform, especially with regard to financial risk that may emerge in the post-2007/2008 financial crisis period. The introduction of other macro-prudential policy instruments for example the debt-to-income ratio would explore the extent to which they could complement countercyclical capital requirement regulations. Finally, the interaction of monetary and macro-prudential policies could be extended to include fiscal and structural policies.

8 APPENDICES

Appendix A Data Description

The data is obtained from the SARB.

Time-varying financial conditions index: 39 monthly time series of the financial market.

Real GDP growth: economic growth measured in real terms related to Gross Domestic Product from one period to another adjusted for inflation.

Domestic credit to the private sector: financial resources supplied by the private sector to nonfinancial corporations using loans among others.

Interest rate: The repo rate is when central banks discount or lend eligible paper for money deposit banks.

Inflation: is measured by quarterly changes in the implicit gross domestic product deflator.

Appendix B Robustness Check using a single regime model VAR

In this section, we examine how monetary policy has responded to financial stress index and a financial conditions index using Vector Autoregression Regression (VAR) model that serves as a robustness check. The financial conditions index represents a single regime model. The single regime model is likely to provide misleading conclusions because they do not differentiate between normal or stress periods. Sims, Waggoner and Zha (2008) show that Vector Autoregression (VAR) model a framework for linearities, may have inconsistent results. This is because the model might lose information by transforming continuous variables into a binary dummy variable (Hartmann et al. 2015). Consistent with this (Sims et al., 2008) shows that the model cannot differentiate between coefficient switching and variance switching. Variance switching suggests that financial distress is a matter of shock volatility, while coefficient regime-switching would propose changes in the transmission shock structure. However, VARs attempts to describe economies, assuming a minimum number of priors.

The primary assumption is that the economy is characterised by a linear, stochastic dynamic system of the following form:

$$Y_t = B_O Y_t + B_1 Y_{t-1} + \cdots + B_p Y_{t-p} + \varepsilon_t \quad (1)$$

where Y_t is an $nX1$ vector of variables in the system at time t, B_i for $i = 0, \ldots, p$, are nXn matrix of coefficients, and ε_t an $nX1$ vector of structural shocks with a variance-covariance matrix of $E(\varepsilon_t \varepsilon_t') = I$. The VAR estimates equation (1) in the reduced form:

$$Y_t = A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + \mu_t \tag{2}$$

where μ_t is the $nX1$ vector of residuals with variance-covariance matrix $E(\mu_t \mu_t') = \Omega$. Defining $A_o = (I - B_0)^{-1}$, implies that $A_o = A_0 B_i$, for $i = 1, \ldots, p$. The reduced-form residuals and the structural shocks are related by:

$$u_t = A_o \varepsilon_t, \tag{3}$$

so that

$$\Omega = A_o A_0' \tag{4}$$

To produce the impulse response functions, write equation (1) and (2) in mean-adjusted form, respectively as $Y_t = [I - B(L)]^{-1} \varepsilon_t$ (5)

and

$$Y_t = [I - A(L)]^{-1} \mu_t \tag{6}$$

From equation (3), the impulse response to structural shocks can be produced from equation (5) and (6) using:

$$[I - B(L)]^{-1} = [I - A(L)]^{-1} A_0 \tag{7}$$

the elements of $A(L)$ are on the right of the regression, some of the n^2 elements of A_0, are identified excluding the imposition of additional assumptions. These so-called ‘identifying assumptions’ are a necessity for recovering the structural shocks, $\varepsilon_{t,}$ from the reduced-form residuals, μ_t. The variance-covariance matrix produced from the estimation provides, using equation (4), $n(n+1)/2$ restrictions on A_0, leaving $n(n-1)/2$ further restrictions needed for full identification. There are identifications that can be obtained using four general approaches, namely: (i) long-run restrictions through equation (1); (ii) restrictions on the contemporaneous relations of variables through B_0; (iii) restrictions on the contemporaneous effects of shocks through A_0; (iv) some combination of these three identification schemes

Empirical results

Figure B 4.4 shows impulse responses of real GDP, inflation, interest rates and credit to the financial conditions index shock. The figure shows that real GDP, inflation, interest rates and credit responds negatively to financial shocks. The only results that are similar to the main results is the negative response of interest rates. This indicates that from 2000 to 2016, the interest rate environment has been low.

Figure B 4.4 represents a single regime impulse response of real GDP, Inflation, interest rates and credit to financial shocks (FCI).

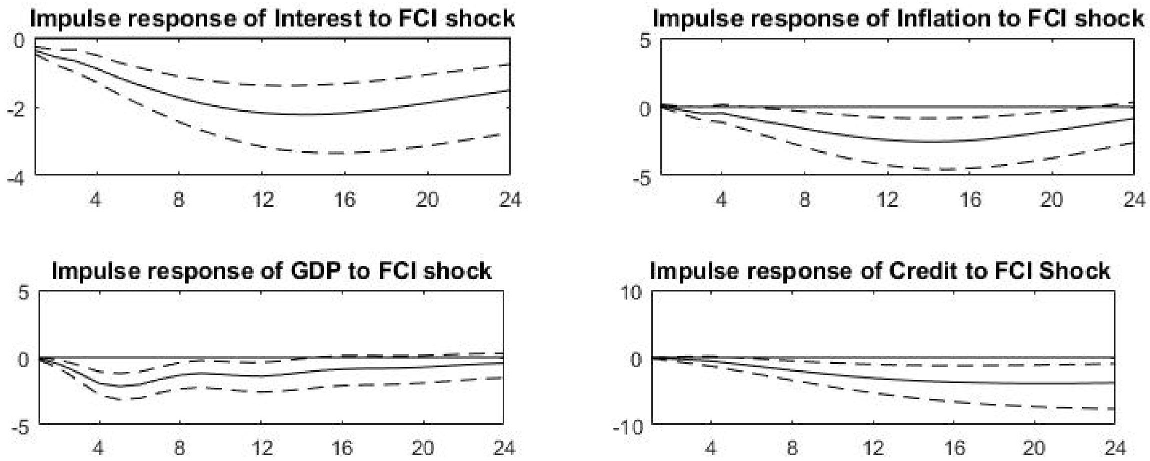
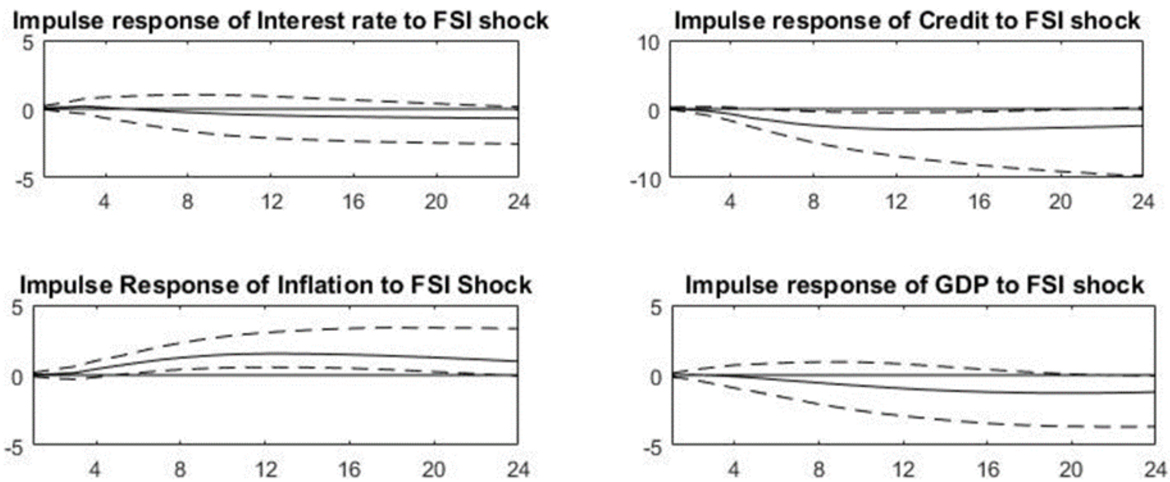


Figure B 4.5 shows the impulse response of real GDP, Inflation, interest rates, and credit to a financial stress index shock (FSI). The figure shows that credit responds negatively while inflation responds positively to a financial stress index shock.

Figure B 4.5 Impulse response of real GDP, Inflation, interest rates and credit to financial stress index shocks.



These findings indicate that the effects of financial stress index (FSI) shocks (as an alternative measure of financial stability) are different from the FCI's effects. Monetary policy variables have a symmetric response to FCI and an asymmetric response to FSI. The asymmetric response implies that monetary authorities take no action when financial stress is normal (see Kasai and Naraidoo, 2012; Thompson et al. 2015). Therefore, the SARB reacts aggressively during high financial stress periods, and almost does nothing during normal financial stress periods.

A reduction in output growth tends to follow the FSI shock. It occurs in tandem with decreasing interest rates to protect the real economy from the negative spillovers of high financial stress. These results are similar to Kasai and Naraidoo (2012), who report that asymmetry is present in the SARB's reaction function concerning the financial system and the real economy. Therefore, this study's empirical findings support the argument that the SARB responds to financial instability asymmetrically and reacts more aggressively when financial stress is high. In other words, the financial system appears to be more critical to the SARB during high financial stress periods, while their significance decreases considerably when financial stress is tranquil.

The FCI considers the accumulation of financial instability; thus, the policy decisions during times of financial instability are different compared to the FSI, which does not account for the accumulation of financial instability. The symmetric response of monetary policy to high financial stress shocks (FCI) allows the SARB to account for the accumulation of financial instability that might be a threat to the real economy during normal financial stress regimes. In inflation targeting countries, monetary authorities respond more symmetrically to financial instability, which is contrary to the perception that in an inflation targeting regime, the monetary policy directly responds to the build-up of financial imbalances (see Bulir and Cihak, 2008; Baxa et al. 2013). These findings corroborate Fouejiu (2013), who compared emerging markets inflation targeting and non-inflation targeting Taylor rules. Inflation targeting emerging markets respond symmetrically to financial instability.

Appendix C Data Description

Output ($Y_{j,t}$): Real gross domestic product (GDP) per capita, seasonally adjusted at annual rate, quarterly.

CPI inflation (π_c): Inflation is measured by a CPI defined as the change in the prices of a basket of goods and services for a group of households.

Consumption (X_t^b): the amount of consumption expenditure by households as percent of GDP.

Employment (n): is the ratio of the employed to the working-age population from age 15-64.

Interest rate (ρ_τ): Overnight interbank cash rate as a proxy of the interest rate. The data is provided in monthly form, we then transform it to quarterly data.

House price(π_D):The middle-segment nominal house price index is presented at a monthly frequency and is changed to quarterly based on a three-month average.

Housing investment (I_t^b): This indicator is measured as a percentage of total gross fixed capital formation. The data is available at annual frequency we then transform it to quarterly.

Appendix D.1 Log-linearised model

Percent deviation from the steady state variables are presented with a hat while those that do not have a time subscript are steady states.

Impatient households

$$\hat{x}_t^b = (1-\gamma)\hat{c}_t^b + \gamma\hat{d}_t^b + \Gamma_{x^b}\hat{g}_t \quad \text{(C.1)}$$

$$\hat{x}_t^s = (1-\gamma)\hat{c}_t^s + \gamma\hat{d}_t^s + \Gamma_{x^s}\hat{g}_t \quad \text{(C.2)}$$

$$\hat{\lambda}_t^b = -\sigma\hat{x}_t^b - \gamma(\hat{c}_t^b + \hat{d}_t^b) + \Gamma_{x^b}\hat{g}_t \quad \text{(C.3)}$$

Patient households

$$\hat{\lambda}_t^s = -\sigma\hat{x}_t^s - \gamma(\hat{c}_t^s + \hat{d}_t^s) + \Gamma_{x^s}\hat{g}_t \quad \text{(C.4)}$$

$$\hat{\lambda}_t^{s^*} = [-\sigma + \gamma(\sigma-1)]\hat{c}_t^* \quad \text{(C.5)}$$

$$\hat{\lambda}_t^s = \hat{\lambda}_t^{s^*} - (1-\alpha)\hat{s}_t \quad \text{(C.6)}$$

$$m\hat{r}s_t^s = -\hat{\lambda}_t^s + \varphi\hat{n}_t^s \quad \text{(C.7)}$$

$$m\hat{r}s_t^b = -\hat{\lambda}_t^b + \varphi\hat{n}_t^b \quad \text{(C.8)}$$

$$\hat{\omega}_t = m\hat{r}s_t^s \quad \text{(C.9)}$$

$$\hat{\lambda}_t^b = \hat{\lambda}_{t+1}^b + \hat{R}_t - \hat{\pi}_{C,t+1} + \frac{\psi}{\beta_b}(\hat{\psi}_t + \hat{R}_t) \quad \text{(C.10)}$$

$$(1+\tau)\hat{q}_t = \beta_b(1-\delta)(1+\tau)\left(\hat{\lambda}_{t+1}^b - \hat{\lambda}_t^b + \hat{q}_{t+1}\right) + \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{\hat{C}^b}{D^b}\frac{1}{Q}\right)\left(\hat{\hat{c}}_t^b - \hat{d}_t^b\right) + \psi(1-x)(1-\delta)\left(\hat{k}_t + \hat{\psi}_t + \hat{\pi}_{C,t+1} + \hat{q}_{t+1}\right) + \Gamma_{D^b}\hat{g}_t \quad \text{(C.11)}$$

$$\hat{R}_t + \hat{b}_t^b = \hat{q}_{t+1} + \hat{d}_t^b + \hat{\pi}_{C,t+1} \quad \text{(C.12)}$$

Tradable goods

$$\frac{C^b}{D^b}\hat{c}_t^b + Q\left(\delta\hat{q}_t + \hat{d}_t^b - (1-\delta)\hat{d}_{t-1}^b\right) + \frac{1}{\beta}\frac{B^b}{D^b}\left(\hat{R}_{t-1} + \hat{b}_{t-1}^b - \hat{\pi}_{C,t}\right) = \frac{B^b}{D^b}\hat{b}_t^b + \frac{1}{\mu}\frac{N^b}{D^b}[(1+\varphi)\hat{n}_t^b - \hat{\lambda}_t^b \quad \text{(C.13)}$$

$$\hat{\lambda}_t^s = \hat{\lambda}_{t+1}^s + \hat{R}_t - \hat{\pi}_{C,t+1} \quad \text{(C.14)}$$

$$(1+\tau)\hat{q}_t = \beta(1-\delta)(1+\tau)\left(\hat{\lambda}_{t+1}^s - \hat{\lambda}_t^s + \hat{q}_{t+1}\right) + \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{\hat{C}^s}{D^s}\frac{1}{Q}\right)\left(\hat{\hat{c}}_t^s - \hat{d}_t^s\right) + \Gamma_{D^s}\hat{g}_t$$

(C.15)

$$(1+\beta_{lC})\hat{\pi}_{C,H,t} = \beta\hat{\pi}_{C,H,t+1} + l_C\hat{\pi}_{C,H,t-1} + k_C\widehat{mc}_{C,t} + \hat{\mu}_{C,t} \quad \text{(C.16)}$$

$$(1+\beta_{lD})\hat{\pi}_{D,t} = \beta\hat{\pi}_{D,t+1} + l_D\hat{\pi}_{D,t-1} + k_D\widehat{mc}_{D,t} + \hat{\mu}_{D,t}$$

(C.17)

$$\hat{\pi}_{C,t} = \hat{\pi}_{C,H,t} + \alpha(\hat{s}_t - \hat{s}_{t-1}) \quad \text{(C.18)}$$

$$\hat{y}_{C,t} = a_{C,t} + \hat{n}_{C,t} \quad \text{(C.19)}$$

$$\hat{y}_{D,t} = a_{D,t} + \hat{n}_{D,t} \quad \text{(C.20)}$$

$$\widehat{mc}_{C,t} = \widehat{\omega}_t + \alpha\hat{s}_t - a_{C,t} \quad \text{(C.21)}$$

$$\widehat{mc}_{D,t} = \widehat{\omega}_t + \hat{q}_t - a_{D,t}$$

(C.22)

$$\hat{q}_t = \hat{\pi}_{D,t} - \hat{\pi}_{C,t} + \hat{q}_{t-1}$$

(C.23)

$$\hat{y}_t = \frac{C}{Y}\left(\hat{y}_{C,t} - \alpha\hat{s}_t\right) + \frac{Q\delta D}{Y}(\hat{y}_{D,t} - \hat{q}_t)$$

(C.24)

$$\hat{y}_{C,t} = (1-\alpha)\hat{c}_t + \alpha\hat{c}_t^* + \alpha[\varsigma + \eta(1-\alpha)]\hat{s}_t$$

(C.25)

$$\hat{y}_{D,t} = \hat{\imath}_{D,t} \quad \text{(C.26)}$$

$$\delta\hat{\imath}_{D,t} = \hat{d}_t - (1-\delta)\hat{d}_{t-1} \quad \text{(C.27)}$$

$$\hat{c}_t = \omega\frac{C^b}{C}\hat{c}_t^b + (1-\omega)\frac{C^s}{C}\hat{c}_t^s \quad \text{(C.28)}$$

$$\hat{d}_t = \omega\frac{D^b}{D}\hat{c}_t^b + (1-\omega)\frac{D^s}{D}\hat{d}_t^s \quad \text{(C.29)}$$

$$\hat{\hat{c}}_t^b = \frac{1}{1-h}(\hat{c}_t^b - h\hat{c}_{t-1}^b)$$

(C.30)

$$\hat{\hat{c}}_t^s = \frac{1}{1-h}(\hat{c}_t^s - h\hat{c}_{t-1}^s)$$

(C.31)

$$\hat{n}_t = \frac{N_C}{N}\hat{n}_C + \frac{N_D}{N}\hat{n}_D \quad \text{(C.32)}$$

$$\hat{n}_t = \omega\frac{N^b}{N}\hat{n}^b + (1-\omega)\frac{N^s}{N}\hat{n}^s$$

(C.33)

$$m\hat{r}s_t^b = m\hat{r}s_t^s \quad \text{(C.34)}$$

Monetary policy and exogenous process

$$\widehat{R}_t = \rho_r \widehat{R}_{t-1} + (1-\rho_r)\left[\Phi_\pi \widehat{\pi}_{C,t} + \Phi_y(\widehat{y}_t - \widehat{y}_{t-1})\right] + e_{m,t} \tag{C.35}$$

$$\hat{r}_t = \widehat{R}_t - \widehat{\pi}_{C,t+1} \tag{C.36}$$

$$a_{C,t} = \rho_{ac} a_{C,t-1} + e_{ac,t} \tag{C.37}$$

$$a_{D,t} = \rho_{ad} a_{D,t-1} + e_{ad,t} \tag{C.38}$$

$$\hat{c}_t^* = \rho_{c^*} \hat{c}_{t-1}^* + e_{c^*,t} \tag{C.39}$$

$$\hat{\mu}_{C,t} = \rho_{\mu c} \hat{\mu}_{C,t-1} + e_{\mu c,t} \tag{C.40}$$

$$\hat{\mu}_{D,t} = \rho_{\mu D} \hat{\mu}_{D,t-1} + e_{\mu D,t} \tag{C.41}$$

$$g_t = \rho_\gamma g_{t-1} + e_{g,t} \tag{C.42}$$

$$\Gamma_{\lambda^b} = \frac{\gamma}{1-\gamma}\left[(\gamma-1)log\left(\frac{\tilde{C}^b}{D^b}\right) - 1\right] \tag{C.43}$$

$$\Gamma_{\lambda^s} = \frac{\gamma}{1-\gamma}\left[(\gamma-1)log\left(\frac{\tilde{C}^s}{D^s}\right) - 1\right] \tag{C.44}$$

$$\Gamma_{x^b} = -\gamma log\left(\frac{\tilde{C}^b}{D^b}\right) \tag{C.45}$$

$$\Gamma_{D^b} = \frac{\gamma}{(1-\gamma)^2}\frac{\tilde{C}^b}{D^b}\frac{1}{Q} \tag{C.46}$$

$$\Gamma_{D^s} = \frac{\gamma}{(1-\gamma)^2}\frac{\tilde{C}^s}{D^s}\frac{1}{Q} \tag{C.47}$$

Appendix D.2 Robustness check

Figure 5.10a: Impulse response of a one percent rise in the LTV ratio

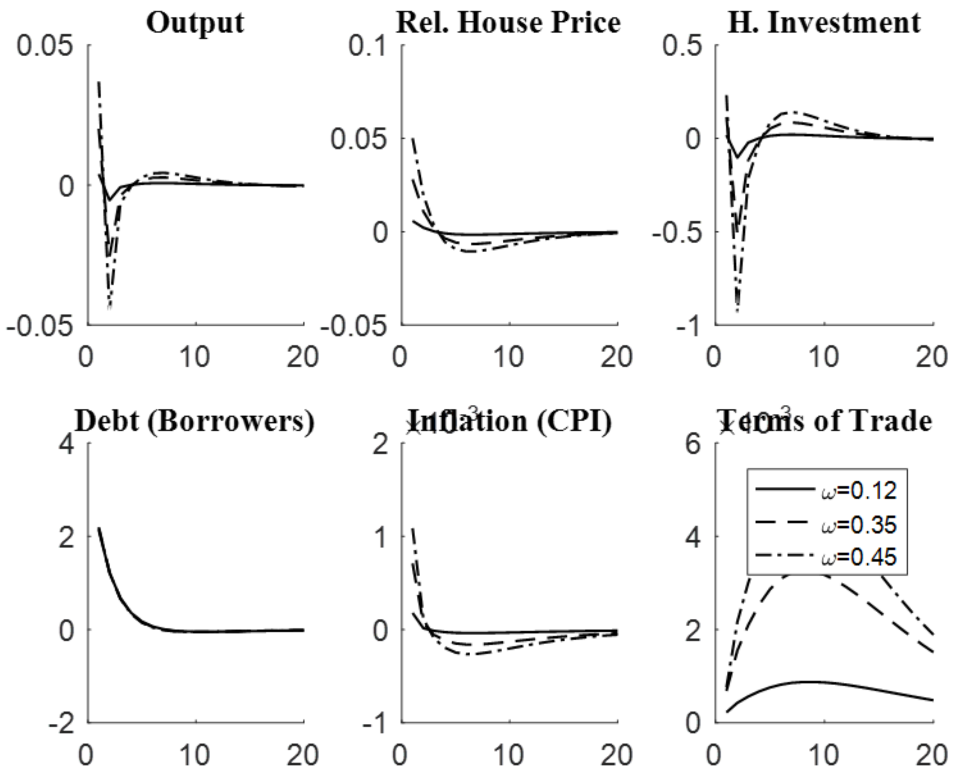


Figure 5.10b: Impulse responses of a one percent point rise in the stamp duty rate

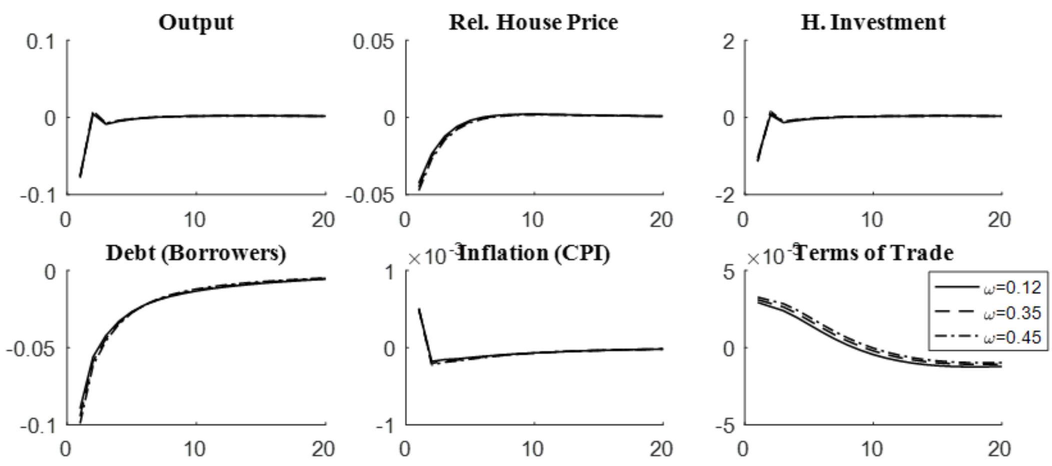


Figure 5.10c: Tight interest rate shocks under macroprudential regimes (different values of ω and x)

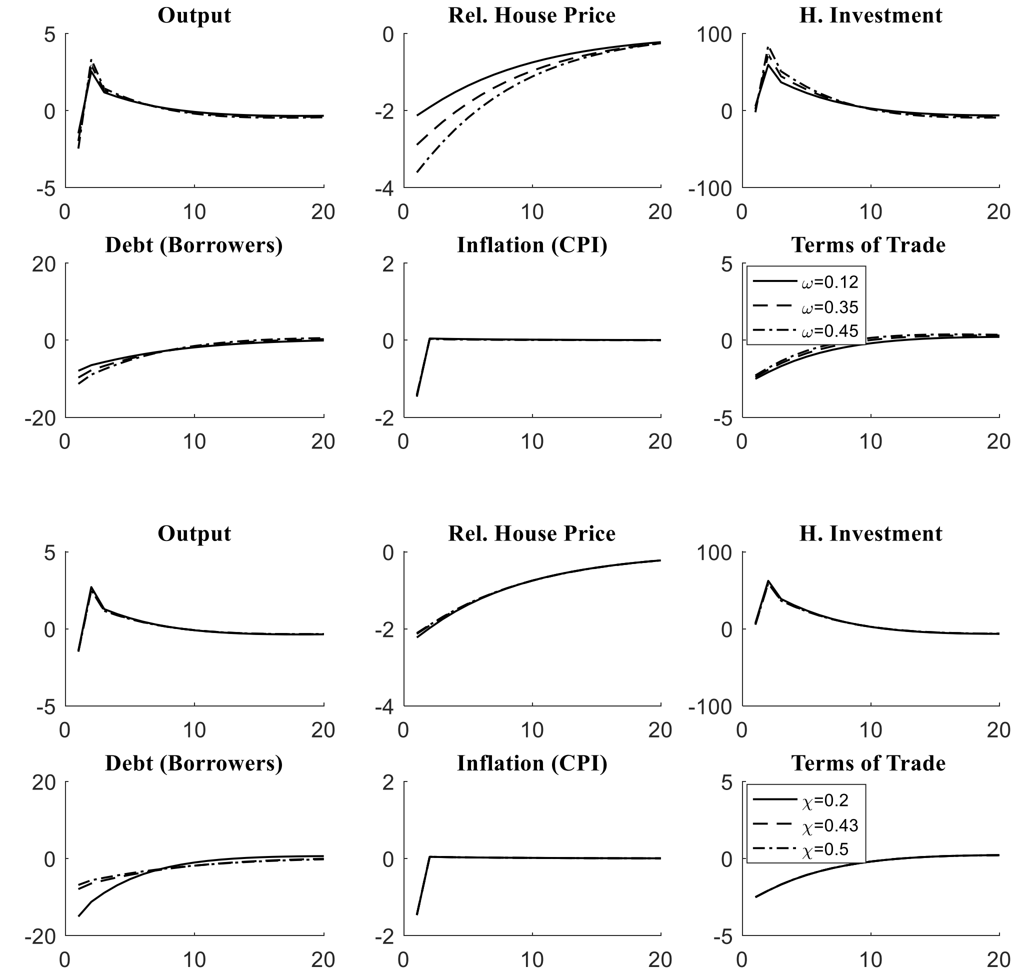


Figure 5.11a: Impulse response of a one percent rise in the LTV ratio

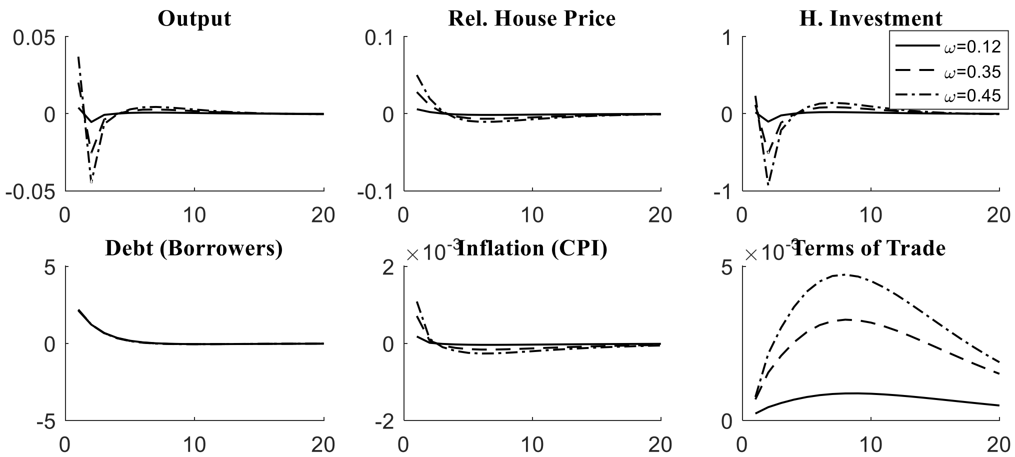


Figure 5.11b: Impulse responses of a one percent point rise in the stamp duty rate

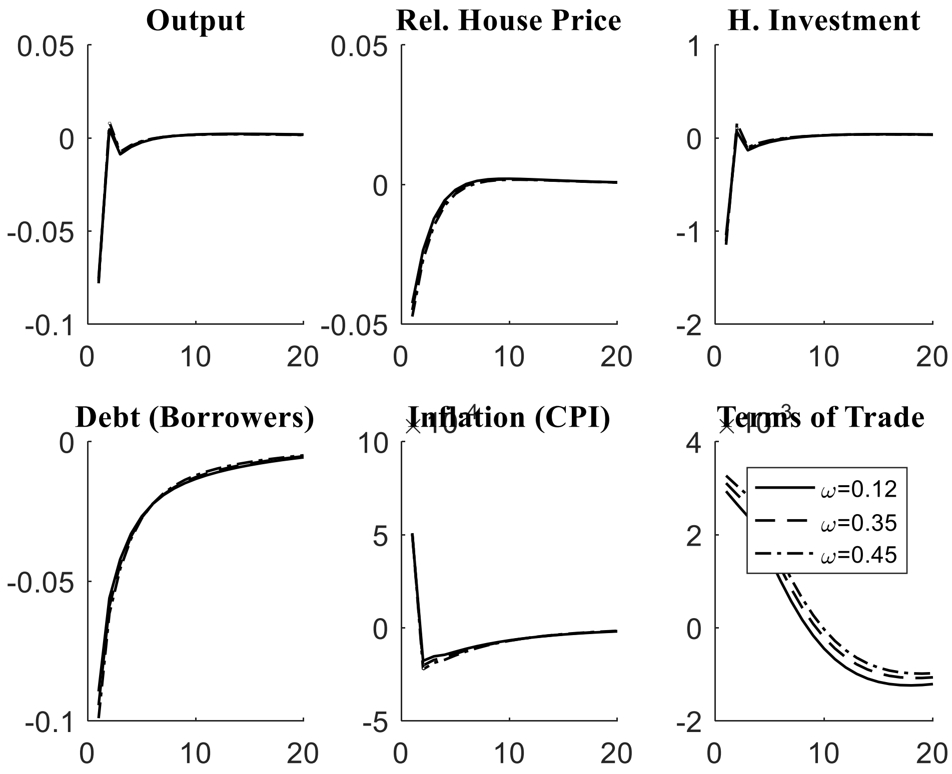
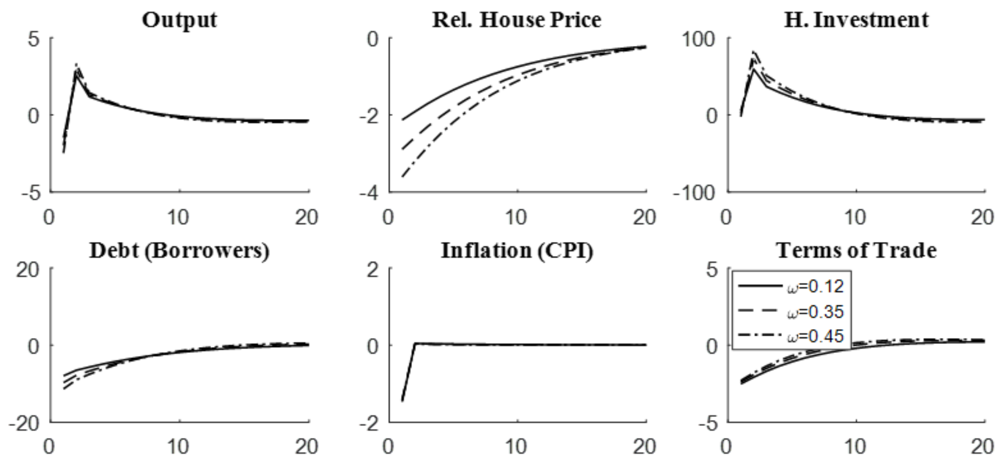
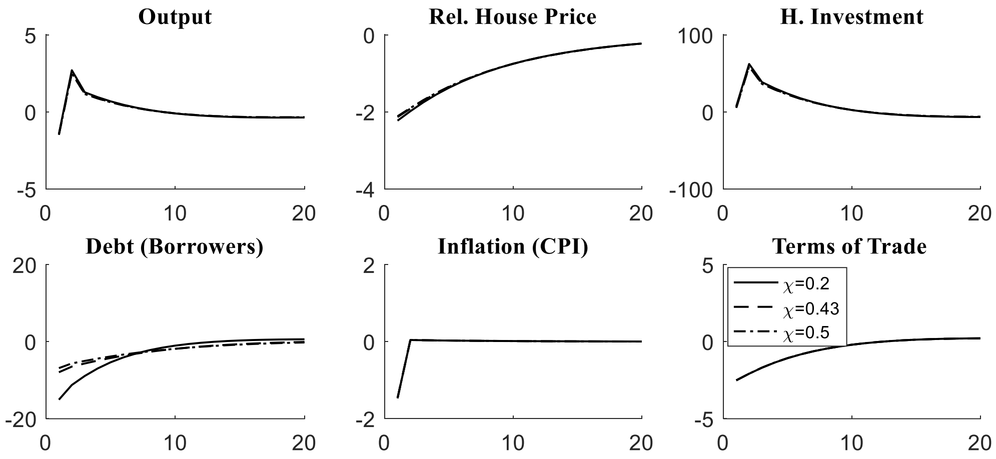


Figure 5.11c: Tight interest rate shocks under macroprudential regimes (different values of ω and x)




Output
Rel. House Price
H. Investment
Debt (Borrowers)
Inflation (CPI)
Terms of Trade
χ=0.2
χ=0.43
χ=0.5

Appendix E Loan rate equation

The simplified loan rate equation in steady-state

The loan rate equation in steady-state has the following assumptions: (i) an idiosyncratic intermediate goods firm risk distribution $U(0{,}2)$; (ii) a constant labour unit labour cost W/A, set equal to unity for convenience. From these assumptions, firms default if $\chi^{\varepsilon^F} < R^L$, where χ represents the likelihood of recouping collateral in the default regime. The highest lower band for the idiosyncratic shock at solvent firms is $\varepsilon^{F,M}$. given that the threshold relies on the loan rate, the probability of default is $\phi = Pr(\varepsilon^F < \varepsilon^{F,M}) = \frac{\varepsilon^{F,M}}{2} = \frac{1}{2} = \frac{R^L}{\chi}$. It should be noted that with constant unit labour cost, $mc = R^L = (pm)^{-1}$, where pm is the price mark-up. Therefore, the probability of default in steady state can be presented as $\phi = \frac{(pm)^{-1}}{\chi}$, which relies only on the structural parameter of the model. The conditions above are applicable in the steady-state loan rate equation derived from 15 yields,

$$R^L = v\{R^D + \Delta(R^V + c - R^D)\} \tag{D.1}$$

Under the above assumptions, the constant risk premium represents $v \equiv \left[1 - \frac{(pm)^{-1}}{\chi}\right]^{-1} > 1$. Adopting thr above assumptions equaions (4) and (18) are rewritten in their steady state,

$$R^V = \frac{R_t^D}{(1-\xi^V)}, \tag{D.2}$$

$$\xi^V = \frac{1}{2}(1-\chi)\frac{1}{\Delta}\frac{(pm)^{-2}}{\chi} \tag{D.3}$$

A1 is divided by R^D and yields,

$$\frac{R^L}{R^D} = v\left\{1 + \Delta\left[\frac{R^V}{R^D} - 1\right] + \frac{c}{R^D}\Delta\right\} \quad \text{(D.4)}$$

Substituting (A.2) and (A.3) in (A.4) results in,

$$\frac{R^L}{R^D} = v\left\{1 + \Delta\left(\frac{1}{1-(1-\chi)\frac{1}{2\Delta}\frac{(pm)^{-2}}{\chi}} - 1\right) + \frac{c}{R^D}\Delta\right\} \quad \text{(D.5)}$$

The following partial effects are immediate:

The loan rate increases due to higher deposit rate (R^D).

The loan rate increase s due to higher cost of issuing bank capital c.

The loan rate increases due to lower recovery rate (χ).

An increased capital ratio (Δ) has an ambiguous effect on the cost of borrowing: as c is very low, then the loan rate is declining in the capital ratio: for ‘large enough’ c it it increasing.

Appendix F Log-linearized system

The Euler Equation (with $\hat{Y}_t = \hat{C}_t$)

$$\hat{Y}_t = E_t \hat{Y}_{t+1} - \varsigma\left[\widehat{\iota_t^D} - E_t \widehat{\pi_{t+1}^P}\right] \tag{F.1}$$

Marginal Costs

$$\widehat{mc}_t = \widehat{\iota_t^L} + \widehat{W_t^R} - \hat{Z}_t \tag{F.2}$$

Employment Demand

$$\widehat{N_t} = -\lambda_\omega\left[\widehat{W_t^R} - \widehat{\iota_t^L}\right] + \hat{Y}_t + (\lambda_\omega - 1)\hat{Z}_t \tag{F.3}$$

Marginal Rate of Substitution (with $\hat{Y}_t = \hat{C}_t$),

$$\widehat{MRS}_t = \frac{1}{\varsigma}\hat{Y}_t + \gamma\widehat{N_t} \tag{F.4}$$

Total productivity shock,

$$\hat{Z}_t = \widehat{A_t} + \widehat{\varepsilon_t^F} \tag{F.5}$$

Probability of Default,

$$\hat{\phi}_t = \left(\frac{\varepsilon^{F.M}}{\varepsilon^{F.M} - \underline{\varepsilon}}\right)\left(\widehat{\iota_t^L} + \widehat{W_t^R} - \widehat{A_t} - \hat{\chi}_t\right) \tag{F.6}$$

Wage inflation

$$\widehat{\pi_t^W} = \beta E_t \widehat{\pi_{t+1}^W} + \frac{(1-\omega_\omega)(1-\beta\omega_\omega)}{(\omega_\omega)(1+\gamma\lambda_\omega)}\left[\widehat{MRS}_t - \widehat{W_t^R}\right] \tag{F.7}$$

Real wages,

$$\widehat{W_t^R} = \widehat{W_{t-1}^R} + \widehat{\pi_t^W} - \widehat{\pi_t^P} \tag{F.8}$$

Loans,

$$\widehat{L_t} = \widehat{W_t^R} + \widehat{N_t} \tag{F.9}$$

Lending Rate,

$$\widehat{\iota_t^L} = \frac{1}{(1+i^L)}\Big\{\rho(1+i^V)\widehat{\iota_t^V} + (1-\rho)(1+i^D)\widehat{\iota_t^D} + \rho(i^V + c - i^D)\big[\widehat{\vartheta_t} + \widehat{\rho}_t\big] +$$

$$\chi A \frac{\phi^2}{W^R}\frac{(\bar{\varepsilon}-\underline{\varepsilon})}{2}\big[2\widehat{\phi}_t - \widehat{W_t^R} + \widehat{A_t} + \widehat{\chi_t}\big]\Big\} \qquad \text{(F.10)}$$

Bank capital Rate,

$$\widehat{\iota_t^V} = \widehat{\iota_t^D} + \frac{\xi^V}{(1-\xi^V)}\widehat{\xi_t^V} \qquad \text{(F.11)}$$

Bank capital premium rate (Aggregate Bank Losses)

$$\widehat{\xi_t^V} = -\frac{\chi}{(1-\chi)}\widehat{\chi_t} + \widehat{L_t} - \widehat{V_t} + \widehat{\chi_t} + \widehat{A_t} - \widehat{W_t^R} + \widehat{\phi_t} + \left(\frac{\varepsilon^{F.M}}{\varepsilon^{F.M} - \underline{\varepsilon}}\right)\widehat{\varepsilon_t^{F,M}} \qquad \text{(F.12)}$$

Regulatory bank capital,

$$\widehat{V_t} = \widehat{\rho_t} + \widehat{\vartheta_t} + \widehat{L_t} \qquad \text{(F.13)}$$

With,

$$\widehat{\vartheta_t} = q\widehat{\phi_t}$$

$$\widehat{\rho_t} = \theta^C(\widehat{L_t} - \widehat{Y_t})$$

Taylor Rule,

$$\widehat{\iota_t^R} = \phi\widehat{\iota_{t-1}^R} + (1-\phi)\left[\phi_Y\widehat{Y}_t + \phi_\pi\widehat{\pi_t^P} + \phi_{\frac{L}{Y}}\big(\widehat{L_t} - \widehat{Y_t}\big)\right] + \epsilon_t^{mp} \qquad \text{(F.14)}$$

The New Keynesian Phillips Curve (NKPC)

$$\widehat{\pi_t^P} = \beta E_t\widehat{\pi_{t+1}^P} + \frac{(1-\omega_p)(1-\omega_p\beta)}{\omega_p}\widehat{mc}_t \qquad \text{(F.15)}$$

Output Gap,

$$\widehat{Y_t^G} = \widehat{Y}_t - \widehat{Y_t^E} \qquad \text{(F.16)}$$

Where $\widehat{Y_t^E} = \frac{(1+\gamma)}{\left(\frac{1}{\varsigma}+\gamma\right)}\widehat{Z}_t$

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Letter Confirming editing

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1 January 2021

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