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The impact of a higher leverage ratio on the South African economy

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Abstract: We employ a micro-founded and stock-and-flow-consistent model to study the impact of a higher leverage ratio on the South African economy. The model provides a rich representation of institutional balance sheets. The relationship between bank capital, risk-taking behaviour, lending spreads, and economic activity is highlighted. The financial accelerator mechanism operates through the balance sheets of all economic institutions. The introduction of a higher leverage ratio is likely to generate negative economic impacts in the short run. The negative gross domestic product effect is greatest if the financial sector reduces leverage by reducing the value of assets. The regulatory shock leads the sector to change its perception of risk, reducing the size of the money multiplier and increasing lending spreads. Higher regulatory requirements also affect the transmission of monetary policy. Effective monetary policy requires understanding how the financial sector is likely to meet new requirements and change its perceptions of risk.

Keywords: computable general equilibrium, financial dynamics, leverage ratio, macroprudential, stock-and-flow consistent, South Africa

JEL classification: D53, D58, E44, E47, G18

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1 Introduction

We analyse how changes in banks' required leverage ratio affect the economy through their impact on the financial sector. The emphasis is on understanding the interaction between real and financial variables. In particular, we are interested in the impact on lending spreads, equity prices, the demand for assets and liabilities, and how the combination of these effects affect the real economy. The stock-and-flow consistency of our framework allows us to study how the financial sector affects the real economy, but also how in second-round effects the developments in the real economy may affect the financial sector. This mechanism has important implications for monetary policy decisions, and we highlight these. The emphasis is on the short run, and thus our aim is not to evaluate whether higher levels of leverage requirements reduce the risk of crisis and default in the long run.¹

The leverage ratio is equal to tier one capital over a measure of exposure. In this paper we use capital ratio to refer to the leverage ratio rather than the risk-adjusted capital ratio. The exposure measure generally consists of on-balance sheet exposures, derivative exposures, securities financing transaction exposures, and off-balance sheet items.

Our analysis is based on the South African economy with its well-developed financial sector. The 2018 Global Competitiveness Report ranks South Africa 18th in terms of its level of financial sector development (World Economic Forum 2018). The South African rand is the 20th most traded currency globally, and the country has one of the highest market capitalization to gross domestic product (GDP) ratios (Bank for International Settlements n.d.). South Africa's deep and liquid financial markets facilitate funding for private and public institutions and support economic development. This indicates that analysis of macroeconomic shocks in the South African context needs to consider financial sector behaviour.

South Africa is currently in the process of implementing Basel III, which started in 2013. The regulatory model will follow the 'twin peaks' approach by setting up a prudential authority and a financial sector conduct authority, both to be housed at the South African Reserve Bank (SARB). In terms of progress, the International Monetary Fund and the Basel Committee on Banking Supervision find that South Africa is compliant with the recommendations for effective banking supervision and the adoption of key Basel III ratios. The phasing-in of the regulation will be completed in 2019. The regulatory framework, which is assessed to be in line with best practice, highlights again the high level of financial sector development in South Africa.

Our results indicate that the transmission of the shock and its impact will depend on how the banks choose to achieve the higher leverage ratio requirements. Initially, we model the impact of an adjustment through a reduction of the banks' asset value, which takes place through all financial instruments. In a second simulation, this is accompanied by higher levels of retained earnings. The results from the first set of simulations are compared with the impact of an alternative adjustment mechanism which assumes that the banks can raise equity capital either at no cost or at a high cost.

¹ Our interest is in the short-run transition to higher capital requirements. FSB (2010) provides estimates of the long-run net benefits. They find that the net benefit of the proposed capital requirements in Basel III is around two per cent of gross domestic product (GDP) on average across countries. The main channel is that a well-capitalized banking system will lead to a reduction in the risk and cost of financial crises and macroeconomic volatility. Caggiano and Calice (2011) find similar results for African economies.

If banks can raise equity capital at low or no cost, the negative impacts on economic activity are small. Increasing the level of retained earnings also generates less negative results compared with achieving the ratio entirely by reducing the value of assets. This, however, negatively affects institutions which rely more heavily on dividend income. Shrinking the asset value of the financial sector or raising equity capital, which translates into high lending spreads, generates significant negative results.

We argue that our framework is better suited to capture capital requirements shocks than previous models used for this type of analysis internationally and in South Africa. The presence of more detailed financial behaviour, lending spreads, asset prices, and stock-and-flow consistency allows a better (but not perfect) representation of Borio and Zhu's (2012) risk-taking channel and the links between financial behaviour, economic activity, and lending spreads identified by Woodford (2010).

We proceed with a review of the relevant literature in the next section. This is followed by a short review of South Africa's experiences with the introduction of macroprudential regulation. Section 4 describes the changes to the baseline model. The data used in the calibration of the model is described in section 5. In section 6, we present our results, and we compare them with those generated by South African and international studies. The conclusion follows and highlights the implications of our analysis for policymakers.

2 Literature review

Higher capital tends to increase the probability of survival by raising the incentives for banks to monitor borrowers, attenuating asset-substitution moral hazard, and reducing the appeal of risky products (Acharya et al. 2015; Allen et al. 2011; Holmstrom and Tirole 1997; Mehran and Thakor 2011; Thakor 2012). Empirically, a number of papers provide support for the positive relationship between bank capital and bank performance (Beltratti and Stulz 2012; Berger and Bouwman 2013; Berger et al. 2012; Cole and White 2012; Estrella et al. 2000).² However, they do not assess how the movement to higher capital affects bank behaviour, the economy, and the feedback mechanism to the financial sector.

A critical channel in this mechanism is how the movement to higher credit requirements affects credit extension in the short run. In the theoretical framework developed by Covas and Fujita (2009), which is based on the work of Holmstrom and Tirole (1997), the mechanism works through the dependence of capital good production on bank funding. During a downturn, agency costs increase due to higher moral hazard on behalf of entrepreneurs; this is accompanied by higher equity issuance costs and higher capital requirements for the financial sector, which exacerbate the credit constraint faced by entrepreneurs and generate a new lower steady-state equilibrium.

The effect of a capital requirements shock is not necessarily negative if banks are characterized by different initial leverage ratios. Zhu (2008) develops a model where the capital requirements of banks depend on their risk profile, with riskier banks having larger requirements. The decline in the capital requirements of less risky banks can offset the increase for riskier banks, reducing the

² Barth et al. (2004) find that a higher capital requirement is associated with a decline in the non-performing loans; however, they argue that their results do not support a robust positive relationship between higher capital requirements and bank development or efficiency.

negative impacts on the credit cycle. The presence of capital buffers also reduces the size of any procyclical effects. The capital buffers can increase, however, even for well-capitalized banks, in response to anticipated difficulties with raising equity in the future. This is part of the underlying mechanism in Repullo and Suarez's (2013) model. In their framework, capital buffers increase as a precaution against shocks that may hinder the banks' future lending. The increase is larger if the regulatory regime requires higher capital during recessionary periods and high social costs of bank failure. The model generates significant credit rationing of borrowers under recessionary conditions.

Similarly, Meh and Moran (2010) present a model where negative economic shocks reduce the profitability of the banking sector and its ability to attract funders. Since banks cannot adjust immediately, lending declines. The negative economic outcomes in the model developed by Van den Heuvel (2008) are driven by the decline in liquidity due to capital requirements. Households have a high preference for liquidity, and their welfare declines as banks face a reduced ability to increase liquidity by taking deposits. Besanko and Kanatas (1996) argue that higher capital requirements may have a perverse impact on insiders and increase rather than reduce risk-taking. As the value of banks' portfolio is diluted, they generate less value from the performance of the loan book. This decreases their oversight on loans, and increases risk-taking.

These models, however, do not provide a comprehensive framework to study the impact of higher capital requirements on the economy. They fall short in addressing how capital requirements affect the transmission of other policies, particularly monetary policy, and how they affect the measurement and distribution of risk. They provide no explanation as to how changes to capital requirements affect the balance sheets of various institutions in a general equilibrium framework, and how these balance sheet effects interact and affect economic activity. There is only a limited representation of financial instruments, and thus the frameworks are highly stylized and unable to illustrate distributional impacts through changes in portfolios. More importantly, the theoretical models do not internalize the financial accelerator and risk-taking channel which characterize the operations of the financial sector, or the linkages between bank capital, the level of intermediation, and the lending spread (Bernanke et al. 1999; Borio and Zhu 2012; Woodford 2010).

The model developed by Borio and Zhu (2012) presents a framework which explains how regulatory capital requirements affect the behaviour of the financial sector. In their model, the impact of higher capital requirements affects the financial sector directly, through the capital threshold effect and the capital framework effect.

The capital threshold effect arises because breaching the minimum threshold is costly for a bank. In the face of a possible breach, banks will take defensive action to avoid the high costs. These high costs are driven by restrictive supervisory actions and reputational costs. In turn, this will affect the availability and pricing of funding extended to customers. This can translate into an increase in lending spreads. The effect is particularly strong and can affect the ability of the financial sector to extend credit when increasing the capital base is costlier than alternative funding sources at the margin.³ Even in the absence of an immediate threat of breaching the minimum requirement, the capital threshold effect may be operational. Borio and Zhu (2012) argue that in this case the effect is a cost or a tax which varies with the size of the cushion over the minimum and with its volatility. At the same time, the size of the cushion is a function of the business cycle and idiosyncratic shocks to the bank's balance sheet. In our framework, we assume that the banks

³ Borio and Zhu (2012) provide reasons why increasing the capital base is costlier than alternative funding sources at the margin. These include, for example, that cutting dividends may signal relatively poor performance, or that taxation may favour debt over equity.

always achieve and operate at the minimum requirement. A shift in the leverage ratio triggers the capital threshold effect.

The capital framework effect influences the way banks measure, manage, and price risk, which affects their behaviour. The economic cycle changes the strength of the capital threshold effect as probabilities of default, valuations, and the perception of risk change. In turn, this shifts the position of the banks' capital relative to the regulatory threshold, and affects bank behaviour. This can increase lending, improve net worth of agents across the economy, and support economic activity further, creating a multiplier effect.

The mechanism is affected by the response of monetary authorities as interest rates affect cash flows, net interest rate margins, earnings, and the valuation of assets, which again affect the position of the bank capital relative to the regulatory threshold. Reductions in the policy rate can decrease the returns from certain assets and encourage risk-taking in order to achieve target rates of return. Monetary policy can also affect risk behaviour through communication policies and the central bank reaction function. Through its communication, the central bank can increase transparency, reduce uncertainty, and compress risk premia. The perception that the central bank reaction function is effective in reducing downside risks can increase risk-taking. The impact depends on the composition of balance sheets and the financing constraints faced by agents in the economy. This mechanism also operationalizes the risk-taking channel in the framework, which is defined as the impact of changes in policy rates on either risk perceptions or risk tolerance.⁴

Liquidity and risk-taking are tightly interconnected and can reinforce each other. Lower perceptions of risks and higher risk tolerance weaken external funding and transferability constraints, and hence increase liquidity. At the same time, weaker liquidity constraints can support higher risk-taking.

The financial accelerator mechanism in the framework developed by Borio and Zhu (2012) works through the regulatory regime; the impact of the cycle on probabilities of default, valuations, and the perception of risk; and monetary policy decisions, as explained above. In addition, the mechanism is supported by the mutually reinforcing relationship between risk-taking and liquidity.

Woodford (2010) presents a theoretical framework which links the capital of the intermediaries, the supply of intermediation services, and economic activity. The willingness of financial intermediaries to provide services depends on the lending spread: the margin that they can charge over the interest rate paid to savers.

The lending spread reflects the marginal costs of intermediation. These costs are an increasing function of the volume of lending, as intermediaries have limited capital. Increasing capital is likely to be costly, and increasing leverage is limited by regulatory capital requirements. Raising funds through loans is constrained by the intermediaries' collateral.

Shocks that impair the capital of the intermediary or higher regulatory leverage ratio requirements will increase the equilibrium credit spread and decrease the volume of lending for any given level of economic activity. The framework can generate financial accelerator effects. For example, the initial decline in economic activity is likely to reduce the net worth of financial intermediaries and the volumes of loans for any given credit spread. The secondary effects if caused by changes to the capital of the intermediary are likely to be more persistent than the initial shock. If

⁴ The presence of the risk-taking channel is supported by empirical studies such as Adrian and Shin (2010).

intermediaries are required to sell assets in a systemic manner, this can create a vicious spiral that reduces the capital of intermediaries and the loan supply.

We view the two frameworks as complementary and fundamental to our analysis. Woodford (2010) provides an explicit link between bank capital, level of intermediation, interest rate spreads, and economic activity. Borio and Zhu's (2012) analysis provides more support as to why intermediaries may be facing an upwards-sloping supply curve for intermediation services, and links the risk-taking behaviour of the financial sector—which is a source of financial accelerator effects—to how it measures, manages, and prices risk. This is not merely a function of the balance sheet of the financial sector, but rather of how the financial sector views the distribution of risk across the economy.

Recent macroeconomic assessments of higher capital requirements are related to the introduction of Basel III. The studies do not model risk-weighted assets; hence their results are more applicable to the likely impact of higher leverage ratio requirements on the economy than to the impact of risk-weighted capital requirements. The short-term impacts are generally negative. MAG (2010b) finds small negative impacts in the short run with small variations, which are dependent on the tool used to assess the impacts, the response of monetary policy, and the spillover effects across countries. The impacts are largely driven by higher interest rate margins. The average impact on annual GDP growth is around 0.03 per cent.⁵ Slovik and Cournède (2011) and EU (2011) find similar results. IIF (2011) finds significantly larger impacts,⁶ arguing that the return on equity must be maintained and increased, which will increase the lending spread by significantly more than estimated in the other studies.

Several studies look at the interaction between monetary policy and higher capital requirements in a dynamic stochastic general equilibrium (DSGE) framework, considering the business cycle. The findings indicate that better coordination, particularly during financial shocks, tends to reduce economic costs (Angelini et al. 2011; Angeloni and Faia 2009; Bean et al. 2010).

Burgess et al. (2016) estimate the impacts of higher capital requirements for the United Kingdom (UK) in a stock-and-flow-consistent model. They study the impacts of an increase in the required risk-weighted capital ratio achieved by raising equity capital. The results indicate a small impact. The lending rate increases by 15 basis points, and the level of GDP declines by 10 basis points.

The outcomes in the different studies are highly dependent on the assumptions being made. For example, Zhu (2008) argues that many banks hold capital above the requirements, and thus the impacts should be small. Banks with a higher than required capital ratio may be perceived as better managed and safer, and are likely to see a decline in funding costs (Noss and Toffano 2016). It is also important how the new capital requirement is achieved (Cohen and Scatigna 2016; Zhu 2008). For example, achieving the new ratio by reducing dividends is unlikely to have the same impact on the credit cycle as reducing the loan portfolio. Banks can also issue equity or substitute riskier

⁵ MAG (2010b) finds that bringing the global common equity capital ratio to a level that meets the agreed minimum and the capital conservation buffer will result in a maximum decline of 0.22 per cent of GDP after 35 quarters. The spillover effects across countries are estimated at 0.17 per cent of GDP.

⁶ Their estimate shows that the introduction of the Basel III requirements could total 3.2 per cent of GDP for the developed economies, which implies 7.5 million jobs forgone.

assets with safer ones, and they can also restructure their business models, reducing inefficiencies and compensation costs (Allen et al. 2012; MAG 2010a).⁷

De Marco and Wieladek (2015) identify three conditions that need to be satisfied for higher capital requirements to affect loan supply: the cost of bank equity must exceed the cost of debt; capital requirements must be binding on a bank's choice of capital; and the sources of funding of borrowers must be limited.

Cohen and Scatigna (2016) provide empirical evidence on how banks in advanced and emerging economies have achieved their capital requirements. Looking at data for 2009–12, they find most banks have achieved their capital requirements through an increase in retained earnings rather than a reduction in loans. The impact on lending spreads is small. However, they also find some differences across countries. For some banks in advanced economies, a reduction in risk-weighted assets has helped with the adjustment to higher capital ratios. For European banks, some of this adjustment has taken place through reducing cross-border assets. There is also some evidence that banks with lower capital ratios at the beginning of the period were more likely to see an adjustment through a reduction in asset growth. This supports the argument put forward by Zhu (2008).

Recent empirical studies looking at UK data find that the higher capital requirements have reduced lending domestically as well as cross-border lending (Aiyar et al. 2014; Bridges et al. 2014; Noss and Toffano 2016). The impact of a one percentage point increase in the capital requirement on loan volumes is a reduction in the region of 3.5–8 per cent. This effect is not the same across firms. Firms with multiple bankers or alternative sources of funding, or those that borrow from banks with better capital ratios, are less affected by the higher capital requirements (Bridges et al. 2014; De Marco and Wieladek 2015).

A fundamental problem with the macroeconomic impact studies is their inability to capture the channels identified by Borio and Zhu (2012) and Woodford (2010). Some of the estimates rely on econometric and DSGE models that have no financial sector dynamics. The impact on interest rate spreads is estimated outside the model, and then the system is shocked accordingly. The most advanced tools used to estimate the likely impacts are DSGE models. These models assume rational expectations and dynamics based on a representative agent, implying almost perfect foresight of risk, and thus it is harder to incorporate cross-sectional and intertemporal coordination failures (Borio and Zhu 2012). The models are often linear and thus have no non-linear dynamics and liquidity, which amplify the risk-taking channel. This makes it difficult to operationalize the risk-taking channel.

The criticism of linear dynamics is addressed by introducing either the financial accelerator mechanism as defined by Bernanke et al. (1999) or the household collateral constraint mechanism following the approach by Iacoviello (2005). Borio and Zhu (2012), however, argue that the financial accelerator mechanism is not able to capture the dynamics of risk-taking, as it ignores the time-varying pricing of risk and effective risk tolerance. The financial accelerator mechanism works through the balance sheet of a representative firm, but it ignores how other balance sheets are affected and all balance sheets interact to determine the impact on the economy. The same criticism applies to the model developed by Iacoviello (2005).

The absence of stock-and-flow consistency in DSGE models prevents them from capturing the distribution of risk in the economy, which is important for understanding the risk-taking channel

⁷ Cohen and Scatigna (2016) explain how the different options are operationalized, and the advantages associated with each.

and for capturing the interlinkages between the balance sheets of various agents in the economy. These interlinkages can generate significant multiplier effects as idiosyncratic risks become systemic.

While the stock-and-flow model developed by Burgess et al. (2016) provides a richer representation of the financial sector, it also lacks a financial accelerator mechanism which represents the dynamics identified by Borio and Zhu (2012).

Recent studies looking at the impact of higher capital requirements on the South African economy also lack balance sheet dynamics. Havemann (2014) and Grobler and Smit (2014) modify large macroeconometric models (without microeconomic foundations) to include an interest rate spread which is driven by a number of factors, including the capital adequacy ratio. Their results indicate a small impact on the economy from a one per cent increase in the capital adequacy ratio, primarily driven by the increase in the interest rate spread.

Our analysis aims to build on previous studies by studying the impact of higher leverage ratios in a model which explicitly models balance sheet dynamics of all economic agents in a stock-and-flow-consistent way. We consider the multiplier effects which characterize the financial sector.

3 South Africa and capital requirements

SARB is responsible for the regulation and supervision of banks and mutual banks. Its mandate, outlined by the Banks Act and the Mutual Banks Act, is exercised through the Registrar of Banks and the Bank Supervision Department. The Minister of Finance is responsible for issuing regulations and formally making supervisory actions. The Financial Services Board (FSB) regulates and supervises the non-bank financial services industries, including insurance companies. Fund managers and stock exchanges are jointly supervised by the FSB and the Johannesburg Stock Exchange. The National Credit Regulator, which reports to the Minister of Trade and Industry, has certain regulatory powers over lending activity for consumer protection.⁸

In some cases, South Africa's regulatory regime tends to be stricter than Basel III in terms of speed of implementation and size of the ratios. Basel III recommends that the risk-weighted capital adequacy ratio should be eight per cent, while the South African authorities are implementing a higher ratio of 10.5 per cent.

South Africa is currently phasing in the leverage ratio in line with the recommendations by the Basel Committee on Banking Supervision.⁹ Its introduction aims to restrict the build-up of leverage and to reinforce the risk-based requirements. The current level set by Basel III is three per cent. The ratio may be adjusted further, based on the current evaluation period whereby regulatory authorities are tracking the behaviour of the leverage ratio relative to the risk-based capital requirements.

⁸ IMF (2015) and BCBS (2015a, 2015b) provide a comprehensive review of the regulatory framework and the progress made with the implementation of Basel III.

⁹ BCBS (2014) provides the framework for the calculation and introduction of the leverage ratio.

Table 1: Selected financial soundness indicators (sample of G20 economies)

	Data point	Regulatory capital to risk-weighted assets	Regulatory tier 1 capital to risk-weighted assets	Return on equity	Capital to assets (leverage ratio)
Argentina	2018Q2	14.8	13.3	39.0	11.6
Australia	2018Q2	14.5	12.3	18.5	6.8
Brazil	2018Q2	17.2	13.8	14.7	10.0
China (mainland)	2017A1	13.6	11.3	12.6	8.6
France	2018Q1	18.7	15.2	5.6	6.4
Germany	2018Q2	19.1	16.8	6.3	6.4
India	2018Q2	14.6	13.6	-1.2	7.4
Indonesia	2018Q2	19.9	20.3	16.1	14.6
Italy	2017Q4	16.7	14.3	7.5	6.6
Japan	2018Q1	17.1	14.9	5.4	5.5
Mexico	2018M8	15.9	14.2	20.7	10.7
Russian Federation	2018Q2	12.2	9.0	6.5	10.3
South Africa	2018M6	16.6	15.0	20.1	8.5
Turkey	2018Q2	16.3	13.5	20.0	10.5
United Kingdom	2017Q4	20.5	17.1	7.6	6.8
United States	2018Q2	14.6	13.6	3.7	11.7

Source: Financial Soundness Indicators, International Monetary Fund.

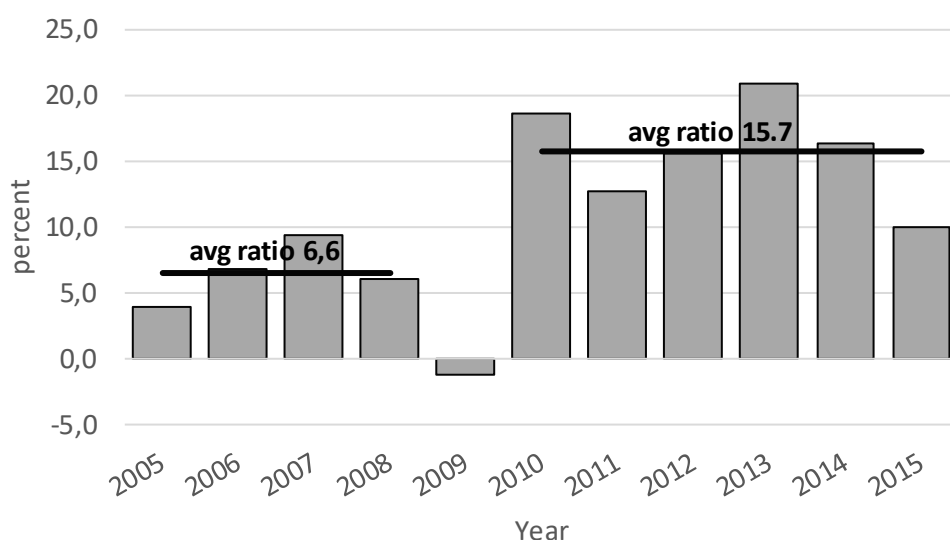
South Africa's capital ratios compare favourably against the benchmarks set by the Basel Committee on Banking Supervision as well as the current ratios of other countries. The tier one risk-weighted measures are higher than in the Bric economies, and higher than some advanced economies such as Australia and the UK (Table 1). It stands out that South Africa has one of the

highest equity returns among the sample of countries, highlighting the strong profitability of the sector.

Despite the relatively high capital ratios, South African banks chose to raise them over the period 2008–16. The regulatory capital to risk-weighted assets ratio increased from 13 per cent in 2008 to 16.6 per cent in 2018. Over the same period, the tier one ratio increased from 11.2 to 15 per cent, and the leverage ratio from 5.7 to 8.5.

If we use the flow of funds data and plot the ratio of net savings of the financial sector to the net incurrence of financial assets, it appears that the adjustment to higher capital ratios has taken place mainly through higher retained earnings (Figure 1). Cohen and Scatigna (2016) also provide empirical evidence that banks in emerging markets, including South Africa, have used retained earnings to achieve higher capital ratios.

Figure 1: Ratio of net savings of the financial sector to the net incurrence of financial assets



Source: authors' illustration based on data from SARB.

4 Model changes

Makrelov et al. (2018) provide a detailed description of the stock-and-flow model employed in this analysis. In this section, we highlight some of the key properties. The model dynamics build on the simple computable general equilibrium model developed by Devarajan and Go (1998), and they incorporate elements of DSGE models and stock-and-flow models in the tradition of Backus et al. (1980) and Godley and Lavoie (2012). The model also incorporates elements of the theoretical models developed by Borio and Zhu (2012) and Woodford (2010).

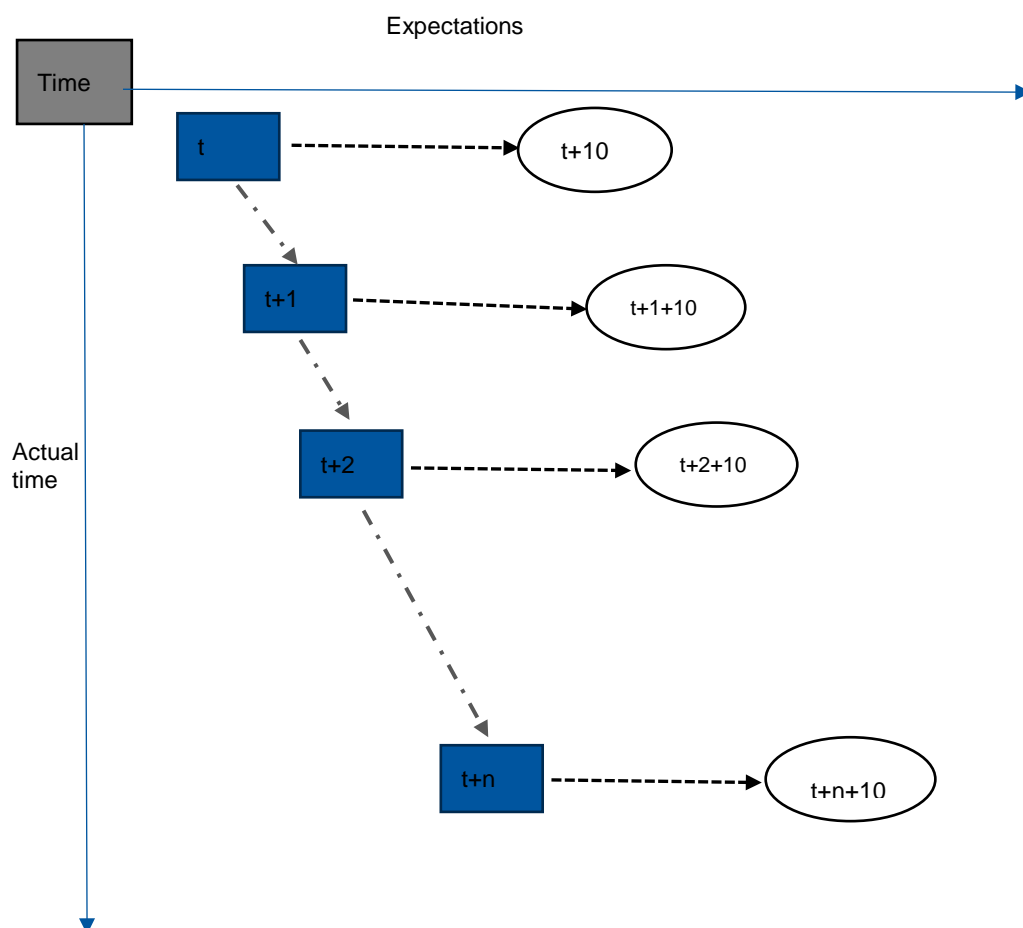
The stock-and-flow consistency of our framework implies that we have several financial instruments, rates of return, and institutional balance sheets. We model equities, bonds, loans, cash, and deposits as financial instruments; their returns; and the balance sheets of the central bank, the household sector, the financial sector, government, the non-financial sector, and the foreign sector. The demand for assets by the financial and foreign sectors is modelled as Tobin asset demand functions (Backus et al. 1980). This is a significantly richer representation than the financial representation of institutions and financial instruments in DSGE models. The stock-and-

flow consistency implies that there are strict budget constraints. Changes to the balance sheet of one institution must be matched by changes to the balance sheets of other institutions.

While our model is similar in terms of its stock-and-flow consistency to models such as those recently developed by Burgess et al. (2016) and Caiani et al. (2014), it is different in terms of the behaviour specification for the different agents. Consumption and production behaviour are micro-founded in agents' intertemporal optimization, allowing us to capture how changes in preferences, technology, and resource constraints affect outcomes. Prices exhibit a degree of stickiness, and there is a monetary policy reaction function based on a Taylor rule. These features make it similar to DSGE models. However, unlike DSGE models, our model is not stochastic.

There are two features of our model that make it different from both the traditional stock-and-flow-consistent models and DSGE model and provide better representation of financial sector dynamics. The first is the theoretical framework our model employs for analysing financial sector behaviour, which is based on Woodford (2010) and Borio and Zhu (2012), with modifications appropriate for application to South Africa. The second is the specification of household expectations.

Figure 2: The household optimization path



Source: authors' illustration.

The household has model-consistent expectations (similar to DSGE models) within each period. It has good understanding of the structure of the economy, and uses the rules in the model to form expectations. However, the ability of the representative household to foresee the future is limited to 10 periods (2.5 years), and the formation of expectations can vary between periods. As

the household solves for each period, new information about the economy becomes available, which is incorporated into the next period's optimization. Our expectation formation resembles the process identified by Roos and Luhan (2013). They find that households have bounded rationality rather than full rationality.¹⁰ A significant number of households use more sophisticated models of the economy, taking additional information into account as it becomes available to form expectations, but they do not have perfect foresight.

Figure 2 provides a diagrammatic representation of the household optimization solution. The boxes represent the optimal path. In principle, the model could run forever; however, we limit the solution to 22 periods.

We introduce the equation:

$$CRR_t = \frac{(sl^{fin,e} + SSAVFIN_t)}{FWCRR_t} \quad [1]$$

where CRR_t is the required leverage ratio, which is exogenously determined. $sl^{fin,e}$ is the equity capital of the financial sector calculated at book value excluding retained earnings. $SSAVFIN_t$ is the value of retained earnings (the stock of savings), and $FWCRR_t$ is the value of assets at book value. The use of book values rather than market values simplifies the model solution. The impact of market value dynamics on the overall results depends on the composition of assets, and consequently on how changes in market prices affect the numerator of the leverage ratio vis-à-vis the denominator. This is an item for further research.

$sl^{fin,e}$ is fixed in the base model. In the present version of the model, it can vary in some of the simulations, illustrating how raising equity capital to achieve the higher leverage ratio may affect the economy.

In the base model, the financial and non-financial sector savings adjust to ensure that total investment is equal to total savings. The model used in this paper assumes that financial sector savings are a function of its after-tax income and interest, dividend, social contributions, and other expenditure. Here the dividends paid by the financial sector are a fixed share of after-tax income calibrated to the average value over the period 2002–12. Changes in this share represent the dividend policy of the financial sector and have a direct impact on retained earnings. The non-financial sector savings are a fixed share of its after-tax income. The foreign sector savings are not fixed as in the base model, but adjust to ensure that the savings-investment balance is maintained. The external balance closure remains an adjustment through the exchange rate.

There are a number of changes that we make to the adjustment mechanism in the loan market. These are required because we assume that the loan liabilities of the financial sector are the adjustment mechanism in response to a contraction in the financial sector balance sheet. The changes are as follows:

- Demand for loans from the financial sector no longer depends on borrowing costs in the economy. The reduction in the value of assets requires an adjustment on the liability side. The adjustment takes place through cash and deposits, with loans (liability) being the balancing item.

¹⁰ Hommes (2011) provides a review of the literature on bounded rationality. The theory of bounded rationality originates in the seminal work of Simon (1955).

- The lending rate does not ensure equilibrium in the lending market. The loan rate is a function of the repo rate and a lending spread which fluctuates with the growth of the financial wealth of the financial sector. Deviations which exceed the steady-state growth rate reduce the spread, whereas growth rates below the steady-state rate increase the lending spread. The steady state is calculated as the average over the period 2002–12.

The supply of loans by the non-financial sector adjusts to ensure equilibrium in the loan market.

5 Data

The construction of the data set and the calibration of the model are outlined in Makrelov et al. (2018). We construct financial macro social accounting matrices for the South African economy over the period 2001–12. Our approach follows the method outlined by Emini and Fofack (2003) and Hubic (2012). Capital and financial blocks are added to the standard social accounting matrix. These reflect the transactions that take place in the financial sector: the incurrence of liabilities and the accumulation of assets by institutions. The changes in liabilities and assets for a particular institution also reflect how the savings-investment balance (capital account) is financed.

The building of balance sheets for institutions relies on flow of funds data from 1970 onwards and the balance sheet information available in SARB’s quarterly bulletins. It is important to note that our institutional balance sheets deal only with financial instruments, as consistent data on ownership of non-financial assets and liabilities is not available. Thus, our balance sheets are partial but consistent when it comes to financial assets and liabilities.

The absence of separate price and quantity effects in the flow of funds data hinders the modelling of prices for financial instruments, particularly the prices of bonds and equities. We model only the equity price, which is based on the Johannesburg Stock Exchange all-share index. The adjustment to the equity stocks follows the same approach as outlined by Aron and Muellbauer (2006). This adjustment leads to equity stock values which are more in line with the balance sheet information from the SARB quarterly bulletins.

Other data on interest rates, growth rates, and price indices used in the calibration of the model is also sourced from SARB’s quarterly bulletins.

A key challenge with our model is that many of the coefficients related to financial behaviour are not available for South Africa. This is a large area for future research. Our strategy here is to utilize coefficients generated by other studies, bearing in mind the limitations of this approach, or to get some sense of the relationship through simple econometric estimates, which are further calibrated in the model to generate a consistent baseline.

6 Results

There are different ways for banks to achieve the higher capital requirements as highlighted in the literature. The simulations aim to illustrate how these different approaches are transmitted in our framework and how they affect the economy.

In the first simulation, we model the impact on the economy by assuming that banks cannot raise more equity and have to reduce the total value of their assets while at the same time cutting the loans (debt) on the liability side. In the second simulation, we illustrate how increasing retained

earnings can reduce the initial negative effects. This, however, also leads to lower household consumption in the short run. The results from the two simulations are compared against two scenarios, which assume that banks can raise equity and thus do not have to shrink their balance sheet. We illustrate the impact if it is costly to raise equity against a scenario where the higher equity issuance does not translate into higher loan spreads.

6.1 Reducing the value of bank assets to achieve the higher capital ratio

The required leverage ratio for South Africa is four per cent, higher than the Basel requirement of three per cent. The shock to the system is assumed to be a 25-basis-points regulatory increase to the required leverage ratio, which is introduced gradually over a period of four quarters. In simulation 1, the loans on the liability side adjust to match the decline in the value of assets. In simulation 2, the loans adjust and the financial sector dividend payments are cut by 10 per cent.

The general response of the financial sector is driven by the capital threshold effect as identified by Borio and Zhu (2012). The financial sector responds to the new requirements because it is costly if it does not. In order to achieve the higher leverage ratio, the financial sector reduces the value of all its assets, except the holding of bonds (Table 2). This effect is driven by the Tobin asset demand function. The relative increase of bond returns to other assets leads to an increase in the financial sector holdings of bonds. This increase is required to ensure that the issued bonds are absorbed by the market.

This mechanism links the bond rate to the contraction in the balance sheet of the financial sector. Higher capital requirements are likely to affect the demand for bonds and reduce the sustainability of fiscal policy in the short run. The increase in the bond rate in Figure 3 (panel 4) far exceeds the increase in the loan rate. Burgess et al. (2016) find that the bond rates decline, but in their simulation the transition is done through increasing the equity capital of the financial sector

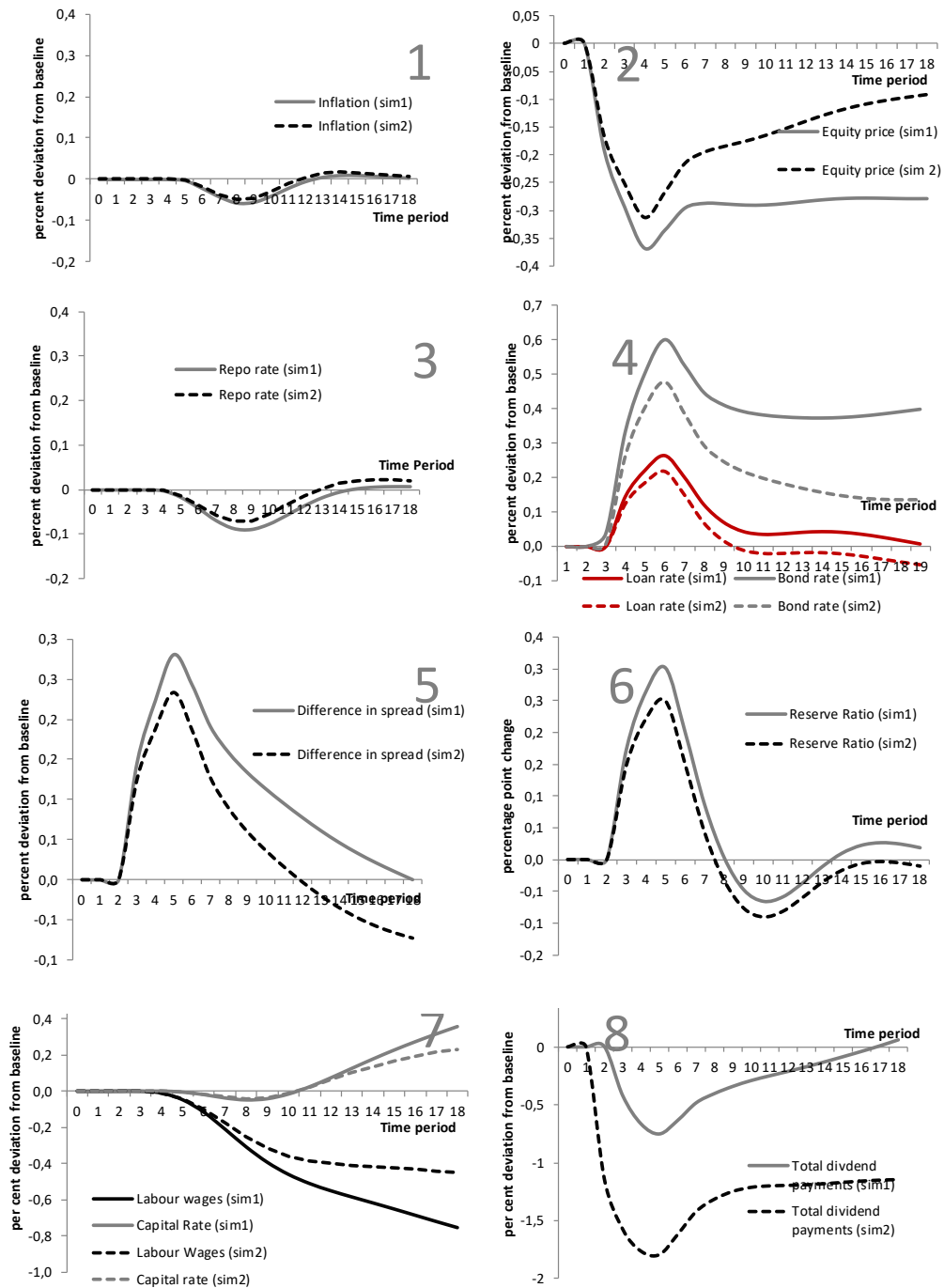
The loans on the asset side decline for two reasons. Firstly, the deposits into the financial system decline across institutions (illustrated in Table 2) due to the slower pace of economic activity. The decline in the cash and deposit assets of the financial sector amplifies this effect.

Table 2: Changes to the holding of financial assets

deviation from baseline	Assets							
	Equities		Bonds		Cash and dep		Loans	
	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
t+10								
Reserve Bank	-0,3	-0,1	-0,1	-0,4	0,0	0,0	0,0	0,0
Financial sector	-1,8	0,0	1,8	2,1	-2,1	-0,1	-1,4	-0,5
Non-financial sector	-0,3	-0,1	0,0	0,0	-0,2	-0,2	-1,3	0,9
Households	-0,9	-0,7	0,0	0,0	-0,4	-0,3	0,0	0,0
Government	-0,3	-0,1	0,0	0,0	-0,3	-0,3	-0,2	-0,2
ROW	-2,8	-2,7	1,3	-0,5	-5,5	-4,0	-2,3	-2,5

Source: authors' model simulations.

Figure 3: Impacts on rates and prices



Source: authors' model simulations.

Secondly, the willingness of the financial sector to hold reserves increases (illustrated in Figure 3), which decreases the money multiplier and the supply of loans. The reduction is driven by the fall in the value of financial assets, which in our framework translates into greater willingness by the financial sector to hold cash reserves. This increase in the willingness to hold reserves reflects higher risk perceptions of the economic environment. The impact on the reserve ratio aims to operationalize the capital framework effect in our model (see Borio and Zhu 2012).

The combination of lower deposits and higher reserves translates into lower levels of intermediation. The bank decreases the growth rate of its assets relative to the baseline. The fall in the value of bank assets translates into a reduction in the supply of loans relative to the baseline and an increase in the lending spread by 0.3 percentage points (Figure 3, panel 5). This mechanism captures the model presented by Woodford (2010). Changes to the financial sector capital and perceptions of risk change the supply of intermediary services, which affects the interest rate spread.

The lower level of intermediation reduces the growth in money supply and affects the equity price. The initial fall is a 0.35 per cent decline compared with the baseline. This affects the balance sheet of all institutions, particularly households.

In Table 3, the fall in the financial assets of the financial sector is matched by a decline in all liabilities except bonds. We assume that the financial sector does not issue bonds. The adjustment item is the loan debt, which declines by 2.6 per cent relative to the baseline. The decline in equities is driven by both prices and quantity effects. The latter reflects a decline in the equity assets of households, which are equity liabilities of the financial sector according to our model specification.

Table 3: Changes to the holding of financial liabilities

deviation from baseline	Liabilities							
	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Reserve Bank	-0,3	-0,1	0,0	0,0	-0,3	-0,3	0,4	0,2
Financial sector	-0,7	-0,5	0,0	0,0	-1,4	-0,4	-2,6	-0,1
Non-financial sector	-3,3	-1,6	0,0	0,0	0,0	0,0	-0,4	-0,1
Households	0,0	0,0	0,0	0,0	0,0	0,0	-0,5	-0,2
Government	-0,3	-0,1	1,5	1,2	0,0	0,0	-0,5	-0,1
ROW	-0,6	-0,4	0,1	0,3	0,1	0,3	-0,4	-0,2

Source: authors' model simulations.

The investment by the non-financial sector, which is the bulk of investment in the economy, declines (Table 4). The decline in investment reflects the higher borrowing costs driven by the increase in the loan rate. For non-financial firms, the fall in investment also reflects the decline in equity prices which feed into the Tobin Q specification. The initial decline is small, but it becomes significant as the equity prices are on a lower growth trajectory. By the 10th period, investment is just over one percentage point lower in the first simulation compared with the baseline.

The non-financial sector experiences a fall in the value of its assets and liabilities. The largest impact is on the equity liabilities. This impact reflects lower demand for equities as an asset across institutions, as well as the lower equity price. The supply of equities by the non-financial sector is residual supply which aims to ensure equilibrium in the equity market.

Table 4: Impacts on real expenditure

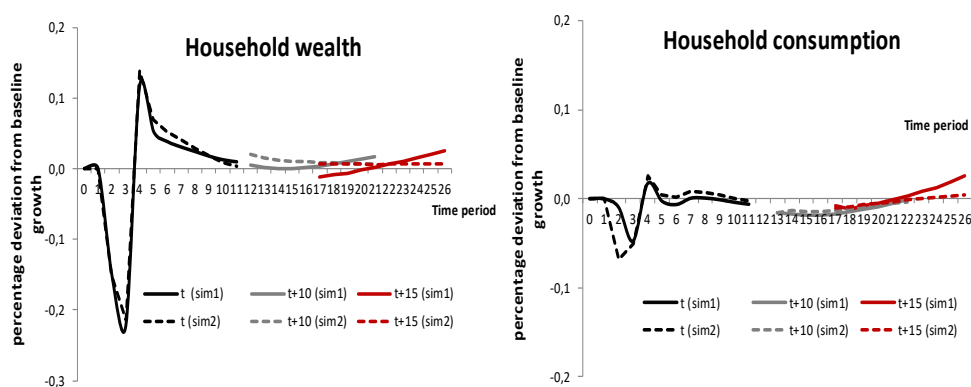
	only loans		loans plus retained earnings	
	t+1	t+10	t+1	t+10
per cent deviation from baseline				
Household expenditure	-0,04	-0,13	-0,11	-0,17
Investment				
Non-financial firms	-0,16	-1,13	-0,67	-0,71
Other-institutions	-0,13	-1,18	-0,11	-0,72
Exports	0,03	-0,07	0,07	0,00
Imports	-0,12	-0,33	-0,21	-0,35
GDP	0,00	-0,12	0,01	-0,07

Source: authors' model simulations.

The household, which has limited ability to foresee the future, experiences a fall in consumption. The result is driven by the fall in equity prices and income, as well as a fall in the flow of loans as a funding source relative to the baseline. The fall in the equity price reduces the value of current assets and makes it more difficult to achieve the target level of wealth.

Figure 4 shows the household optimization behaviour. The graph presents the household optimization behaviour at three points in time: the time the shock takes place (t), 10 periods after the shock ($t+10$), and 15 periods after the shock ($t+15$). It plots the difference in growth rates between the baseline and the two simulations.

Figure 4: Household consumption optimization behaviour



Source: authors' model simulations.

In order to achieve the level of targeted real wealth, household savings need to rise, and consumption must fall. This is reflected in Figure 4. The growth in household wealth falls initially, and then it recovers relative to the baseline. In the right-hand panel, the growth in household consumption follows a similar trend in the first optimization period (the black line). Stronger growth in household wealth is required in the second half of the first optimization period in order to achieve the target level of wealth. This is supported by higher levels of domestic savings and the lower levels of inflation, which make it easier to achieve the target level of real wealth. The

household also has model-consistent expectations that economic conditions will normalize, which allows it to accelerate consumption in the outer years of the first optimization period.

If we look at period $t+10$, the growth in household wealth is close to the baseline, whereas the household consumption growth rate is marginally below the baseline. The household expectation of recovery has not materialized. Consumption growth rates have to be lower in order for the real wealth target to be achieved. While households foresee some improvement in economic conditions in period t , they cannot foresee the subsequent shocks in the next optimization periods $t+1$. It is only by period $t+15$ that baseline and simulation growth rates are equal.

In Table 2, household's stock of equities falls due to the lower equity price and lower income relative to the baseline. On the liability side, the stock of loans declines by 0.5 per cent as lending rates increase and household income falls relative to the baseline.

Government consumption expenditure remains unchanged relative to the baseline, as it is exogenously determined. On the financial side, the government sees a decline in its stock of loans as a source of funding. This reflects lower income and higher real rates. The bond issuance increases in line with the slower pace of tax revenue collection and dividend income. This is a major driver behind the higher bond rates. Given the contraction in the balance sheet of the financial sector, higher supply of bonds requires even higher bond yields. We model exogenously the volume of equities for the government sector, and thus the declines on the asset and liability sides reflect the fall in the equity price relative to the baseline.

In line with the lower income and higher debt levels, the government reduces its extension of loans and demand for cash and deposits. This reinforces the multiplier effect described above, as it contributes to lower deposits with the financial sector. We assume that the level of government debt remains sustainable. In the presence of unsustainable levels of debt, government consumption would generate significant crowding effects, amplifying the real economy impacts and financial effects.

The reserve bank's debt liabilities increase marginally (Table 3). The reserve bank's income increases marginally due to the higher interest rates, which drive interest income. Most of the income of the reserve bank is interest income. The higher levels of income lead to a higher demand for loans.¹¹ The growth in money supply represented by the extension of cash and deposits declines as overall income in the economy falls. For equities, the decline is driven by the fall in the equity price, as the quantity of shares is assumed to be exogenous. On the asset side, the decline in the sources of funding relative to the baseline translates into lower demand for government bonds, which puts further pressure on the bond rate in order to encourage demand by the financial and foreign sectors.

The impact on the foreign sector is driven by the fall in foreign savings and the depreciation of the currency. The two effects move in opposite directions. The fall in foreign savings reduces the levels of financial wealth, whereas the depreciation increases the value of the foreign sector liabilities and thus the sources of funding. The equity and loan liability decline as they are a function of the nominal level of domestic GDP expressed in foreign currency units. This mechanism links stronger domestic growth and currency with greater purchases of financial assets by domestic residents from the rest of the world.

¹¹ The loan demand is a function of real interest rates and nominal income.

The value of bonds and cash and deposit liabilities is kept constant in foreign currency units, and thus the increase in the value reflects the weaker currency.

The provision of loans by the foreign sector is a function of its total financial wealth and the repo rate. A lower repo rate encourages lending, as economic conditions are likely to improve. However, in this case the decline in financial wealth dominates the impact, and the stock of loans provided by the foreign sector declines relative to the baseline. The demand for other assets is modelled as a Tobin asset demand function. The fall in financial wealth available for investment decreases the stock of equities and cash and deposits held by the foreign sector. The decline in cash and deposits contributes to the decline in lending by the financial sector. The stock of bonds increases, driven by the jump in the bond rate. This exacerbates the retreat from equities and cash and deposits.

The depreciation of the currency driven by the fall in foreign savings causes net exports to rise. The relatively low responsiveness of exports to the exchange depreciation is in line with recent South African experience. These responses are dependent on the elasticities of substitution in the constant-elasticity-of-transformation and Armington functions.

Table 5 presents the impacts on net financial wealth, which is measured as the difference in value between the value of assets and liabilities divided by nominal GDP. It is assumed that the impact on the net wealth of the reserve bank is always neutral. For the financial sector, the initial impact is also neutral, as the adjustment to the higher capital ratio reflects only changes in the balance sheet of the sector. However, as real economy effects start to feed in, the financial sector sees a marginal improvement in its net wealth. The improvement in the non-financial sector net wealth is driven by the fall in equities issued by the sector, as well as the fall in the equity price. The non-financial sector provides equities on demand. For all other institutions, the net financial wealth declines in the first simulation relative to the baseline. This decline is more pronounced 10 periods after the shocks.

Table 5: Net financial wealth

Net Financial Wealth	only loans		loans plus retained	
	t+1	t+10	t+1	t+10
change as percent of GDP				
Reserve Bank	0,0	0,0	0,0	0,0
Financial sector	0,0	0,6	0,2	1,6
Non-financial sector	0,5	2,9	0,5	2,0
Households	-0,2	-0,4	-0,2	-0,4
Government	0,0	-1,2	0,0	-1,0
ROW	-0,3	-1,9	-0,4	-2,3

Source: authors' model simulations.

The results reflect the operations of our accelerator mechanism. The negative impact on balance sheets, the lending spread, and equity prices translates into real effects, which reinforce the financial effects. The continuous interaction between the real and financial sides of the economy and the interaction between institutions in the various markets lead to an amplifying mechanism.

We now move to our second simulation. The empirical literature indicates that most of the adjustment to higher capital ratio has taken place through a reduction in dividends. We illustrate how an increase in retained earnings affects our results. We assume that the financial sector reduces the dividend payouts by 10 per cent relative to the baseline. This is a permanent decline over the entire period. The results are labelled *sim2*. The lower dividend payments increase the retained earnings of the financial sector, and reduce the need for a reduction in the value of assets held by

the financial sector. The contraction in the balance sheet of the financial sector is significantly smaller. In Table 2, the financial sector equity holding remains unchanged, the value of bond holdings increases by more compared with the first simulation, and the holding of cash and deposits and the supply of loans experience smaller contractions relative to simulation 1. By period $t+10$, the loans as a source of funding in Table 3 decline by 0.1 per cent, compared with 2.6 per cent in the first simulation.

This lower contraction in the balance sheet of the financial sector translates into lower economic impacts. The negative impacts on the lending spread, equity prices, and reserve ratio are significantly smaller, as shown in Figure 3. Other balance sheets in the economy also experience smaller contractions compared to the first simulation (Tables 2 and 3). The negative impacts on the economy are smaller, as the decline in investment relative to simulation 1 is significantly smaller.

One exception is the impact on household consumption. Household income is highly dependent on dividend income. The fall in dividend payouts, shown in Figure 3, leads to a fall in household income, which makes it more difficult for the representative household to achieve its real wealth target. The household needs to save more as a share of its income in the short run, which translates into lower consumption. This channel highlights the importance of flow consistency and the strength of our framework. While higher retained earnings reduce the negative impacts on the financial sector, they increase the adverse effects on institutions, which receive a high share of financial sector dividend payments.

The optimization behaviour shown in Figure 4 shows the sudden drop in household consumption in the second simulation. The drop is larger than in the first simulation. The growth rate recovers in the outer periods; however, the level remains below the baseline and the first simulation.

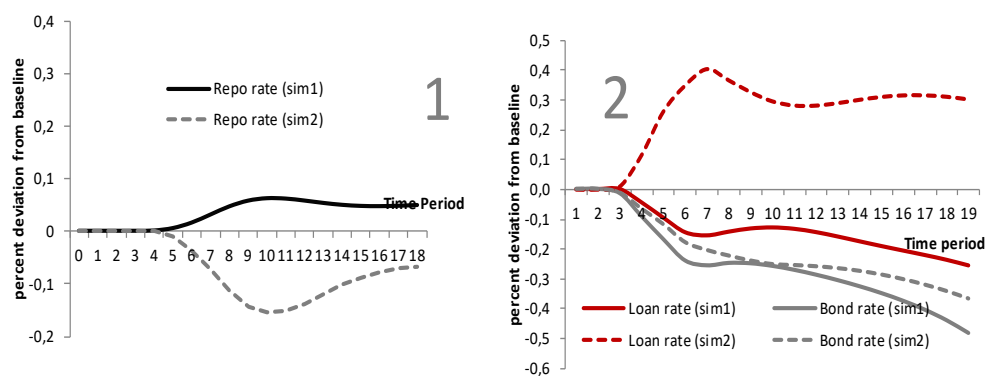
In terms of impacts on net wealth, only households and the rest of the world see no improvement in their positions. In the case of households, this is driven by the drop of income. In the case of the foreign sector, the decline is driven by a larger depreciation of the currency due to lower reliance on foreign savings compared with simulation 1.

6.2 Achieving the higher ratio through higher equity capital

We provide two additional simulations, which show the impact on the economy if the higher capital ratio is achieved by higher issuance of equity. In the first simulation, we assume that the conditions identified by De Marco and Wieladek (2015) are not satisfied. Banks can raise equity, and there is no significant cost to it. In the second simulation, we introduce cost by exogenously shocking the spread (raising equity is expensive, and the bank passes the cost onto its customers). The second simulation is similar to the simulations in most of the models used to study the impact on capital requirements, where the spread is shocked exogenously to account for the cost of equity.

In Figure 5, we show the impact on the repo rate and bond and loan rates. Here *sim1* refers to the first simulation with no impact on the spread, and *sim2* to the second simulation with a higher lending spread. The shock is implemented by releasing the equity constraint on the financial sector. Unlike the previous two simulations, where we assumed that banks could not raise equity, now we assume that the constraint is no longer in place.

Figure 5: Impact on interest rates following issuance of capital



Source: authors' model simulations.

Instead of shrinking the value of their assets, banks can increase their capital. In *sim1*, banks experience a capital injection through an increase in equity capital, which is not accompanied by higher spreads. Table 6 shows the large increase in the equity debt of the financial sector. While this leads to a rise in the leverage ratio, it also increases the value of liabilities, and it requires a corresponding increase in the value of assets (we assume that an increase in the equity capital is not accompanied by a decline in other liabilities). This increase in the value of the financial sector assets is expansionary. The increase in the equity liability of the financial sector increases the sources of funding, and it allows an increase in the financial wealth of the sector.

Table 6: Changes to the holding of financial assets when equities are unconstrained

deviation from baseline	Assets							
	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Central Bank	0,4	0,0	0,0	-1,5	0,0	0,0	0,0	0,0
Financial sector	4,6	3,6	0,3	0,8	4,7	3,9	2,5	2,0
Non-financial sector	0,4	0,0	0,0	0,0	0,0	-0,6	-2,4	-4,6
Households	0,3	0,3	0,0	0,0	0,3	-0,8	0,0	0,0
Government	0,4	0,0	0,0	0,0	0,3	-0,6	0,1	-0,2
ROW	0,8	-2,9	-4,5	-6,3	2,1	-1,5	0,2	-2,9

Source: authors' model simulations.

The increase in financial wealth available for investment leads to higher demand for cash and deposit, equities, and bonds. The stronger growth in the value of assets compared with the baseline reduces the reserve ratio, as the financial sector perceptions of risk are reduced. This increases lending and reduces the loan spread, as shown in the second panel of Figure 5. This is despite an increase in the repo rate driven by the better economic conditions and higher inflation. The higher demand for bonds reduces the bond rate, as shown in the second panel of Figure 5.

The reduction in the lending spread driven by the stronger growth in the balance sheet of the financial sector leads to a lower real borrowing rate and higher investment relative to the baseline (Table 7). Equity prices benefit from an increase in money supply as the financial sector deposit creation accelerates, but also from higher levels of economic activity. The combination of cheaper loans and higher equity prices makes it easier for the household to achieve its level of target wealth, and thus it can increase its level of consumption (Table 7).

Table 7: Real economy impacts of raising capital through equity issuance

	equity		equity plus spread	
	t+1	t+10	t+1	t+10
per cent deviation from baseline				
Household expenditure	0,05	0,27	-0,39	-0,47
Investment				
Non-financial firms	0,05	1,22	-1,29	-1,88
Other-institutions	0,04	1,25	-0,11	-2,85
Exports	-0,03	-0,03	0,22	-0,01
Imports	0,09	0,63	-0,68	-1,15
GDP	-0,01	0,08	0,04	-0,21

Source: authors' model simulations.

The sources of funding for the foreign sector are negatively affected by an exchange rate appreciation. This is reflected in the marginal decline of the bond and cash and deposit liabilities for the sector. However, the higher domestic economic activity encourages the purchase of foreign assets by domestic residents, which increases the equity and loan liability of the foreign sector. The sector decreases its holding of bonds as the relative return of bonds declines.

The impact on the non-financial sector serves as a constraint to the positive impact from the initial shock. The injection of equity in the financial sector reduces the equity purchases from the non-financial sector, as shown in Table 5. Investors may believe that the banks are well run with good profit projections, and they take advantage of the opportunity to purchase new equity capital. This causes the financial wealth of the non-financial sector to fall, and it translates into a reduction in the loans extended by the sector. The fall in the sources of funding requires a decline in the uses of funding. The reduction of loans extended by the non-financial sector provides a marginal offset against the higher supply by the financial sector. A stronger demand for equities by the financial sector and other institutions can reduce the negative impact of this channel and amplify further the accelerator mechanism in the model framework. Equity demand must be more elastic to changes in the return.

The overall impact on GDP in Table 7 is marginally positive, as stronger import growth offsets somewhat the positive effects from higher domestic aggregate demand. These effects are only likely if the banks are already well capitalized and managed, and if there is high demand for their equities.

In the next simulation, the higher equity flows are accompanied by an exogenous increase in the loan spread equivalent to 50 basis points. This is reflected in the higher loan rate in Figure 5. The real economic effects are significantly worse compared with the first simulation, as the higher loan rate discourages demand for loans by institutions, which negatively affects consumption and investment (Table 8). The extension of loans in Table 5 declines across institutions, except for the financial sector.

Table 8: Changes to the holding of financial liabilities when equities are unconstrained

deviation from baseline	Liabilities							
	Equities		Bonds		Cash and dep		Loans	
t+10	sim1	sim2	sim1	sim2	sim1	sim2	sim1	sim2
Central Bank	0,4	0,0	0,0	0,0	0,3	-0,4	-0,8	-0,5
Financial sector	6,6	6,1	0,0	0,0	2,7	1,7	0,0	0,0
Non-financial sector	-1,2	-3,9	0,0	0,0	0,0	0,0	0,9	-2,2
Households	0,0	1,0	0,0	0,0	0,0	0,0	1,1	-2,3
Government	0,4	0,0	-0,6	-0,6	0,0	0,0	1,1	-2,1
ROW	0,6	-0,5	-0,6	1,0	-0,6	1,0	0,2	-0,5

Source: authors' model simulations.

The value of assets held by the financial sector increases following the mechanism outlined in the previous simulation, but the increases are smaller (Table 8). While the balance sheet of the financial sector does not contract, the cost of borrowing is higher relative to the baseline and *sim1*. This is despite a fall in the repo rate. The higher lending rates have negative effects on economic activity.

Investment by non-financial institutions declines, initially due to the higher lending rates, and in the outer simulation periods due to lower equity prices and economic activity. The lower levels of economic activity along with the capital-raising of the financial sector negatively affect the sale of non-financial sector equities. As in the previous simulation, the decline in the sources of funding is matched by a decline in the extension of loans. The reduction in loans is larger than in the first simulation, and offsets the stronger provision of loans by the financial sector.

Household consumption also declines relative to the baseline and *sim1*. Lending to the representative household decreases, as the lending rate is higher. Equity prices also decline relative to the baseline as the level of economic activity decelerates. The combination of a decrease in the sources of funding and lower equity prices requires that the household saves more to achieve the same level of target wealth. This leads to a decline in household consumption.

The reserve bank sees an increase in its interest income relative to the previous simulation, which is still lower than at the baseline. This leads to a marginally smaller decline in loan liabilities. However, the lower overall income in the economy decreases the growth of cash and deposit liabilities for the reserve bank. This is matched by a decline in the holding of bonds.

Government consumption expenditure remains exogenous, which translates into higher issuance of bonds given the slower pace of economic activity. While the bond yield increases relative to the first simulation in Figure 5, it remains below the baseline. This is driven by the higher capital of the financial sector, which still drives the demand for financial assets, and the lower equity return.

The rand depreciates, which cushions the impact on the sources of funding for the foreign sector: the value of bonds and cash and deposits increases. However, equities and loans decline, as domestic GDP expressed in foreign currency units is lower, and the inflows of foreign savings fall relative to the baseline. Overall, the financial wealth of the foreign sector declines, and the net wealth of the domestic economy vis-à-vis the foreign sector improves.

The depreciation of the currency also improves net exports, which reduces the overall negative effects on GDP.

The increase in the loan spread reduces the positive effects associated with the expansion of the balance sheet of the financial sector. In our framework, a small increase of 50 basis points is

sufficient to offset the positive effects from the first simulation. The mechanism works through the reduction in the demand for loans and the impact on household consumption and investment. This in turn affects the demand for financial assets by institutions, which offsets the positive effects associated with the expansion of the financial sector balance sheet. The real and financial elements of our framework interact to determine the net effect on the economy.

The results also highlight how macroprudential policies may affect the transmission and effectiveness of monetary policy decisions. The introduction of higher leverage ratio requirements affects the lending spread, depending on how the higher ratio is achieved. In our framework, the monetary policy response is not sufficient to offset the impact of the higher lending spread on borrowing costs.

The change in macroprudential regulation affects the risk-taking channel identified by Borio and Zhu (2012) and thus the operations of monetary policy. In setting policy rates or introducing other monetary policy interventions, central bankers must consider these effects. Otherwise borrowing rates may be either too high or too low compared with the policy-desired level as the lending spread shifts, and this can lead to unintended impacts on economic activity.

Our results indicate stronger impact than comparative studies on South Africa. The results generated by Grobler and Smit (2014) and Havemann (2014) rely on an econometric equation which links the lending spread directly to the capital adequacy ratio. There are no balance sheet dynamics, and the capital ratio is not a function of the financial sector balance sheet. It is modelled exogenously. Havemann (2014) finds that a 100-basis-point increase in the capital ratio leads to a decline of 0.07 percentage points in GDP growth. The lending rate increases by 0.4 percentage points. Grobler and Smit (2014) generate a stronger impact on GDP, which declines by 0.2–0.3 percentage points relative to the baseline. Our results are of similar magnitude, but this is driven by a large adjustment in imports.¹² The impact on domestic demand is a decline by more than 0.5 percentage points relative to the baseline.

7 Conclusion

Our results confirm that, depending on how the capital requirements are achieved, the impact on the economy can be significantly different, with some institutions and some components of GDP being more affected than others. The worst-case scenarios seem to be when adjustment is achieved by a reduction in the value of assets held by the financial sector, or when the increase in equity capital translates into a large increase in the lending spread.

Our results also highlight again the importance of stock-and-flow consistency. Achieving the higher leverage ratio though higher retained earnings seems less costly for the financial sector. However, this reduces the dividend income of households, and has a negative impact on their balance sheet and consumption.

¹² Our shock is to leverage ratio, whereas the shocks by Grobler and Smit (2014) and Havemann (2014) are to the capital adequacy ratio. The shocks are the same in relative terms given the initial value of the respective ratios. Grobler and Smit (2014) and Havemann (2014) do not model risk weights, similarly to us. The absence of risk weights in the adjustment assumes that the compositional effects are less important, and allows some comparison between the two sets of results.

The stock-and-flow consistency also highlights that if the financial sector increases its equity capital, the equity capital of another sector may fall. This will reduce the sources of funding for that sector and generate negative effects.

Our analysis highlights that by changing the financial sector perceptions of risk through the capital framework effect, changes to leverage ratio can affect the transmission of monetary policy decisions. This can cause lending rates to deviate from what a central bank may perceive as optimal levels, and may have unintended consequences for the economy. The lending spread can offset policy rate interventions. Policymakers need to understand the impact of macroprudential interventions on risk-taking by the financial sector, the impact on lending spreads and extension of loans, and the feedback effects through the real and financial behaviour of other institutions. CGFS (2016) indicates that it is uncertain how the introduction of the various Basel III components will jointly affect the transmission mechanism of monetary policy.

Current DSGE models are unable to capture these effects, as pointed out by Borio and Zhu (2012). We have provided an alternative framework that addresses some of the concerns, but not all. More research is required in understanding risk-taking and incorporating it in a reasonably realistic way into macroeconomic models.

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