South African Journal of Economics

SPECIAL ISSUE ARTICLE

The Impact of Basel III Implementation on Bank Lending in South Africa

Xolani Sibande[1] | Alistair Milne[2]

[1]South African Reserve Bank (SARB), Pretoria, South Africa | [2]Loughborough Business School, Loughborough University, Loughborough, UK

Correspondence: Xolani Sibande (xolani.sibande@resbank.co.za)

Received: 16 July 2024 | **Accepted:** 12 January 2025

Funding: This work was supported by South African Reserve Bank.

Keywords: bank capital | bank credit | bank regulation

ABSTRACT

This study investigates the impact of the Basel III capital requirement on the supply of bank credit in South Africa. The literature offers greatly varying estimates of the impact of bank capital requirements on loan supply. Using a specification closely modelled on a related study of Peru, we report panel regressions using monthly balance sheet data for the four biggest banks in South Africa. We distinguish between three different categories of bank lending for household and corporate borrowers and report complementary local projection estimates to capture dynamic impacts. We find little evidence that the introduction of higher capital requirements under Basel III has reduced the supply of bank credit in South Africa. We surmise that this is mainly due to the large banks being well capitalised and operating with capital buffers that are larger than regulatory minimum requirements.

JEL Classification: G01, G18, G28, G32, G38

1 | Introduction

This paper investigates the impact of the higher regulatory capital requirements of Basel III, implemented between 2013 and 2019, on the supply of bank credit in South Africa. Following earlier literature, the investigation reported here focuses on the impact of changes in minimum required levels of bank capital and of changes in the 'buffers' of capital and liquidity above these minima. The principal data employed are monthly balance sheet data for the four largest South African banks, which together account for more than 80% of bank assets in South Africa. These data are both higher frequency (monthly) and more detailed (distinguishing between several categories of corporate and household credit) than the data used in other related empirical studies.

Focusing on a small set of large banks has several advantages. These banks have similar business models. They all use sophisticated tools of capital management and take a substantial proportion of funding as wholesale deposits from nonfinancial corporates and non-bank financial institutions, which affects their Basel III net stable funding ratios. However, this narrow focus also has the disadvantage of providing only a relatively small data set, over a period in which banks faced no substantial problems of balance sheet capital management.

Section 2 is our literature review. It summarises the findings of similar empirical studies of the impact of changes in capital and capital requirements on bank credit supply in mostly developed countries. It states several grounds for caution about the interpretation of the reported coefficients in existing studies. Section 3 summarises the key developments in South African banking over our sample period. These include the recovery of the banking sector from the impact of the global financial crisis over the period 2009–2011 and an associated rebuilding of capital buffers, and the phasing in of Basel III from 2013 to 2019. Section 4 describes our data set and sets out our empirical specification. Section 5 presents our main

https://doi.org/10.1111/saje.12398

results. Section 6 concludes. There are three appendices: Appendix A provides a theoretical framework for understanding the impact of bank capital on supply lending; Appendix B details data sources; and Appendix C provides some alternative estimation results.

2 | Existing Empirical Literature

This section provides an overview of the empirical literature on the impact of bank capital, bank regulatory requirements and bank capital buffers (the difference between capital and capital requirements) on the supply of bank credit.[1] The estimation attempted in this empirical literature is extremely challenging. One reason for this, a prediction of the theory of bank capital as summarised in Appendix A, is that the relationships involved are highly non-linear. For well-capitalised banks with substantial capital buffers, when there is a very low probability of breaching minimum required capital requirements over the period for which credit is extended, changes in the level of bank capital or of required regulatory requirements have a relatively small impact on the overall cost of funding and credit supply. As capital buffers fall towards zero, the probability of a breach of minimum capital requirements increases nonmonotonically, at first only slightly and then much more substantially. The impact of a change in capital requirements on credit supply increases nonmonotonically along with the increase in probability of a breach.

A second reason is the confounding impact of both credit demand and banks' own risk and capital management. For example, bank capital may fall and bank capital requirements may be increased at the same time as the bank's own borrowers are reducing demand for credit; additionally, the bank itself may be increasing its assessments of borrowers' risk of default. For both these reasons, banks may reduce lending to that borrower independently of any associated change in capital requirements or capital buffers. Furthermore, it is necessary to take account of the dynamics of bank capital management and the consequent endogeneity of changes in bank capital and bank capital buffers. Specifically (this is the case for the changes in Basel III minimum capital requirements in South Africa investigated in the present paper), changes in the capital requirement can be announced well before they are implemented, giving banks the opportunity to increase capital buffers, and both smooth and minimise the portfolio impact of changed capital requirements when they are implemented.

Despite these empirical challenges, the literature does reveal that bank capital and changing bank capital requirements can have a substantial impact on bank credit supply when banks are capital constrained. An early branch of this literature exploits differences in capitalisation of bank holding companies and bank subsidiaries or branches (to correct for the endogeneity of bank capital, resulting from the impact of credit demand on bank earnings and hence capital) to quantify the impact of a decrease in capitalisation on the supply of bank credit. Peek and Rosengren (1997) find that in the period 1989H1 to 1995H2, a 1% reduction in the Japanese parent bank's risk-based capital ratio, due to the Japanese financial crisis, reduces the 6-month growth rate of total lending by Japanese bank branches in the United States by about 1.9% of total branch assets and commercial and industrial lending by 0.8% of total assets.

Houston, James, and Marcus (1997) similarly find that loan growth in US bank subsidiaries increases by 2% following a 1% addition to holding company capital, but there is no statistically significant impact from an addition to subsidiary capital. Calomiris and Wilson (2004) review the data on large declines in the book and market value of the equity capital of large New York City banks during the Great Depression of the 1930s and infer, from substantial deposit withdrawals and increased credit spread on remaining uninsured deposits, that this resulted in a substantial reduction in their supply of credit. Several other papers find lower rates of credit expansion for banks close to the regulatory minimum level of capital (see Hancock and Wilcox 1994; Berger and Udell 1994; Gambacorta and Mistrulli 2004; Nier and Zicchino 2005; Van den Heuvel 2008; Berrospide and Edge 2010).

Another branch of the empirical literature investigates the impact of bank-specific changes in regulatory capital requirements on bank credit growth. Much of this work has been undertaken using UK data. In the United Kingdom, bank regulators have set frequently adjusted individual bank 'trigger ratios' for minimum risk-weighted capital. These bank-specific capital ratios can be higher or lower than the Basel international minima, and breaching them prompts additional supervisory intervention. Francis and Osborne (2012) investigate the impact of changes in buffer capital, finding that a decline of 1% in risk-weighted capital relative to an estimated target reduces risk-weighted assets by 7% (but the impact is relatively small when the decline is the result of a recent change in capital requirements and the impact has no statistically significant effect on unweighted lending or total assets). Aiyar, Calomiris, Hooley, et al. (2014) and Aiyar, Calomiris, and Wieladek (2016) exploit the same UK data on individual changes in bank capital requirements to quantify the direct impact of a change in the UK trigger ratios.

Aiyar, Calomiris, Hooley, et al. (2014) investigate the impact of changes in the UK bank trigger ratio on credit growth using quarterly data for the period 1998–2007 and employing the current and three lags of changes in the trigger ratio (i.e., a similar specification to that used in this paper). They report that 'an increase in the capital requirement ratio of 100 basis points, induces on average a cumulative fall in loan growth of 5.7 and 6 percentage points'. These estimates include a bank-specific credit demand proxy, based on weighted average employment growth in 14 industrial sectors and bank lending shares, but this proxy is not statistically significant. Aiyar, Calomiris, and Wieladek (2016) extend the specification to include changes in interest rates, reporting similar but slightly smaller loan responses to changes in the trigger ratio. Aiyar, Calomiris, and Wieladek (2014) focus on the impact on international lending by UK banks. Allowing a stronger control for credit demand based on country-specific time effects, they report a cumulative fall of international lending of 5.5%.

A concern with these estimates of the impact of a change in the UK trigger ratio on bank credit supply is that they are typically increased when supervisors are concerned about increased bank risk exposure. The reported estimates may reflect the response of the bank to this increased risk exposure rather than the impact of higher capital requirements. This criticism does not apply to the estimates of Jiménez et al. (2017), which exploit the dynamic forward-looking loan loss provisioning in Spain combined with firm-bank level data to identify credit supply impacts. Their identification follows the approach pioneered by Khwaja and Mian (2008), exploiting firm-bank level data on borrowing by firms with two or more bank credit relationships. Where a shock has a varying bank impact, the credit supply impact of the shock can be estimated as a 'difference in difference'. For Jiménez et al. (2017), this is an estimate of the impact of the differences between banks in changes in capital requirement (arising from the Spanish regime of forward-looking dynamic provisioning introduced in 2000Q3) on the difference in growth of credit by banks whenever they lend to the same firm. Specifically, they focus on 'bad times', the reduction in the required capital for anticipated loan loss provisions from 33% to 10% in 2008Q4 and then from 10% to 0% in 2009Q4. They find that the resulting countercyclical reductions in capital requirements in these 'bad times' helped sustain credit growth (a 1 percentage point increase in capital buffers increased credit to firms by 9 percentage points).

De Jonghe, Dewachter, and Ongena (2020) use a similar approach to identification in their examination of the impact on corporate lending in Belgium of discretionary supervisory adjustments to additional discretionary capital requirements (over and above the Basel II minima) between April 2011 and November 2014. These adjustments were made periodically on a bank-by-bank basis, in much the same way as the changes in the United Kingdom trigger ratios exploited by Aiyar, Calomiris, Hooley, et al. (2014). Belgian credit registry data for firms borrowing from multiple banks allow De Jonghe et al. to compare quarterly credit growth from a bank impacted by a change in required capital with credit growth by other banks to the same borrower. De Jonghe et al. find that an increase in required regulatory capital of 1.5% results in 0.19% lower credit growth—that is, an impact that is an order of magnitude smaller than reported by Aiyar, Calomiris, Hooley, et al. (2014) and Jiménez et al. (2017).

Fraisse, Lé, and Thesmar (2020), using the same 'difference in difference' approach to identification, look at the impact of borrower-specific capital weights on corporate credit extended by the six largest French banking groups and their subsidiaries under the Basel II internal model–based determination of risk-weighted assets for the years 2008 to 2011. They find that a 1% increase in the risk capital weighting of a firm reduces lending to that firm by 1.4% to 2.1% (at the intensive margin, i.e., conditional on lending still taking place) and reducing overall credit by 2.3% to 4.5% (also allowing for the extensive margin, i.e., a decision to completely cease lending). While the identification strategy is similar, the approach is otherwise very different to that of Jiménez et al. (2017). Fraisse, Lé, and Thesmar (2020) 'saturate' their panel estimation with bank-year dummies, thus consciously excluding the impact of aggregate capital requirements or aggregate capital buffers on the supply of bank credit. They focus instead on how differences in banks' internal risk weights for individual firms impact on the supply of bank credit to those firms. This tells us that internal capital allocation has an impact on relative credit supply to different firms but is not informative about the impact of overall capital requirements or capital buffers on bank credit.

There are very few studies that investigate the impact of bank capital requirements on credit supply in emerging markets. One is by Fang et al. (2020), who model bank loan growth in Peru using a specification similar to Aiyar, Calomiris, and Wieladek (2014, 2016), including a similar demand proxy, and using quarterly bank data for 2005–2016. The Fang et al. (2020) data include an increase in minimum required capital from 9.1% to 10% of risk-weighted assets announced in July 2008 and implemented in three stages, in July of the following 3 years: 2009 (to 9.5%), 2010 (to 9.8%) and 2011 (to 10.0%). The data also include the introduction of a regime of additional bank-specific capital buffers, which were implemented in July of each year over the period 2012–2016. They report that a 1 percentage increase in the capital requirement—during the second phase of additional bank-specific capital buffers—reduces lending by 4% to 6% in the same quarter. However, strikingly, this impact lasts only one quarter; by the following quarter, the impact is no longer statistically significant. Their specification addresses the concern with Aiyar, Calomiris, Hooley, et al. (2014) changing bank risk as a confounding variable, correlated with changes in discretionary adjustment to bank capital, by using only the relatively large changes to required capital in July of the years 2012–2016 ('jumps') and ignoring small changes ('wiggles') in other months.

Aiyar, Calomiris, Hooley, et al. (2014) and Fang et al. (2020) control for credit demand using a measure based on sector-specific lending weights as a proportion of sector output. Pillay and Makrelov (2024) construct the same measure in the South African context. Both Fang et al. (2020) and Pillay and Makrelov (2024) find that this measure was not significant. As described below, we use a different approach to control for demand based on bank-specific loan product lending rates.

3 | Developments in South African Banking

3.1 | Economic Background

From 1993 to 2008, real South African GDP grew at more than 3.5% per year,[2] supported by the post-apartheid reintegration into the global economy, trade liberalisation, a diversification of economic activity and a policy regime emphasising both fiscal and monetary discipline.[3] Public debt was reduced from 48% of GDP in 1995 to 28% in 2007.[4] Inflation fell from 9.1% in 1993–1995 to 3.2% in 2004–2005, with inflation targeting formally introduced in February 2000.

South Africa was also financially stable, with a profitable and well-capitalised albeit concentrated banking sector. GDP growth slowed temporarily on occasion, triggered by capital outflows and pressure on the exchange rate, both in 1998 during the aftermath of the Asian financial crisis and in 2001 during the post-dot.com global economic slowdown. There were some small bank failures during the latter episode, but neither episode had any systemic financial impact, and demand and growth recovered relatively quickly.

3.2 | Banking Sector: Structure and Regulation

There are 34 active licensed banks in South Africa.[5] Of these, five domestically controlled commercial banks together account for around 90% of banking sector assets.[6] South Africa also has a sophisticated non-bank financial services industry with large life insurance, pension and unit-trust sectors. The ratio of bank assets to GDP is 112%, while total financial sector assets amount to 298% of GDP.

South Africa has a well-developed regime of financial regulation that has evolved in line with international financial standards. A solvency regime, similar to the European Union's Solvency II, for the life insurance sector was introduced in 2011, along with a programme of regulatory reform including a shift to a 'twin peaks' organisational structure legislated in 2017. The South African Reserve Bank (SARB) is responsible for prudential and systemic risk while the Financial Sector Conduct Authority is responsible for market conduct and consumer protection.

This prudential regulation and South Africa's well-capitalised banking sector have prevented a systemic financial crisis from emerging. There is concern about the reliance of the main South African banks on wholesale deposit funding from non-financial corporates and non-bank financial institutions, as it has created some challenges in meeting the Basel III 'net stable funding requirements' ratio. However, none of the episodes of

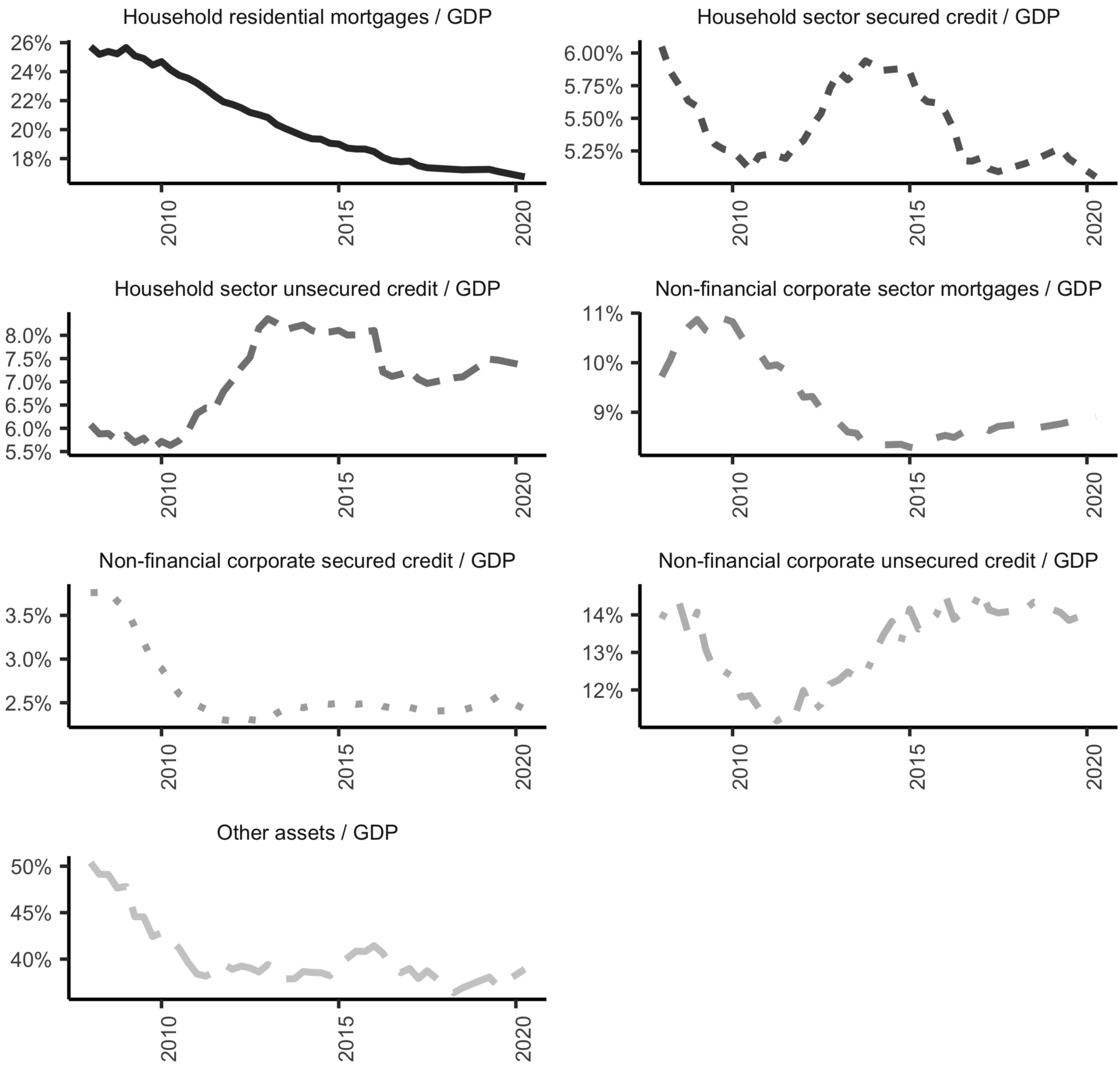

FIGURE 1 | Bank assets as a percentage of GDP.

financial stress in the past three decades have triggered systemic financial problems. These episodes are the exchange rate depreciations of 1998 and 2001, the latter associated with several small bank failures; the impact of the 2008 global financial crisis; the failure of a small lender, African Bank, in 2014; and the 2020 COVID-19 pandemic. Non-performing loans have risen substantially as a share of bank loans, both in the early 2000s and following the 2008 global financial crisis and the 2020 pandemic to reach around 5% of gross loans outstanding.[7] But the banking sector has remained profitable, with return on assets of close to 1.5% and return on equity of around 15% over the years 2008–2020.

While banks have remained profitable, the growth of private sector credit in South Africa slowed substantially after the global financial crisis (see Figure 1). The share of banking sector household mortgage lending to GDP fell from 26% in 2008 to 18% in 2020. Other forms of secured and unsecured household credit grew by around 2% of GDP between 2008 and 2013 but have since fallen back. Credit to nonfinancial corporations has also fallen somewhat since 2008.

In general, the path of the individual credit categories is in line with the increase in bank lending in the second half of the 2000s and the subsequent slowdown because of tighter monetary policy and the introduction of Basel II in South Africa. However, after 2013, some categories of lending such as unsecured credit for households increased relative to GDP due to policy easing after the global financial crisis. Moderation can be observed after 2013 due to structurally slower economic growth in the country and more recently the COVID-19 crisis.

3.3 | Capital Requirement Reforms in South Africa

South Africa implemented the Basel III bank capital regulation framework between 2013 and 2019. The full framework covers three forms of equity capital: core equity; additional Tier 1 capital that absorbs losses on a ‘going concern’ basis; and the total capital (Tier 1 plus Tier 2) that protects depositors and taxpayers when a bank fails. The focus of our work is on total capital.

Table 1 shows the various elements of the total capital requirements introduced in South Africa. This starts with the Basel III minimum of 8% of each bank's risk-weighted assets. To this are added the Pillar 2 elements based on supervisory risk assessment (Pillar 2A is the systemic risk requirement, Pillar 2B is the bank-specific individual capital requirement) and three additional buffers that are available for use as macroprudential policy instruments.[8]

The authorities stipulated the phase-in period shown in Table 2. The conservation buffer, countercyclical buffers and the capital charge for systemically important domestic banks were only

TABLE 1 | Basel III total capital (Tier 1 + Tier 2) requirements in South Africa.

	Percent
Basel III minima	8
South African minima	8
Pillar 2A	0.5 to 2
South African base minima	8 + Pillar 2A
Pillar 2B (ICR)	No specific range
Prudential minima	8 + Pillar 2A + ICR
Systemically important buffer	0.5 to 2.5
Capital conservation buffer	0 to 2.5
Countercyclical buffer	0 to 2.5

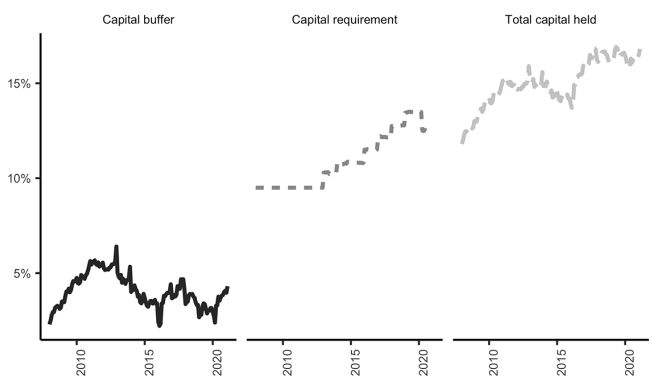

FIGURE 2 | Capital requirements. *Note:* RWA is risk-weighted assets.

TABLE 2 | Basel III implementation (%).

	2013	2014	2015	2016	2017	2018	2019
Basel III minima	8	8	8	8	8	8	8
Pillar 2A for total capital	1.5	2	2	1.8	1.5	1.3	1
Minimum total capital plus Pillar 2A	9.5	10	10	9.8	9.5	9.3	9
Phasing in of specified charge for systemically important banks (as % of Pillar 2A)				25	50	75	100
Capital conservation buffer				0.625	1.25	1.875	2.5
Countercyclical buffer				0.625	1.25	1.875	2.5

introduced in 2016. At the same time, the systemic risk capital requirement (Pillar 2A) was reduced to avoid double counting. The authorities persisted with the phase-in schedule, with only minor deviations to the range-bound measures.

South African banks hold a discretionary buffer above the regulated minimum requirements. The buffer of bank capital over minimum regulatory requirements for the sector has varied. It rose from around 2% in 2008 to 6% in 2013, but with the introduction of the higher Basel III requirements, it has since fallen, fluctuating between 2% and 4% since 2015 (see Figure 2).

4 | Data and Methodology

We collected data on the four major South African banks: Absa Bank, Standard Bank, First National Bank and Nedbank. Together, they constitute around 90% of banking sector assets. Our main data sources were the monthly Banks Act (BA) statutory disclosures collected by the SARB. The BA obliges the SARB to collect and publish bank balance sheets and other data to understand the country's banking activity scale. We mainly used the BA900s (bank balance sheet returns) and the BA930s (bank product lending rates). The Basel III capital requirements

TABLE 3 | Variable definitions and summary statistics.

Variable	Definition	Category	Median	SD	Min	Max	Obs
$\Delta LOAN$	Month-on-month change in the natural logarithm of nominal loans	Household secured credit	0.005	0.008	−0.029	0.025	363
		Household unsecured credit	0.005	0.010	−0.032	0.035	363
		Household mortgage credit	0.003	0.003	−0.005	0.011	363
		Nonfinancial corporations secured credit	0.004	0.013	−0.042	0.045	363
		Nonfinancial corporations unsecured credit	0.005	0.011	−0.025	0.037	363
		Nonfinancial corporations mortgage credit	0.003	0.029	−0.066	0.092	363
ΔKR	Month-on-month changes in the minimum capital requirement (Basel III), January of 2014 to 2019		0.000	0.002	−0.002	0.009	363
ΔKS	Monthly difference between the total capital buffer requirement and the minimum capital requirement		−0.001	0.004	−0.012	0.018	363
$\Delta IntMargin$	Monthly change in the interest rate margin (category credit rate less the policy rate or repo)	Household secured credit	0.000	0.127	−0.430	0.380	363
		Household unsecured credit	−0.000	0.129	−0.473	0.560	363
		Household mortgage credit	−0.002	0.177	−0.961	0.533	363
		Nonfinancial corporations secured credit	0.010	0.128	−0.650	0.260	363
		Nonfinancial corporations unsecured credit	0.006	0.117	−0.449	0.566	363
		Nonfinancial corporations mortgage credit	0.004	0.126	−0.417	0.526	363
ROA	Return on assets during the month, that is, net income divided by total assets		0.012	0.003	0.003	0.020	363
ROE	Return on equity during the month, that is, net income divided by shareholder equity		0.169	0.042	0.042	0.263	363
Liquidity	Natural logarithm of the monthly level of high-quality liquid assets required to be held		17.592	0.212	17.112	18.088	363

TABLE 4 | Household results.

$Dep.Var: \Delta LOAN_{t,t-1}$	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Household secured credit model					
$\Delta KR_{t,t-1}$	−0.1185	−0.1941	−0.3583	0.3135	0.0831
	(0.1152)	(0.2621)	(0.2719)	(0.3298)	(0.3021)
$\Delta KS_{t,t-1}$		−0.0815	−0.0355	−0.0102	0.0281
		(0.1587)	(0.1773)	(0.1248)	(0.1390)
$\Delta IntMargin_{t,t-1}$			0.0032		0.0031
			(0.0042)		(0.0052)
ROA_{t-1}				0.2672	0.1810
				(1.3378)	(1.3242)
ROE_{t-1}				−0.0900	−0.0816
				(0.1107)	(0.1170)
$Liquidity_{t-1}$				−0.0081	−0.0076
				(0.0068)	(0.0085)
Num.Obs.	372	372	369	368	365
Adj.R squared	0.28	0.28	0.28	0.31	0.31
Test of equality (p-value)	0.35	0.65	0.18	0.11	0.95
Household unsecured credit model					
$\Delta KR_{t,t-1}$	0.3774	0.1734	−0.1726*	0.6432**	0.1395
	(0.2962)	(0.2029)	(0.0963)	(0.2994)	(0.2593)
$\Delta KS_{t,t-1}$		−0.2201	−0.0987	−0.1551	−0.0490
		(0.1783)	(0.1708)	(0.1700)	(0.1597)
$\Delta IntMargin_{t,t-1}$			−0.0034		−0.0041
			(0.0034)		(0.0033)
ROA_{t-1}				0.9497	0.6684
				(1.1502)	(1.2171)
ROE_{t-1}				−0.0858	−0.0709
				(0.0898)	(0.1011)
$Liquidity_{t-1}$				−0.0045	−0.0012
				(0.0070)	(0.0074)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.37	0.37	0.39	0.35	0.37
Test of equality (p-value)	0.18	0.26	0.19	0.00	0.33
Household mortgage credit model					
$\Delta KR_{t,t-1}$	0.2652***	0.2818**	0.2933**	0.1843**	0.1981**
	(0.1008)	(0.1110)	(0.1156)	(0.0860)	(0.0853)
$\Delta KS_{t,t-1}$		0.0180	0.0193	0.0196	0.0216
		(0.0190)	(0.0209)	(0.0164)	(0.0185)

(Continues)

TABLE 4 | (Continued)

$\boldsymbol{Dep.Var}$: $\boldsymbol{\Delta LOAN_{t,t-1}}$	(1)	(2)	(3)	(4)	(5)
$\Delta IntMargin_{t,t-1}$			−0.0008		−0.0009
			(0.0011)		(0.0009)
ROA_{t-1}				0.4418*	0.4625*
				(0.2669)	(0.2478)
ROE_{t-1}				−0.0377**	−0.0395**
				(0.0166)	(0.0190)
$Liquidity_{t-1}$				0.0024	0.0024
				(0.0020)	(0.0022)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.59	0.59	0.58	0.62	0.61
Test of equality (p-value)	0.01	0.03	0.04	0.07	0.04

Note: The dependent variable is loan growth at bank level at a monthly frequency, calculated as the log difference at t and $t-1$. All control variables are defined in Table 3. Standard errors are clustered at a bank level. All equations include bank fixed effects and monthly time dummies. A test for equality p-value of <0.1 is significant.
***$p<0.01$.
**$p<0.05$.
*$p<0.1$.

(BA700s) data were collected from South Africa's Prudential Authority—the financial sector regulator. From the same source, we also collected the control data. Tables B.1 and B.2 summarise the specific data. Most bank-level data are confidential data held by the SARB; however, the BA900 bank-level balance sheet data are public.

These data have some distinctive features for investigating the determinants of bank credit supply when compared to what is available for other countries. First, unusually, the South African data provide granular public domain monthly balance sheet reports with a detailed breakdown of bank assets and liabilities for individual banks. Second, confidential granular matching loan category data on product lending rates are available for each bank. These pricing data offer the potential of employing a new approach from that used in the existing literature to identify credit supply effects.

Our focus is on the effect of higher capital requirements on lending to nonfinancial household and corporate borrowers. The BA900s have 24 lending categories to households and nonfinancial corporations. Many of these categories are closely related, so some aggregation is appropriate. The aggregation of these data, combining related granular lending categories into broader categories, is explained in Appendix B. This results in three lending categories for both households and nonfinancial corporations: unsecured credit, secured credit and mortgages. These six categories form the foundation of our analysis.

Table 3 provides the definitions of and summary statistics for our dependent and independent variables. In Section 2, we explained the challenges in separating the bank lending effect of specific Basel III actions from banks' normal risk and portfolio adjustment actions. To address this identification problem, we follow Fang et al. (2020), using a dummy variable interaction to distinguish between changes due to Basel III—in the case of South Africa, the jumps in capital requirements are introduced in January of the years 2014 to 2019 in the phased introduction of the Basel III higher minimum capital requirements (Table 2)—and smaller fluctuations for other months resulting from changes in risk-weighted assets (see Figure 2). ΔKR or minimum capital requirement is an interactive dummy that isolates the specific Basel III changes to the regulatory capital buffer requirements arising in January of each of these years. We also include a measure of the excess capital that the banks choose to hold above the minimum capital buffer requirement (ΔKS).

To control for demand for credit, we use the lending rates corresponding to our six broad lending categories (see Figure B.1). We use $\Delta IntMargin$, defined as the change in the interest rate margin (lending rate less the SARB policy rate), as a control for loan demand. The intuition is that an increase in the lending rate relative to the policy rate is indicative of an increase in demand, so by including this in the specification, we can control for changes in bank-specific loan demand correlated with changes in capital requirements. This approach requires that we only use flexible rates, which can adjust with the policy rate. The interest rate margin may not only reflect demand aspects. For example, other idiosyncratic factors such as a shock to bank funding conditions can also have an impact on interest margins. This is therefore a more general control than the demand proxy used in Fang et al. (2020).

After adjusting the data in Table 3 for outliers (winsorising the data with a 1% threshold), we estimate the following equation for the six lending categories using the ordinary least squares estimator:

$$\Delta LOAN^i_{t,t-s} = \beta \Delta KR^i_{t,t-1} + \lambda \Delta KS^i_{t,t-1} + \alpha \Delta IntMargin^i_{t,t-1} + \gamma' \mathbf{X}^i_{t-s} + \phi^i + \tau_t + \varepsilon^i_t.$$

TABLE 5 | Nonfinancial corporation results.

$Dep. Var$: $\Delta LOAN_{t,t-1}$	(1)	(2)	(3)	(4)	(5)
Nonfinancial corporations secured credit model					
$\Delta KR_{t,t-1}$	−0.2343	−0.2869	−0.6262***	−0.4304	−0.8876*
	(0.1977)	(0.1977)	(0.2179)	(0.4645)	(0.5286)
$\Delta KS_{t,t-1}$		−0.0568	0.0602	−0.0025	0.0884
		(0.1047)	(0.0932)	(0.1297)	(0.1178)
$\Delta IntMargin_{t,t-1}$			0.0041*		0.0107***
			(0.0024)		(0.0022)
ROA_{t-1}				0.3983	0.4640
				(1.1814)	(1.0702)
ROE_{t-1}				−0.0550	−0.0556
				(0.0735)	(0.0637)
$Liquidity_{t-1}$				−0.0168***	−0.0174***
				(0.0028)	(0.0022)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.23	0.22	0.25	0.26	0.29
Test of equality (p-value)	0.22	0.29	0.00	0.51	0.05
Nonfinancial corporations unsecured credit model					
$\Delta KR_{t,t-1}$	1.2403	1.0208	1.1655	−0.2135	0.0328
	(1.7367)	(2.0391)	(2.0912)	(1.0102)	(1.4455)
$\Delta KS_{t,t-1}$		−0.2367	−0.2941	0.0170	−0.0703
		(0.7184)	(0.6996)	(0.6239)	(0.6501)
$\Delta IntMargin_{t,t-1}$			0.0082*		0.0167***
			(0.0044)		(0.0050)
ROA_{t-1}				4.3763***	4.5737***
				(1.3114)	(1.3986)
ROE_{t-1}				−0.2096***	−0.2190***
				(0.0735)	(0.0783)
$Liquidity_{t-1}$				−0.0326***	−0.0385***
				(0.0086)	(0.0101)
Num.Obs.	372	372	364	368	360
Adj.R squared	0.10	0.10	0.11	0.15	0.16
Test of equality (p-value)	0.47	0.57	0.50	0.81	0.98
Nonfinancial corporations mortgage credit model					
$\Delta KR_{t,t-1}$	−0.3059	−0.6987**	−0.6491*	−0.5612	−0.5177
	(0.2421)	(0.3379)	(0.3655)	(0.4547)	(0.4246)
$\Delta KS_{t,t-1}$		−0.4236***	−0.4129***	−0.4575***	−0.4488***
		(0.1349)	(0.1491)	(0.1613)	(0.1470)

(Continues)

TABLE 5 | (Continued)

$Dep. Var$: $\Delta LOAN_{t,t-1}$	(1)	(2)	(3)	(4)	(5)
$\Delta IntMargin_{t,t-1}$			−0.0034*		−0.0047***
			(0.0018)		(0.0011)
ROA_{t-1}				1.5275	1.3383
				(2.1529)	(1.9310)
ROE_{t-1}				−0.0978	−0.0846
				(0.1460)	(0.1285)
$Liquidity_{t-1}$				0.0075	0.0082
				(0.0075)	(0.0075)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.12	0.13	0.13	0.14	0.14
Test of equality (p-value)	0.24	0.01	0.02	0.01	0.02

Note: The dependent variable is loan growth at bank level at a monthly frequency, calculated as the log difference at t and $t-1$. All control variables are defined in Table 3. Standard errors are clustered at a bank level. All equations include both bank and monthly fixed effects. A test for equality p-value of <0.1 is significant.
***$p<0.01$.
**$p<0.05$.
*$p<0.1$.

$\Delta LOAN^i_{t,t-s}$ is the log difference of lending between months t and $t-s$ for bank i. $\Delta KR^i_{t,t-1}$ is the bank-level change in the minimum capital requirement between months t and $t-1$. Similarly, $\Delta KS^i_{t,t-1}$ is the change in the bank-level capital buffer between months t and $t-1$. Based on Table 1, this definition of $\Delta KR^i_{t,t-1}$ implies that we estimate the bank-specific changes to the capital requirement since all other capital requirements are the same among the banks. $\Delta IntMargin^i_{t,t-1}$ is the lending demand proxy represented by the bank-level change in the interest rate margin between months t and $t-1$. $\mathbf{X}^i_{t-s}$ is a bank-level controls set at month $t-s$. Our choice of controls flows from Fang et al. (2020), which are at a bank-level return on assets, return on equity (profitability) and high liquid assets held (liquidity). The fixed effects (ϕ^i) estimate other unobserved differences in bank characteristics. To account for other factors, such as changes in the macroeconomic environment, we employ time-fixed effects (τ_t). In summary, we estimate this specification for each of the lending categories with a panel of four banks between 2013 and 2019. As shown in Section 5, this amounts to six regressions per estimation, that is, three regressions for households and nonfinancial corporations (unsecured credit, secured credit and mortgages), respectively.

5 | Results

5.1 | Panel Estimation Results

Tables 4 and 5 report the main results from panel estimation, increasingly adding variables from Columns 1 to 5. In Column 1, we take the baseline impact of Basel III changes in capital requirements on credit growth. In Column 2, we add the capital buffers; we add our lending demand proxies in Column 3. Lastly, in Columns 4 and 5, we add the bank-specific controls while excluding the demand proxy in Column 4. We estimate the regressions with monthly time dummies and bank fixed effects, with standard errors clustered at bank level. We also report R squared and a p-value for joint significance (test for equality).

The results reveal only limited evidence of any reduction in the supply of credit by the four largest South African banks as a result of higher capital requirements introduced with the implementation of Basel III. Estimates for household lending reveal no evidence of an impact of capital requirements on the volume of credit. While we obtain significant coefficients for household mortgage credit, indicating a contemporaneous effect from changes in capital requirements, this estimate is wrongly signed in relation to the prior that higher capital requirements will reduce credit supply. We obtain significant but economically small negative coefficients for the impact of higher minimum capital requirements on the growth of secured credit to nonfinancial corporations, when controlling for demand using bank loan margins. A 1% increase in the capital requirement results in a contemporaneous reduction in the same month of bank lending of between 0.63% (with no bank controls) and 0.89% (with bank-level controls). There is also some evidence, of borderline statistical significance, of a reduction of about the same magnitude in corporate mortgage lending. These impacts are small and more in line with those reported by De Jonghe, Dewachter, and Ongena (2020) for Belgium than those in other studies.

5.2 | Dynamic Estimation

To complement these panel data estimates, we also report some preliminary dynamic estimation. We use the local method of Jordà (2005) for calculating impulse responses called local projections, which uses an expanding window to quantify the impact on the dependent variables of a shock on the independent variables at a specific period, at each unit of the shock period. That is, we estimate a change in capital requirements (ΔKR) at each period of the expanding window of the change in lending ($\Delta LOAN$). This estimation employs the same control variables as our baseline panel model.

Figure 3 shows the resulting impulse response of the log of loans for each of the six categories of lending, to an initial shock to minimum required capital (ΔKR) from 1 to 12 months. In almost all loan types and periods, the error bounds for these estimates include zero, revealing again little or no evidence of an impact of minimum capital requirements on the supply of bank lending.

Appendix C reports estimates in which we vary our baseline model to investigate the presence of anticipatory impacts of the changes in minimum capital requirements on bank lending (with an impact on bank lending arising before the increase in required minimum capital), contemporaneous impacts or longer lags than investigated in our baseline model (see Tables C.1 and C.2). These estimates correspond to the estimates in Column 3 of Tables 4 and 5. Again, there is little evidence that changes in minimum capital requirements have an impact on the supply of bank lending.

We have explored a variety of other specifications, but again with no clear evidence of an impact of the changes in Basel III minimum capital requirements on the level of bank lending.

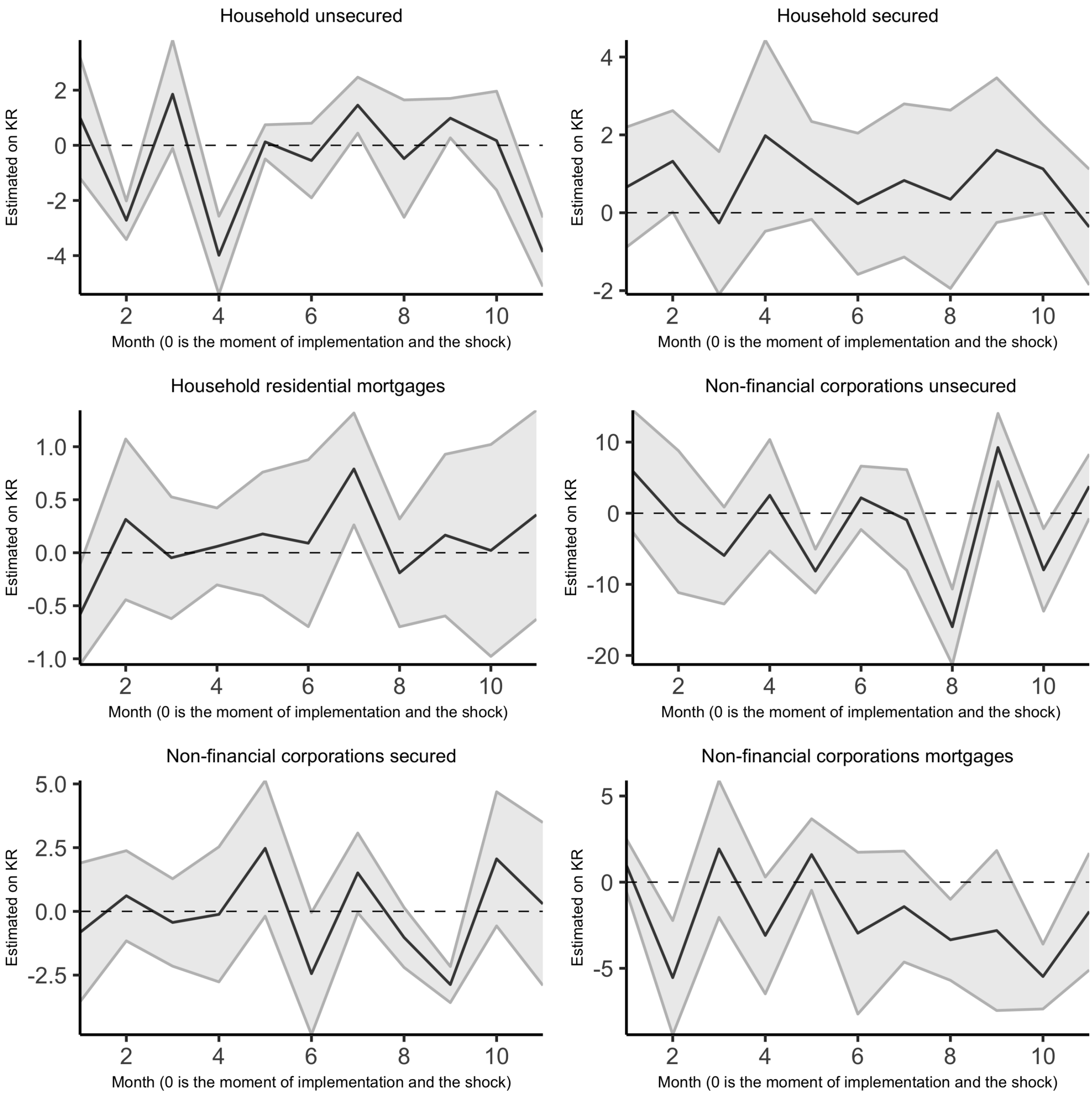

FIGURE 3 | Impulse responses via local projections of lending ($LOAN$) to a shock in capital requirements (KR).

6 | Conclusion

This paper has investigated the impact of the increased minimum bank capital requirements on banks in South Africa, introduced in the transition to the more stringent Basel III capital regime. From our detailed review of the literature, which highlighted the substantial challenges of estimating causal impacts of changes in capital requirements on the supply of lending, we chose an empirical specification based on the one employed by Fang et al. (2020) for Peru. Their specification avoids the shortcoming of many other studies of the impact of changing capital requirements on bank lending, where the changes to minimum capital may be a response to higher perceived loan portfolio risk, so reported estimates of the impact of capital on lending are confounded by changes in credit risk. This is achieved by focusing on larger pre-announced increases in minimum capital requirements and excluding smaller changes that can be attributed to changes in portfolio risk.

While our setup is similar to Fang et al. (2020), we find much weaker evidence of an impact of capital requirements on the supply of bank lending. We investigate the impact on three categories of lending for both household and corporate borrowers. Only in the case of secured credit for nonfinancial corporations do we obtain statistically significant and economically sensible coefficient estimates, and the coefficient is relatively small—a 1% increase in capital requirement reduces lending by 0.63% (with no bank controls) and 0.89% (with bank-level controls). For the relatively short data period of our estimation, from 2013 to 2019, we find no significant impact of the level of capital or of capital buffers over the minimum requirement on the level of lending. Exploring alternative dynamic estimations similarly yields little evidence of any impact.

There are several reasons why the impact of higher minimum capital requirements introduced in South Africa under Basel III may be small. Most obviously, in our estimation period, the large South African banks have operated with large capital buffers and faced only a remote risk of falling short of capital; minimum equity capital may simply not be a constraint on their portfolio decisions. Furthermore, the Basel III changes in minimum capital were announced well in advance, with a longer period to adjust than was the case for the changes in Peru investigated by Fang et al. (2020). Clearly, further investigation is warranted, but it appears that the South African authorities have introduced the higher capital requirements of Basel III in a sensible way with little or no impact on bank lending, at least for the four large banks in our sample. Lastly, other research can exploit the availability of loan category and bank-specific average lending rates for South African banks and further explore their use controls for loan demand, including other bank-funding-specific factors. Other researchers can also compare our approach to other approaches such as using sector lending data.

Acknowledgements

We thank the reviewers for their invaluable comments.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings are not publicly available due to privacy agreements between the South African Reserve Bank and the banking industry in South Africa. Some data, though, are publicly available from South African Reserve Bank and other public institutions. Please contact the corresponding author for further information.

Endnotes

[1] This literature is part of a broader literature on credit supply shocks and bank lending; see Degryse et al. (2019) for a more comprehensive review.

[2] Macroeconomic data, except where otherwise specified, are from the IMF data mapper: https://www.imf.org/external/datamapper/profile/ZAF.

[3] Nowak (2005); Nowak and Ricci (2005).

[4] See the 2010 IMF Article IV consultation, September 2010, highlighting South Africa's strong economic performance since the mid-1990s.

[5] https://www.resbank.co.za/en/home/what-we-do/Prudentialregulation/sa-registered-banks-and-representative-offices, January 2022; these consist of 13 branches of foreign banks, 4 foreign-controlled commercial bank subsidiaries, 14 locally controlled commercial banks and 3 mutual banks.

[6] As of April 2020, these were (% of banking sector assets) Standard Bank (24.1%), First Rand (20.4%), Absa Bank (19.8%), Nedbank (17.0%) and Investec (7.8%); the next largest bank is Capitec (2%).

[7] IMF financial soundness indicators.

[8] Annexure A of Directive 5 of 2013 by the Office of the Register of Banks.

References

Aiyar, S., C. W. Calomiris, and T. Wieladek. 2014. “Does Macro-Prudential Regulation Leak? Evidence From a UK Policy Experiment.” *Journal of Money, Credit and Banking* 46, no. s1: 181–214.

Aiyar, S., C. W. Calomiris, and T. Wieladek. 2016. “How Does Credit Supply Respond to Monetary Policy and Bank Minimum Capital Requirements?” *European Economic Review* 82: 142–165.

Aiyar, S., C. W. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek. 2014. “The International Transmission of Bank Capital Requirements: Evidence From the UK.” *Journal of Financial Economics* 113, no. 3: 368–382.

Berger, A N, and G. F. Udell. 1994. “Lines of Credit and Relationship Lending in Small Firm Finance.” Jerome Levy Economics Institute Working Paper 113.

Berrospide, J M, and R. M. Edge. 2010. “The Effects of Bank Capital on Lending: What Do We Know, and What Does It Mean? CAMA Working Paper Series 26/2010.

Calomiris, C. W., and B. Wilson. 2004. “Bank Capital and Portfolio Management: The 1930s “Capital Crunch” and the Scramble to Shed Risk.” *Journal of Business* 77, no. 3: 421–455.

Calomiris, C. W., and C. M. Kahn. 1991. “The Role of Demandable Debt in Structuring Optimal Banking Arrangements.” *American Economic Review* 81, no. 3: 497–513.

De Jonghe, O., H. Dewachter, and S. Ongena. 2020. “Bank Capital (Requirements) and Credit Supply: Evidence From Pillar 2 Decisions.” *Journal of Corporate Finance* 60: 101518.

Degryse, H., O. De Jonghe, S. Jakovljević, K. Mulier, and G. Schepens. 2019. “Identifying Credit Supply Shocks with Bank-Firm Data: Methods and Applications.” *Journal of Financial Intermediation* 40.

Fang, X., D. Jutrsa, S. M. Peria, A. F. Presbitero, and L. Ratnovski. 2020. "Bank Capital Requirements and Lending in Emerging Markets: The Role of Bank Characteristics and Economic Conditions." *Journal of Banking & Finance* 135: 105806.

Fraisse, H., M. Lé, and D. Thesmar. 2020. "The Real Effects of Bank Capital Requirements." *Management Science* 66, no. 1: 5–23.

Francis, W. B., and M. Osborne. 2012. "Capital Requirements and Bank Behavior in the UK: Are There Lessons for International Capital Standards?" *Journal of Banking & Finance* 36, no. 3: 803–816.

Gambacorta, L., and P. E. Mistrulli. 2004. "Does Bank Capital Affect Lending Behavior?" *Journal of Financial Intermediation* 13, no. 4: 436–457.

Hancock, D., and J. A. Wilcox. 1994. "Bank Capital and the Credit Crunch: The Roles of Risk-Weighted and Unweighted Capital Regulations." *Real Estate Economics* 22, no. 1: 59–94.

Hellwig, M., and A. Admati. 2014. *The Bankers' New Clothes: What's Wrong With Banking and What to Do About It. Updated Edition*. Princeton and Oxford: Princeton University Press.

Houston, J., C. James, and D. Marcus. 1997. "Capital Market Frictions and the Role of Internal Capital Markets in Banking." *Journal of Financial Economics* 46, no. 2: 135–164.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina. 2017. "Macroprudential Policy, Countercyclical Bank Capital Buffers, and Credit Supply: Evidence From the Spanish Dynamic Provisioning Experiments." *Journal of Political Economy* 125, no. 6: 2126–2177.

Jordà, Ò. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95, no. 1: 161–182.

Khwaja, A. I., and A. Mian. 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence From an Emerging Market." *American Economic Review* 98, no. 4: 1413–1442.

Milne, A, and A. Whalley. 2002. "Bank Capital Regulation and Incentives for Risk-Taking." Cass Business School Research Paper, WBS Finance Group Research Paper no. 15.

Modigliani, F., and M. H. Miller. 1958. "The Cost of Capital, Corporate Finance and the Theory of Investment." *American Economic Review* 48: 261–297.

Nier, E, and L. Zicchino. 2005. "Bank Weakness and Bank Loan Supply." Bank of England Financial Stability Review (December): 85–93.

Nowak, M. 2005. "The First Ten Years After Apartheid: An Overview of the South African Economy." In *Post-Apartheid South Africa: The First Ten Years*, edited by M. Nowak and L. A. Ricci, 1–10. Washington, DC: International Monetary Fund.

Nowak, M., and L. A. Ricci, eds. 2005. *Post-Apartheid South Africa: The First Ten Years*. Washington, DC: International Monetary Fund.

Peek, J., and E. S. Rosengren. 1997. "The International Transmission of Financial Shocks: The Case of Japan." *American Economic Review* 87, no. 4: 495–505.

Pillay, N, and K. Makrelov. 2024. "The Lending Implications of Banks Holding Excess Capital." South African Reserve Bank Working Paper Series WP/24/02.

Van den Heuvel, S. J. 2008. "The Welfare Cost of Bank Capital Requirements." *Journal of Monetary Economics* 55, no. 2: 298–320.

Appendix A: Theoretical Review

This appendix is a review of the theory of bank capital and bank lending. It identifies several key points relevant to the empirical investigation.

A.1 | A Conceptual Framework Drawing on Corporate Finance and Banking Theory

A large literature examines the impact of regulatory capital requirements on bank credit supply. To draw a consistent picture of the findings from this literature, it is helpful to review the mechanisms linking bank capital to credit supply, employing a conceptual framework based on standard corporate finance theory. In the complete markets setting of Modigliani and Miller (1958), the mix of equity and debt funding, and therefore also capital regulation, is irrelevant; but, there are several reasons why the mix of funding will in practice impact on lending and other business decisions. Some of these reasons apply broadly to banks, non-bank financial intermediaries and nonfinancial corporates, while others are bank specific.

The focus of what follows is on how capital structure and capital regulation impact the overall costs of bank funding and hence the supply of bank credit and, in empirical estimation, on distinguishing credit supply from the demand for credit:

$$L^d = \alpha_0 + \alpha_1 r^l + \alpha_2 y + \mu$$
$$L^s = \beta_0 + \beta_1 \left(r^l - \omega\right) + \nu$$

where β represents the cost of bank funding and y represents factors such as income and expected income growth that affect the demand for bank credit.

The composition of the bank balance sheet can be represented schematically as distinguishing different categories of loans (L_1, L_2), security investments (B), core deposits (D), wholesale funding (W) and equity capital (E). Bank capitalisation c, the buffer of capital c^b above the minimum regulatory capital requirement, funding liquidity λ and the liquidity buffer above the minimum regulatory liquidity ratio (the net stable funding ratio λ^{min}) can then be represented (with risk weights w_1, w_2) as

$$c = E / \left(w_1 L_1 + w_2 L_2\right)$$
$$c^b = c - c^{min}$$
$$\lambda = (D + E) / \left(L_1 + L_2\right)$$
$$\lambda^b = \lambda - \lambda^{min}.$$

For capital structure and capital regulation to have any impact at all, equity must be more expensive than debt funding, whether in the form of core deposits or other forms of debt. If there are then also costs associated with renegotiating debt obligations or any corporate restructuring following a default on debt obligations, then the expected frequency and hence costs of debt default will rise as leverage is increased.

This implies that there is a desired target or market-driven level of capitalisation c^* at which the marginal benefit of higher capitalisation (reducing the expected frequency and hence costs of debt default) equals the marginal higher funding cost (the higher costs of equity relative to debt). Raising new capital and returning new capital to shareholders are costly for tax and signalling reasons. This further implies that capital cannot always be maintained at the desired level ($c \neq c^*$). Similarly, changing the composition of debt finance, for example, attracting additional core deposits, is also costly, so while we can expect a desired level of liquidity λ^*, actual liquidity can depart from desired liquidity ($\lambda \neq \lambda^*$).

A further factor determining the desired capital buffer is the 'charter' or 'franchise' value of an institution and the extent to which a bank can alter the balance of risk and returns on its balance sheet without outside stakeholders, especially debt holders and regulators, being aware. Charter value loosely represents the value of claims on future earnings lost in the event of a reorganisation following a breach of minimum levels of capital and liquidity that triggers a resolution and reorganisation of liabilities, with equity holders potentially losing their claims.

The observation of risk taking is critical because of the possibility of 'moral hazard'. If an institution can take high risks without a corresponding increase in the costs of debt finance, then it may be induced to take deliberately high levels of risks that create value through ‘risk shifting’—that is, transferring the costs of risk and resulting resolution from equity to debt holders. One insight from theoretical modelling of bank capital buffers (e.g., Milne and Whalley 2002) is that there are two potential qualitatively different solutions. The first solution has a relatively high charter value, in which incentives for risk shifting are low and are dominated by the desire to preserve charter value. As a result, there is an ‘internal optimum’ with a high level of desired capital and relatively low levels of risk taking. The second solution has a low charter value, in which incentives for risk shifting dominate those for preserving charter value, leading to a ‘corner solution’ in which capital buffers are maintained at very low levels and there are high levels of risk taking.

The overall cost of funding (ω) will depend on the market rate of interest (r), the departure between actual and desired bank capital and actual and desired liquidity:

$$\omega = r + f\left(c - c^*, \lambda - \lambda^*\right).$$

The consequence is that, according to this basic theory, the impact of a change in capital on the supply of lending is non-linear. The function $f\left(c - c^*, \lambda - \lambda^*\right)$ falls to a minimum γ when $c \geq c^*$, $\lambda \geq \lambda^*$, at which point $\omega = r + \gamma$ (γ reflecting bank-specific operational and other costs); but when capital or liquidity falls short of the target levels (c^*, λ^*), then costs of funding rise and $\omega > r + \gamma$.

The extent to which a shortfall of capital or liquidity increases the cost of funding $f\left(c - c^*, \lambda - \lambda^*\right)$ will depend on the probability of a breach of minimum levels of either capital or liquidity. When a shortfall from desired levels is relatively small, then the probability of a breach and the impact on funding costs of a change in capital or liquidity are also relatively small. But when a shortfall from desired levels is large, then the probability of a breach and the impact on funding costs of any change in capital or liquidity are relatively large. Thus, $f\left(c - c^*, \lambda - \lambda^*\right)$ is non-linear, and we can expect the first and second derivatives to be signed as follows:

$c-c^*$	$\lambda-\lambda^*$	f_c	f_λ	f_{cc}	$f_{c\lambda}$	$f_{\lambda\lambda}$
≥ 0	≥ 0	0	0	0	0	0
<0	≥ 0	<0	0	>0	0	0 .
≥ 0	<0	0	<0	0	0	>0
<0	<0	<0	<0	>0	>0	>0

These higher costs of funding ($\omega - r = f\left(c - c^*, \lambda - \lambda^*\right) > \gamma$) arise because of the costs of altering capital and liquidity towards their desired or target levels. Again, there is a trade-off: as capital or liquidity falls further below target, more balance sheet resources are allocated to increasing capital and liquidity, and less resources are allocated to the funding of lending. We can expect the expected rate of accumulation of capital and liquidity to be (approximately) proportional to the marginal costs of reduced capital or liquidity:

$$c \propto -f_c \lambda \propto -f_\lambda$$

and (employing a somewhat loose notation) the dynamic evolution of funding costs, capital and liquidity can be summarised as follows:

$\varepsilon\frac{dc-c^*}{dt}$	$\varepsilon\frac{d\lambda-\lambda^*}{dt}$	$\varepsilon\frac{d(w-r)}{dt}$	$\varepsilon\frac{dc}{dt}$	$\varepsilon\frac{d\lambda}{dt}$
≥ 0	≥ 0	0	0	0
$<$	≥ 0	<0	>0	0 .
≥ 0	<0	<0	0	>0
<0	<0	<0	>0	>0

How are the costs of funding $f\left(c - c^*, \lambda - \lambda^*\right)$ impacted by minimum capital and liquidity requirements c^{min} and λ^{min}? It is necessary to distinguish between long-term and short-term impacts.

Over the longer run, the desired target of the market level of capitalisation is increased but with relatively small impacts on the cost of funding $f\left(c - c^*, \lambda - \lambda^*\right)$ and the supply of credit. Standard corporate finance theory suggests, somewhat against the intuitions of banking practitioners, that regulatory capital and liquidity requirements will have only a minor long-run impact on the cost of bank funding and the supply of bank credit (for elaboration, see Hellwig and Admati 2014). This is because the marginal benefits of higher leverage resulting from the separation of ownership and control and resulting agency costs of equity depend on the threat of intervention and consequent loss of managerial control. A breach of regulatory minimum capital or liquidity requirements triggers intervention and disciplines management in much the same way as a default on debt payments. Therefore, the relevant leverage is based on the buffer of excess capital or liquidity ratios over and above the required regulatory minima.

If these buffers are independent of the regulatory minima—that is, if the desired capital and desired liquidity are determined by fixed buffers $c^{(b^*)}$ and $\lambda^{(b^*)}$ independently of the regulatory minima c^{min} and λ^{min}—then

$$c^* = c^{(b^*)} + c^{min}$$
$$\lambda^* = \lambda^{(b^*)} + \lambda^{min}.$$

Over the longer run, once balance sheets have fully adjusted, c and λ increase in line with c^* and λ^*, and there is no impact on funding costs or credit supply.

This is not the entire story, even over the long run. Taxation may increase costs of debt relative to equity and hence raise minimum funding costs γ. On the other hand—in the event of a breach of minimum capital or liquidity requirements—resolution may be less costly, avoiding, for example, protracted legal disputes. In this case, the desired buffers $c^{(b*)}$ and minimum funding costs γ could be reduced by higher capital requirements. Thus, both the sign and magnitude of the long-run impact of minimum capital requirements is an empirical question. Since many factors will influence funding costs over the long run, these are likely to be difficult to quantify empirically.

What the theory indicates is that these effects can be expected to be second-order impacts, relatively smaller than the short-term impact of changing capital requirements, arising when regulation leads to a fall in the buffers of capital and liquidity over their long-run levels.

For example, following an increase in regulatory capital requirements or an unexpectedly high level of loan loss provisions, a bank may find that its buffer of excess capital is below the level it desires and, in response, increase the margins on lending rates and limit lending until capital is rebuilt.

A.2 | Implications for Empirical Modelling

This discussion of corporate finance and banking theory leads to an insight that can be exploited empirically in estimating the impact of regulatory requirements on the supply of lending. The short-term impact of an increase in required bank capital or liquidity will be quantitatively very similar to a decline in actual capital or liquidity resulting from balance sheet shocks. This insight is useful because it allows conclusions about the impact of higher capital and liquidity requirements on the costs and volume of loans to be based on observations of the impact shocks to observed bank capital and liquidity due to market, credit or other risks.

All this indicates that empirical modelling of the impact of regulatory requirements for capital and liquidity on the supply of bank lending is a challenging research task. This task is made more challenging by variations in banks' risk appetite and in the perception of loan and other asset risks, both cross-sectionally between banks and in time series cyclically. Some banks may have relatively conservative business models, seeking to avoid substantial portfolio tail risk and doing all they can to avoid potential financial distress; other business models may involve much greater risk taking. These differences affect both desired capital buffers and the response to the discrepancy between desired and actual capital. In periods of credit expansion, banks across the industry may perceive risks of loss as relatively small and be unconcerned about low levels of capital buffers, while episodes of credit loss and especially systemic financial crisis may trigger perceptions of high levels of risk and more cautious behaviour.

Relatively high costs of bank equity arise for several reasons, most obviously agency costs arising from the separation of ownership and control in larger institutions: Senior management are disciplined by greater leverage and the resulting greater impact of their decisions on returns to equity holders. Debt may also have a relatively lower cost than equity for institutional reasons, for example, tax deductibility or access to strong retail deposit franchises. These reasons are especially important in an environment of high nominal interest rates. Arguably, short-term wholesale debt funding is also relatively less costly than long-term debt or equity because it exerts a stronger disciplinary role on management (Calomiris and Kahn 1991).

Costs of debt renegotiation and corporate restructuring are more difficult to characterise. These costs arise for several reasons, including the following: (i) the legal and administrative costs of valuing assets and assessing liabilities; (ii) the loss of value associated with finding purchasers of illiquid assets in 'fire sales'; (iii) the resolution of conflicting claims in debt renegotiation or corporate restructuring; and (iv) the loss of value from not continuing future value-creating operations or selling them at a discount, what is referred to in the banking context as loss of 'charter' or 'franchise' value. To offset these costs, in order to create value for equity and debt holders, it is possible to 'shift risk'—that is, transfer losses onto third parties, through government-backed bailouts or deposit insurance arrangements.

A further factor magnifying the costs and reducing the supply of bank credit is opacity. As long as bank portfolio risks are understood by outside investors, then the marginal benefit of higher capitalisation depends only on the resulting reduction in the expected costs of debt renegotiation and corporate restructuring, not on the allocation of return on loans or other investment assets between debt and equity holders. Equity holders, in response to higher capitalisation, will require higher returns to compensate them for greater risk exposure, but this is offset by lower required returns for debt holders, leaving overall funding costs unchanged. Opacity of risk imposes further costs on all outside investors, holders of both debt and equity. If risks are better understood by bank management and employees than by outside investors, then these costs can in theory be reduced through sharing equity with employees and management (i.e., giving them 'skin in the game'), but the extent of such reductions is unclear. Opacity of risk is also a major reason why low-income households and small businesses are excluded from access to credit. This implies that financial technologies can potentially reduce the opacity of bank credit portfolios and improve the supply of bank credit.

Appendix B: Data

B.1 | Data Sources

TABLE B.1 | Data sources.

	Description	Availability	Source
BA900	Banking sector balance sheet data at a bank level	Public data	SARB
BA930	Banking sector lending rates at a bank level	Aggregated data are public. Bank-specific data are private.	SARB
Controls	Banking sector performance data at a bank level	Aggregated data are public. Bank-specific data are private.	Prudential Authority
GDP	Nominal gross domestic product in a calendar year	Public data	Statistics South Africa
BA700	Regulatory capital buffer requirements	Aggregated data are public. Bank-specific data are private.	Prudential Authority
Repo rate	Policy rate of the SARB	Public data	SARB

B.2 | Data Description

TABLE B.2 | Data description.

Variable description	Data description	Measure	Cross-section	Sample	Frequency
Loans by lending category and bank	BA900 data on bank-level credit at a monthly frequency. We have summarised these into six lending categories, as explained in this appendix: household secured credit, household unsecured credit, household residential mortgages, nonfinancial sector secured credit, nonfinancial sector unsecured credit and nonfinancial sector mortgages.	Rand	Nedbank, First National Bank, Standard Bank, Absa	January 2008 to November 2022	Monthly
Lending rate by lending category and bank	BA930 data on bank-level lending rates at a monthly frequency. Lending rates are defined as the weighted average rate by lending category. These were also summarised into the same six lending categories as shown in this appendix.	Percent	Nedbank, First National Bank, Standard Bank, Absa	January 2012 to June 2022	Monthly
Capital buffer	Aggregate amount of qualifying capital and reserve funds less minimum required capital and reserve funds	Percent	Nedbank, First National Bank, Standard Bank, Absa	January 2008 to September 2020	Monthly
Capital requirement	Basel III required level of capital as a percentage of risk-weighted assets	Percent	Nedbank, First National Bank, Standard Bank, Absa	January 2008 to September 2020	Monthly
Repo rate	SARB policy rate	Percent	N/A	January 2008 to February 2021	Monthly
GDP	Nominal gross domestic product	Rand	N/A	March 2008 to March 2022	Quarterly
Bank-level performance metrics	The following bank performance metrics are included in the data: total assets, gross loan advances, retained earnings, net interest income (12 months), level one high-quality liquid assets required to be held, average daily amount of level one high-quality liquid assets held up to the 14th business day of the month following the month to which this return relates, aggregate risk-weighted exposure, return on equity, return on assets, total capital adequacy ratio and leverage ratio.	Rand and percent	Nedbank, First National Bank, Standard Bank, Absa	January 2008 to September 2022	Monthly

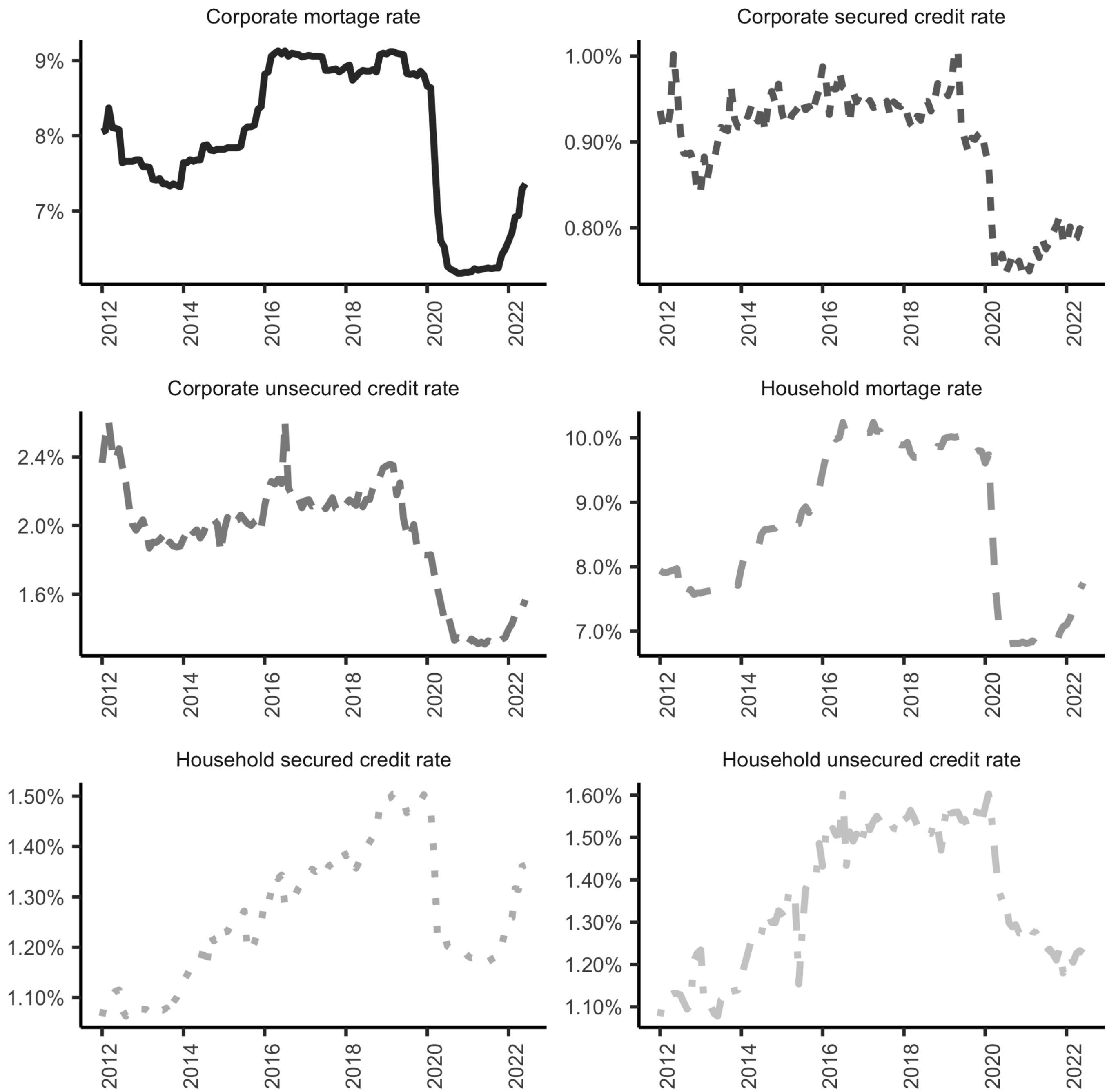

FIGURE B.1 | Lending rates.

B.4 | Aggregation Schema

The following table is derived from the BA900s, which provide the balance sheet return loan data (lines 103 to 277). The BA900s give relative magnitudes by financial corporate sector, nonfinancial corporate sector and household sector. These are the most granular data provided. The missing item numbers are all aggregations of these numbers.

TABLE B.3 | Aggregation schema.

BA900 categories	Item number	Sector	Aggregation key
Instalment sales	141	Financial corporate sector	—
	142	Nonfinancial corporate sector	a
	143	Household sector	c
	144	Other	a
Leasing transactions	146	Financial corporate sector	—
	147	Nonfinancial corporate sector	a
	148	Household sector	c
	149	Other	a
Farm mortgages	152	Nonfinancial corporate sector	b
	153	Household sector	b
	154	Other	b
Residential mortgages	156	Nonfinancial corporate sector	b
	157	Household sector	d
	158	Other	b
Commercial and other mortgages	160	Public financial corporates	—
	161	Public nonfinancial corporates	—
	162	Private financial corporates	—
	163	Private nonfinancial corporates	b
	164	Household sector	b
	165	Other	b
Credit cards	167	Financial corporate sector	—
	168	Nonfinancial corporate sector	a
	169	Household sector	c
	170	Other	c
Overdrafts	178	Public sector (includes public corporations and local government)	—
	181	Financial corporate sector	—
	182	Nonfinancial corporate sector	a
	183	Unincorporated business enterprises	e
	184	Other household sector	c
	185	Non-profit organisations serving households	c
Factoring debtors	187		a
Other loans and advances	189	Financial corporate sector	—
	190	Nonfinancial corporate sector	b
	191	Unincorporated business enterprises	e
	192	Other household sector	—
	193	Non-profit organisations serving households	—

The following aggregation scheme, which results in six categories, was followed based on Table B.3, with unincorporated enterprise credit as part of household unsecured lending.

a. Nonfinancial corporate sector secured credit: Items 142 + 147
b. Nonfinancial corporate sector unsecured credit: Items 168 + 182 + 187 + 190
c. Nonfinancial corporate sector mortgages (commercial and other mortgage advances): Items 152 + 153 + 154 + 156 + 158 + 163 + 164 + 165
d. Household sector secured credit: Items 143 + 148
e. Household sector unsecured credit: Items 169 + 184 + 185 + 192 + 193 + 183 + 191 (note, the last two items include unincorporated business enterprise credit)
f. Household sector residential mortgages: Item 157

The loan quantities from the BA900s are then linked to the lending rate data from the BA930s to create six lending rate categories, the weighting schema for which is provided in Table B.4.

The six categories, therefore, are as follows:

a. Nonfinancial corporate sector secured credit rate: weighted average of Items 49 + 51

TABLE B.4 | Weighting schema.

Sector	BA930 categories	Item number	Weighting key
Corporate	Overdrafts	48.000	b
	Instalment sale agreements flexible rate	49.000	a
	Instalment sale fixed rate	50.000	—
	Leasing transactions flexible rate	51.000	a
	Leasing transactions fixed rate	52.000	—
	Mortgage advances flexible rate	53.000	c
	Mortgage advances fixed rate	54.000	—
	Credit cards	55.000	b
	Other	56.000	b
Household	Overdrafts	58.000	e
	Instalment sale agreements flexible rate	59.000	d
	Instalment sale fixed rate	60.000	—
	Leasing transactions flexible rate	61.000	d
	Leasing transactions fixed rate	62.000	—
	Mortgage advances flexible rate	63.000	f
	Mortgage advances fixed rate	64.000	—
	Credit cards	65.000	e
	Other	66.000	e

b. Nonfinancial corporate sector unsecured credit rate: weighted average Items 48 + 55 + 56
c. Nonfinancial corporate sector mortgage rate: Item 53
d. Household sector secured credit rate: weighted average of Items 59 + 61
e. Household sector unsecured credit rate: weighted average of Items 58 + 65 + 66
f. Household sector residential mortgages: Item 63

Appendix C: Three-Month Loan Growth Results

TABLE C.1 | Household sector results with 3-month loan growth.

Dep. Var: $\Delta LOAN_{t,t-3}$	(1)	(2)	(3)	(4)	(5)
Household secured credit model					
$\Delta KR_{t,t-1}$	−0.0094***	−0.0096***	−0.0061*	−0.0076***	−0.0041
	(0.0030)	(0.0028)	(0.0034)	(0.0017)	(0.0033)
$\Delta KS_{t,t-1}$		−0.1009	−0.0152	−0.0315	0.0502
		(0.2955)	(0.3348)	(0.1753)	(0.2039)
$\Delta Demand_{t,t-1}$			−0.0001		0.0004
			(0.0089)		(0.0100)
ROA_{t-3}				0.3273	0.1973
				(4.5698)	(4.3791)
ROE_{t-3}				−0.2378	−0.2302
				(0.3768)	(0.3664)
$Liquidity_{t-3}$				−0.0274	−0.0267
				(0.0224)	(0.0236)
Num.Obs.	372	372	369	368	365
Adj.R squared	0.410	0.409	0.407	0.459	0.458
Test of equality (p-value)	0.00	0.00	0.16	0.00	0.26
Household unsecured credit model					
$\Delta KR_{t,t-1}$	−0.0099*	−0.0100*	−0.0032	−0.0096**	−0.0039
	(0.0051)	(0.0052)	(0.0056)	(0.0041)	(0.0063)
$\Delta KS_{t,t-1}$		−0.0522	0.1648	−0.0816	0.0769
		(0.1246)	(0.1561)	(0.1393)	(0.2098)
$\Delta Demand_{t,t-1}$			−0.0213*		−0.0194*
			(0.0122)		(0.0103)
ROA_{t-3}				2.7782	2.0878
				(4.1950)	(3.9166)
ROE_{t-3}				−0.2210	−0.1838
				(0.3458)	(0.3276)
$Liquidity_{t-3}$				−0.0153	−0.0089
				(0.0233)	(0.0241)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.565	0.564	0.580	0.561	0.573

(Continues)

TABLE C.1 | (Continued)

***Dep. Var*: Δ*LOAN*$_{t,t-3}$**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Test of equality (p-value)	0.05	0.03	0.07	0.02	0.22
Household mortgage credit model					
$\Delta KR_{t,t-1}$	−0.0020	−0.0020	−0.0018	−0.0028*	−0.0026**
	(0.0014)	(0.0015)	(0.0013)	(0.0015)	(0.0013)
$\Delta KS_{t,t-1}$		0.0055	0.0100	0.0200	0.0265
		(0.0498)	(0.0513)	(0.0624)	(0.0713)
$\Delta Demand_{t,t-1}$			−0.0016		−0.0015
			(0.0014)		(0.0013)
ROA_{t-3}				1.6274***	1.6751***
				(0.6151)	(0.5685)
ROE_{t-3}				−0.1130**	−0.1170**
				(0.0526)	(0.0468)
$Liquidity_{t-3}$				0.0085	0.0084
				(0.0072)	(0.0071)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.694	0.693	0.693	0.736	0.736
Test of equality (p-value)	0.19	0.24	0.19	0.02	0.01

Note: The dependent variable is loan growth at bank level at a monthly frequency, calculated as the log difference at t and $t-3$. All control variables are defined in Table 3. Standard errors are clustered at a bank level. All equations include both bank and monthly effects. A test for equality p-value of <0.1 is significant.
***$p<0.01$.
**$p<0.05$.
*$p<0.1$.

TABLE C.2 | Nonfinancial corporations results with 3-month loan growth.

***Dep. Var*: Δ*LOAN*$_{t,t-3}$**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Nonfinancial corporations secured credit model					
$\Delta KR_{t,t-1}$	−0.0113**	−0.0114**	−0.0013	−0.0084	−0.0016
	(0.0054)	(0.0055)	(0.0087)	(0.0059)	(0.0073)
$\Delta KS_{t,t-1}$		−0.0510	0.2170	0.1645	0.3136
		(0.1622)	(0.2017)	(0.1943)	(0.1922)
$\Delta Demand_{t,t-1}$			−0.0126*		0.0064
			(0.0070)		(0.0063)
ROA_{t-3}				1.1543	0.9446
				(3.5779)	(3.8589)
ROE_{t-3}				−0.1414	−0.1250
				(0.2154)	(0.2376)
$Liquidity_{t-3}$				−0.0496***	−0.0493***
				(0.0047)	(0.0042)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.410	0.409	0.407	0.459	0.458
Test of equality (p-value)	0.00	0.00	0.16	0.00	0.26

(Continues)

TABLE C.2 | (Continued)

$\boldsymbol{Dep. Var}$: $\boldsymbol{\Delta LOAN_{t,t-3}}$	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Nonfinancial corporations unsecured credit model					
$\Delta KR_{t,t-1}$	0.0313***	0.0303***	0.0157**	0.0408***	0.0190**
	(0.0016)	(0.0018)	(0.0066)	(0.0074)	(0.0093)
$\Delta KS_{t,t-1}$		−0.4822	−0.7947	−0.3665	−0.8247
		(0.6430)	(0.6690)	(0.4773)	(0.5198)
$\Delta Demand_{t,t-1}$			−0.0134		0.0046
			(0.0082)		(0.0092)
ROA_{t-3}				3.0914	4.0843
				(4.8279)	(4.1092)
ROE_{t-3}				−0.1259	−0.1892
				(0.2285)	(0.1804)
$Liquidity_{t-3}$				−0.0738***	−0.0807***
				(0.0216)	(0.0223)
Num.Obs.	372	372	364	368	360
Adj.R squared	0.565	0.564	0.580	0.561	0.573
Test of equality (p-value)	0.05	0.03	0.07	0.02	0.22
Nonfinancial corporations mortgage credit model					
$\Delta KR_{t,t-1}$	0.0027	0.0025	0.0015	0.0006	0.0006
	(0.0113)	(0.0117)	(0.0112)	(0.0113)	(0.0108)
$\Delta KS_{t,t-1}$		−0.1010	−0.1307	−0.1236	−0.1566
		(0.3393)	(0.3985)	(0.3404)	(0.3608)
$\Delta Demand_{t,t-1}$			0.0037		−0.0007
			(0.0057)		(0.0034)
ROA_{t-3}				4.1386	3.6179
				(6.2007)	(6.0718)
ROE_{t-3}				−0.2979	−0.2599
				(0.4071)	(0.4075)
$Liquidity_{t-3}$				0.0225	0.0234
				(0.0251)	(0.0244)
Num.Obs.	372	372	368	368	364
Adj.R squared	0.694	0.693	0.693	0.736	0.736
Test of equality (p-value)	0.19	0.24	0.19	0.02	0.01

Note: The dependent variable is loan growth at bank level at a monthly frequency, calculated as the log difference at t and $t-3$. All control variables are defined in Table 3. Standard errors are clustered at a bank level. All equations include both bank and monthly effects. A test for equality p-value of <0.1 is significant.
***$p<0.01$.
**$p<0.05$.
*$p<0.1$.