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The Impact of Bank Regulation on Commercial Bank Performance: Evidence From South Africa

Tendai Gwatidzo

School of Economics and Finance, Witwatersrand University, Johannesburg, South Africa

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ABSTRACT

Using data on South Africa's commercial banks in the period 2005–2018, this paper investigates the impact of bank regulation on bank performance. The study uses a fixed effects model to run the regression model as well as the data envelopment analysis approach to estimate efficiency scores. We find a number of interesting results. First, we find a negative relationship between capital stringency and bank performance, suggesting that increased capital requirements force banks to increase their reserves, adversely affecting their performance. Second, we find a positive relationship between activity restrictions and bank performance, indicating that this kind of regulation, which may well be good for the public as argued by the public interest view of regulation, is also good for the regulated banks. Third, we find a negative and significant relationship between supervisory power and bank performance. Fourth, we find a positive and significant relationship between the market discipline index and bank performance, suggesting that by creating environments characterised by high market discipline, the regulatory regime enhances the ability and incentives of private investors to efficiently monitor banks. This ensures better management of banks, ultimately increasing profitability. Overall, the study finds that regulation matters for bank performance.

JEL Classification: G21, E58, L51, O16

1 | Introduction

During and after the 2008–2010 global financial crisis (GFC), several regulatory reforms were introduced (Hassan 2020; Barth, Caprio, and Levine 2006; Admati and Hellwig 2013). This was in part an acknowledgement that inadequate regulation may have contributed to the crisis. Indeed, the debate on the role and efficacy of bank regulation was reignited during and just after the GFC.[1] Prior to 2008, most policymakers and researchers leaned heavily towards minimal bank regulation (or deregulation).

Bank regulation is especially important given the role that banks play in any given economy and the implications of bank failures for a nation's economy. First, a number of problems are inherent in the financial system, including ubiquitous market failure, information asymmetry and externalities (negative and positive). Given their relationships with borrowers, banks face problems of moral hazard and adverse selection. In an environment with acute information asymmetry, the outcomes from that can be highly suboptimal (Stiglitz and Weiss 1981; Akerlof 1970). For example, they may result in credit rationing (Stiglitz and Weiss 1981) or reckless lending. Banks also sell financial products and, in most cases, know more about their products than do the buyers; it may take a long time for buyers to learn about the products, if at all (Barth, Caprio, and Levine 2006; Pelaez and Pelaez 2009). This leads to the creation of a new industry (such as asset management firms) in which professionals are hired to represent the buyers, but this creates its own problems of information asymmetry and comes with its own agency costs. Some products are highly complex, such that the general public (mostly buyers) may not

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be able to properly evaluate them. Moreover, some products (such as mortgages) involve substantial financial resources that are borrowed over very long periods. Any mistakes by the banks may be felt in the long term and may be very costly for the individual consumer.

Second, a significant proportion of bank debt is held by households, which are generally not in a position to monitor a complex entity like a bank. Because their individual deposits are small relative to the holdings of individual banks and they are dispersed and largely uninformed, these household depositors have little to no incentive to monitor banks. In most cases, they lack the organisational capacity and coordination to monitor banks. The government is therefore well-placed to regulate and monitor banks on behalf of its citizens.

Third, if a bank faces challenges (e.g., poor management or poor performance), depositors are more likely to leave the bank than intensify their monitoring of it. This can cause the bank to fail, which, if not well managed, could lead to the failure of the entire banking system through contagion. A bank failure can directly affect multiple stakeholders, including depositors, bank shareholders, other banks and borrowers (who may have created a valuable long-term relationship with the failing bank). A bank failure can also affect a country's national payments system, and the effects of a banking system failure can be propagated across the entire economy. Table 1

TABLE 1 | Estimated economic costs of banking crises.

Country	Years of crisis	Cost of crisis as % of GDP
Argentina	1980–1982, 1985	13–55
Brazil	1994–1996	4–10
Chile	1981–1985	19–41
Colombia	1982–1987	5–6
Finland	1991–1993	8–10
Indonesia	1994	2
Japan	1990	3
Malaysia	1985–1988	5
Mexico	1994–1995	12–15
Norway	1988–1992	4
Philippines	1981–1987	3–4
Spain	1977–1985	15–17
Sri Lanka	1989–1993	9
Sweden	1991–1993	4–5
Thailand	1983–1987	1
Turkey	1982–1985	3
USA	1984–1991	5–7
Uruguay	1981–1984	31
Venezuela	1980–1983, 1994–1995	17

Source: IMF (1998).

shows that the economic costs of a banking crisis can be significant—the International Monetary Fund (IMF) estimates that the costs can be as high as 55% of a country's gross domestic product (GDP) (IMF 1998).

Fourth, if not efficiently monitored, banks can easily abuse their monopolistic powers, ultimately harming the welfare of ordinary civilians. Fifth, in a country like South Africa, which continues to face the challenges of unemployment, poverty and inequality, there is undoubtedly a need for a multi-pronged approach to the country's multi-faceted challenges. A well-regulated banking sector can play an important role by, for example, increasing financial inclusion; protecting investors, customers and other users of the financial system; guaranteeing macroeconomic stability (especially financial system stability); correcting market failures inherent in the financial system; ensuring banking sector efficiency; stimulating banking sector competition; and preventing crime. The above points demonstrate the need for financial system regulation, and the South African Reserve Bank (SARB), the country's central bank, emphasises the need for banking sector stability.[2]

This study's main objective is to investigate the impact of bank regulation on bank performance. We ask whether enhanced bank regulation stimulates bank performance—an important issue given that there is no agreement in the literature on this question. In fact, the two theories on regulation (the public interest and private interest views) predict contrasting results. The public interest view suggests that regulation is beneficial, whereas the private interest view suggests that regulation can be bad for the financial system and the country at large. Furthermore, regulation takes many forms, some of which may have contrasting effects. It includes activity restrictions, entry restrictions, capital requirements, supervision, safety net support and market monitoring. It is therefore important to understand the differential effects of the various regulations on bank performance. This is especially important for the regulator and the government, as care must be taken to ensure that regulation does not impose unnecessary costs on the regulated and that it does not create perverse incentives.

The effects of regulation also differ according to the context and environment being considered. Country-specific studies that take into account the environment in which banks operate can be very useful and offer more insights than cross-country studies. This study therefore focuses on South Africa, an emerging economy with a highly developed financial system. South Africa also has a number of banks operating in other African countries. Understanding the impact of regulation in South Africa can be useful for other emerging and developing economies, especially those in the rest of the continent. Indeed, as African countries continue to economically integrate[3] and cross-border banking gains momentum, strategies on efficient regulation are of paramount importance. Such regulation should, among other things, also look at reducing regulation arbitrage.

The paper is organised as follows: Section 2 provides some background information on the South African banking sector, and Sections 3 and 4 review the theoretical and empirical literature

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on bank regulation, respectively. Section 5 presents the methodology for the study, and Section 6 presents the approach used to estimate efficiency scores. Data and variables used for the study are presented in Section 7. Sections 8 and 9 present the estimation results. Section 10 concludes the study.

2 | The South African Banking Sector and the Relevant Legislative Instruments

In this section, we briefly look at the main indicators of the South African banking sector and the legal instruments that guide its operations. The South African banking sector is an important component of the country's financial system. As of January 2023, the sector had eighteen registered commercial banks, four mutual banks, five cooperative banks and twelve local branches of foreign banks. Figure 1 shows that over the period 2000–2020, domestic credit provided by banks to the private sector (as a percentage of GDP) averaged about 62%. Table 2 shows that the banking sector's asset base is quite strong, with total assets of R6 215 billion in 2017 and R6 943 billion in 2022, an increase of about 12% over the period. Over the same period, total deposits increased by an annual average of about 5%. Profitability indicators averaged 12% (return on equity) and 0.97% (return on assets) over the same period, and the cost-to-income ratio averaged 58%.

The SARB is the national regulator of the banking sector. The sector is regulated through several legal instruments, including the Banks Act of 1990, the Financial Sector Regulation Act of 2017 and the National Credit Act of 2005. The Banks Act is the main legal instrument governing the country's banking sector, mainly governing bank licensing (South Africa 1990). To ensure sufficient coverage of all players in the financial system, the legal framework in South Africa also includes the Insurance Act of 2017, the Mutual Banks Act of 1993 and the Co-operative Banks Act of 2007. Commercial banks, mutual banks and cooperative banks must also comply with the country's Companies Act. The Financial Sector Regulation Act created the Prudential Authority and the Financial Sector Conduct Authority, paving the way for the country's Twin Peaks model of regulation. The main functions of the Prudential Authority include the licensing of banks, bank supervision, ensuring compliance through enforcement, protecting bank customers and promoting financial

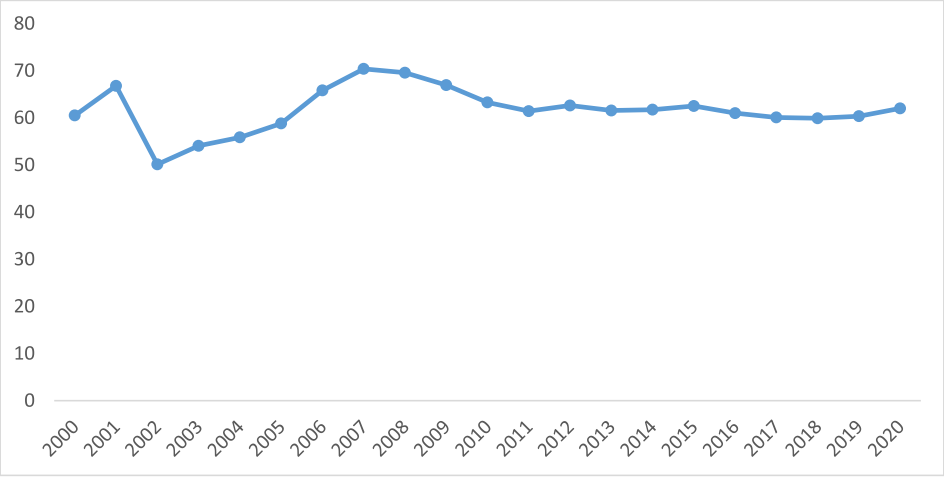

FIGURE 1 | Domestic credit to the private sector by South African banks (% of GDP). *Source:* World Development Indicators database [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 2 | Selected banking indicators for the South African banking sector.[a]

Year	Bank total assets (in billions of rands)	Total deposits (in billions of rands)	Return on equity (%)	Return on assets (%)	Cost-to-income ratio
2017	6215	4162	17.43	1.33	55.20
2018	6355	4518	15.74	1.31	57.07
2019	6514	4652	14.37	1.15	58.8
2020	7038	4973	6.93	0.51	58.73
2021	6886	5041	13.79	1.09	58.24
2022	6943	5166	14.87	1.14	57.04
Annual average	6658	4752	12.49	0.97	58.20

Source: SARB selected South African banking sector trends (various years).
[a]Total assets and total deposits are in real terms (2021 = 100).

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institutions' safety.[4] The Financial Sector Conduct Authority's functions are to enhance financial system efficiency, promote the fair treatment of customers and ensure that bank customers are literate enough to make sound financial decisions (South Africa 2017). In addition, the National Credit Act of 2005 created the National Credit Regulator, the country's main regulator of credit providers (South Africa 2005).

3 | Literature Review

In this section, we briefly look at two important views on regulation: the public interest and private interest views. We also look at the various types of regulations and how they are hypothesised to affect bank performance. We focus on the following regulations: activity restrictions, capital regulations, market discipline and supervisory powers.

According to the public interest view, regulation is necessary to promote public interests. According to this view, there are many problems facing the banking sector that necessitate government intervention (Barth, Caprio, and Levine 2006). These problems include, but are not limited to, monopolies (lack of competition), externalities, information asymmetry and contract enforcement failure (Pelaez and Pelaez 2009). If not adequately addressed, these problems can seriously affect resource allocation and, ultimately, the performance of the economy. For example, excessive bank market power can result in dominance abuse, leading to welfare loss for consumers, whereas externalities (positive or negative) can result in reckless lending or excessive credit rationing.

Information asymmetry affects two important contracting relationships: the relationship between lenders (banks) and borrowers and the relationship between banks and depositors. The first relationship is affected by moral hazard and adverse selection. Depending on the environment, information asymmetry, through adverse selection and moral hazard, can result in credit rationing or excessive risk-taking by banks (both of which are suboptimal outcomes). Although these problems have received a lot of attention in the literature, the second relationship has received less attention. Information asymmetry affects the relationship between depositors and banks because insiders (such as bank managers) have more information than outsiders (such as depositors). As a result, shocks such as sharp drops in real estate prices can easily trigger bank runs as depositors lose confidence in banks with high real estate exposure (Barth, Caprio, and Levine 2006). There is therefore a need for governments to regulate banks to ensure public interest goals (such as protecting consumers, enhancing competition, preventing costly banking crises and facilitating economic growth). Moreover, banks need to be regulated as instability in the banking sector can easily affect the entirety of both the banking sector and the economy (Admati and Hellwig 2013). In its 1998 Economic Outlook, the IMF found that the economic costs of a banking crisis can be as high as 55% of a country's GDP.

The private interest view, on the other hand, argues that an important risk of bank regulation is that it may be used to pursue the interests of private individuals, groups or organisations. In the extreme, the regulated may be so influential such that they may ensure the establishment of regulations that promote their own interests. The private interest view also argues that government may fail to correct the problems of market failure it seeks to correct.

In addition to the above views on regulation, we also look at how the specific bank regulations of capital regulation, activity restriction, supervisory power and market discipline affect bank performance. There are opposing views on the relationship between capital regulation and bank performance. Capital regulation can force bank owners to expose an increased amount of their own capital to risk, aligning the incentives of bank owners with those of depositors (Barth, Caprio, and Levine 2013). For example, capital adequacy requirements force banks to be more careful when lending or engaging in other bank activities. This reduces the possibility of future default and can stimulate bank performance. However, high capital requirements create high barriers of entry into the sector (Admati and Hellwig 2013; Barth, Caprio, and Levine 2013), which can impose costs on society and bank customers through, for example, rent extraction by banks or inefficiencies associated with monopolistic environments, adversely affecting bank performance.

There are opposing views on the relationship between activity restrictions and bank performance. One view argues that activity restrictions can be detrimental to the performance of banks because they make it difficult for banks to take advantage of economies of scale and scope (Barth, Caprio, and Levine 2013). According to Barth, Caprio, and Levine (2013), activity restrictions also make it difficult for banks to diversify their income streams. Innovative banks seeking alternative streams of income may therefore find it difficult to operate in highly restrictive regulatory regimes. However, another view argues that without such restrictions, banks may become involved in too many non-core activities, making them highly complex and difficult to monitor and regulate (Laeven and Levine 2007). The relationship between activity restrictions and bank performance is therefore empirical.

There are also opposing views on the relationship between supervisory power of bank regulators and bank performance. A regulatory regime that gives supervisory agencies sufficient powers to monitor and exert corporate governance over banks may encourage bank vigilance and help enhance their performance. However, there is also a danger that they will abuse their powers to the detriment of the regulated banks. We thus argue that the relationship between supervisory power and bank performance is also empirical.

Finally, we hypothesise a positive relationship between market discipline and bank performance. By forcing banks to furnish investors with the right information for the efficient monitoring and enhancement of good corporate governance, a regulatory regime ensures that the market can discipline errant banks. Such efficient monitoring and good corporate governance force banks to perform better. Private investors and regulators have different incentives, but because they have a stake in the banks, private investors may be motivated to monitor and discipline the banks (Barth, Caprio, and Levine 2013). Our hypothesis is thus that banks perform better in environments that allow for more private investor monitoring.

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4 | Empirical Literature on the Effects of Bank Regulation on Bank Performance

The GFC reignited the debate on the effectiveness of bank regulation. A number of studies have been conducted to inform policy on how best to regulate banks, including Deli and Hasan (2017), Hassan (2020), and Naceur and Omran (2011). Pelaez and Pelaez (2009) and Barth, Caprio, and Levine (2006) provide comprehensive reviews of bank regulation. Deli and Hasan (2017) examine the effect of a number of bank capital regulations on loan growth and find that, overall, capital stringency has a negative effect on loan growth. They argue that this is completely offset if banks hold moderately high levels of capital. They also find that the components of capital stringency with the strongest negative effect on loan growth are those that prevent banks from using borrowed funds and assets other than cash or government securities as capital.

Barth, Caprio, and Levine (2013) use a sample of over 4000 banks in a number of countries, including South Africa, to investigate whether bank regulation, supervision and monitoring enhance or impede bank operating efficiency. They find that tighter restrictions on bank activities are negatively associated with bank efficiency, whereas greater capital regulation stringency is positively associated with bank efficiency. They also find that strengthening official supervisory power is positively associated with bank efficiency, especially in countries with independent supervisory authorities.

Hassan (2020) finds that high capital requirements come with reputation rewards and tend to enhance bank performance. He also finds that activity restrictions are negatively associated with productivity, in line with the view that activity restrictions affect the bank's ability to benefit from economies of scope. Supervisory powers are also found to exert a positive and significant effect on bank performance (Hassan 2020). Naceur and Omran (2011) find that bank-specific characteristics, in particular bank capitalisation and credit risk, exert a positive and significant impact on bank performance.

Pasiouras, Tanna, and Zopounidis (2009) used 2000–2004 data on 615 listed commercial banks from 74 countries to investigate the impact of bank regulation on bank efficiency (both cost efficiency and profit efficiency). Using the stochastic frontier approach, they focus on bank supervision, activity restrictions, capital adequacy and market discipline and find that different types of bank regulation have different effects on bank efficiency. For example, they find that increases in market discipline and bank supervision tend to enhance bank efficiency (both cost efficiency and profit efficiency), whereas stricter capital requirements are found to enhance cost efficiency but adversely affect profit efficiency. Activity restrictions, on the other hand, are found to reduce cost efficiency while improving profit efficiency, suggesting that banks may sacrifice cost efficiencies to exploit profit efficiency opportunities (Pasiouras, Tanna, and Zopounidis 2009). Pasiouras, Tanna, and Zopounidis (2009) also argue that bank regulation affects bank competition and efficiency. For each country, it is therefore important for regulators to consider the relationship between regulation, competition and efficiency (Pasiouras, Tanna, and Zopounidis 2009). The relationship between capital requirements and bank efficiency is corroborated by Bitar, Pakthuanthong, and Walker (2018) using a sample of 1992 banks from countries within the Organisation for Economic Co-operation and Development. Demirguc-Kunt, Laeven, and Levine (2003), using a sample of 1400 banks from 72 countries, find a positive relationship between bank activity restrictions and net interest margins.

Using data on more than 4000 banks from 72 countries between 1999 and 2007, Barth, Caprio, and Levine (2013) investigate the impact of bank regulations on operating efficiency. Their study, which uses panel data analysis, finds that activity restrictions, capital requirement stringency and bank supervision all have significant impacts on bank performance. The findings also suggest that different forms of bank regulation may have conflicting effects on bank efficiency. For example, increased activity restrictions and increased bank supervision are found to negatively affect bank efficiency, whereas increased capital requirements stringency exerts a positive effect on bank efficiency. This implies that simultaneously increasing bank activity restrictions and capital requirements stringency can result in conflicting impacts on bank efficiency.

Delis, Molyneux, and Pasiouras (2011) use data on 582 banks from 22 countries between 1999 and 2009 to investigate the impact of bank regulation on bank productivity. Using a semiparametric two-step approach, they find that restrictions on bank activities and market discipline have a positive effect on bank productivity.

5 | Methodology and Data

This study uses several bank performance measures [return on assets (ROA), return on equity (ROE), net interest margin (NIM), gross loan ratio (GLR) and efficiency scores], as does the existing literature. ROA, ROE, NIM and GLR can easily be calculated from the provided data, but the efficiency scores must be calculated first. The calculated efficiency scores are then regressed on bank regulation measures and control variables. We use the data envelopment analysis (DEA) approach to estimate Malmquist productivity indices. The following equation on the relationship between bank performance and regulation shows the estimated baseline panel regression model:

$$Bank\ performance_{it} = \alpha_0 + \alpha_1 Regulation_t + \sum_{k=1}^{j} \beta_k BSF_{kit} + \sum_{k=1}^{j} \gamma_k Macro_{kt} + v_{it} \quad (1)$$

where v_{it} is a composite error term given by $v_{it} = \alpha_i + u_{it}$; α_i is an unobserved bank effect or bank fixed effect; and u_{it} is the time-varying error component. $Bank\ performance_{it}$ is the performance of bank i at time t. The banking sector regulations

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(activity restrictions, capital regulation, supervisory power and market discipline) are measured using the variable '*Regulation*'. BSF_{kit} is the bank-specific factor k for bank i at time t; the bank-specific factors include bank size, equity ratio, risk and staff expense ratio. $Macro_{kt}$ is the macroeconomic factor k at time t.[5] Equation (1) was estimated using a fixed effects panel data model. For robustness, and to the extent that current performance is affected by past performance, we also estimate a dynamic model using the generalised method of moments (GMM):

$$Bank\ performance_{it} = \alpha_0 + \alpha_1 Regulation_t + \alpha_2 Bank\ performance_{it-1} + \sum_{k=1}^{j} \beta_k BSF_{kit} + \sum_{k=1}^{j} \gamma_k Macro_{kt} + \varepsilon_{it} \quad (2)$$

We also estimate bank efficiency scores and assess the impact of regulation on efficiency, as in the existing literature. The parameter of interest is α_1: if α_1 is found to be positive, we conclude that regulation enhances bank performance; if α_1 is found to be negative, we conclude that regulation is detrimental to bank performance.

6 | Estimating Bank Efficiency

To estimate bank productivity growth, we use the DEA approach to estimate the Malmquist indices. The approach estimates output- and input-oriented efficiency scores assuming either constant returns to scale or variable returns to scale (Chen and Ali 2004). Assuming a bank that uses a vector of inputs $x=(x_1, x_2, \ldots \ldots \ldots \ldots \ldots x_k)$ to produce a vector of outputs given by $y=(y_1, y_2, y_3, \ldots \ldots \ldots \ldots \ldots y_L)$, then total factor productivity (TFP) growth is estimated by M_0 as follows:

$$M_0 = \left[\frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^t(y_t, x_t)} \times \frac{D_0^{t+1}(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_t, x_t)} \right]^{\frac{1}{2}} \quad (3)$$

M_0 measures the productivity change between period t (base period) and period $t+1$. M_0 takes various important ranges: It can be greater than 1 (indicating productivity gain from period t to $t+1$), equal to 1 (indicating no change in productivity) or less than 1 (indicating productivity loss for the bank) (Chen and Ali 2004). $D_0^t(y_{t+1}, x_{t+1})$ measures the distance from period $t+1$ observation to period t technology (Delis, Molyneux, and Pasiouras 2011). Once the efficiency scores have been estimated, they are used as a dependent variable in a regression to better understand the effect of bank regulation on bank performance.

This two-stage procedure has been criticised in the literature, as it can generate biased efficiency scores. To correct for this, we also use the approach suggested by Simar and Wilson (2007) to generate bias-corrected scores, which we then also use to measure bank performance.

To estimate the efficiency scores, one needs to determine the bank inputs and outputs. We use the intermediation approach (Sealey and Lindley 1977; Curi et al. 2013), according to which banks use physical capital, labour and deposits to generate loans and other assets. The inputs for the bank are therefore labour (measured as total labour expenses), physical capital (measured using total fixed assets) and deposits (measured using both customer and interbank deposits). The outputs for the banks are loans and other income-earning assets.

7 | Data and Variables Used for the Study

We use panel data on South Africa's 18 commercial banks for the period 2005–2018. Bank-specific characteristics change across banks over the sample period, whereas the macroeconomic variables and bank regulation measures are not bank-specific; they change over time but not across banks. The data

TABLE 3 | Summary statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
ROA	206	1.53	1.99	−8.59	9.55
ROE	206	13.04	8.68	−13.15	33.68
NIM	206	5.03	4.92	0.89	29.74
Gross loans to total assets	206	56.33	18.90	0.30	92.39
TFP change (output-oriented)	191	0.98	0.18	0.15	1.50
BCES-CRS	210	0.263	2.518	1	30.76
BCES-NIRS	205	0.58	0.22	0.00	0.91
ARI	206	6.02	1.02	5.00	8.00
CSI	206	7.61	1.91	5.00	9.00
SPI	206	9.24	3.62	4.00	13.00
MDI	206	9.54	0.50	9.00	10.00
Bank size	209	15.11	2.80	0.97	18.66
Equity ratio	207	0.13	0.12	0.04	1.00
Staff expense ratio	208	0.02	0.02	0.01	0.13
Risk	206	0.86	0.65	0.16	5.47
Inflation	206	5.19	2.19	−0.69	10.07
GDP growth	206	2.44	2.47	−6.34	5.60

Abbreviations: BCES-CRS stands for bias-corrected output efficiency scores assuming constant returns to scale (CRS). BCES-NIRS stands for bias-corrected efficiency scores assuming non-increasing returns to scale (NIRS).
Source: Own calculations from BankFocus, World Bank regulatory databases.

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TABLE 4 | Correlation matrix.

Variables	ARI	CSI	SPI	MDI	ROA	ROE	NIM	BAS	ER	Risk	GLR	GG	INF	SER	TFP	BCES-CRS	BCES-NIRS
ARI	1.00																
CSI	1.00	1.00															
SPI	−0.31	1.00	1.00														
MDI	0.56	−1.00	−0.49	1,00													
ROA	0.10	−0.10	−0.10	0,02	1.00												
ROE	0.25	−0.17	0.16	0,25	0.81	1.00											
NIM	−0.01	−0.05	−0.05	0.03	0.08	0.07	1.00										
Bank size (BAS)	0.31	−0.24	−0.22	0.32	0.21	0.33	−0.14	1.00									
Equity ratio (ER)	−0.11	0.10	0.09	−0.12	−0.39	−0.26	0.25	−0.45	1.00								
Risk	0.05	−0.02	−0.02	0.04	0.09	0.06	0.35	0.09	0.19	1.00							
GLR	0.22	−0.17	−0.16	0.23	0.31	0.30	0.10	0.37	−0.33	0.45	1.00						
GDP growth (GG)	0.73	−0.20	−0.17	0.47	0.13	0.22	0.00	0.13	−0.03	0.03	0.12	1.00					
Inflation (INF)	−0.19	−0.38	−0.15	−0.01	0.15	0.18	0.10	−0.01	0.02	0.05	0.10	−0.06	1.00				
Staff expense ratio (SER)	−0.04	0.02	0.02	−0.03	−0.61	−0.50	0.38	−0.41	0.79	0.04	−0.40	−0.06	−0.00	1.00			
TFP change (TFP)	0.05	0.02	0.02	0.01	0.35	0.37	0.09	0.12	−0.00	0.30	0.26	0.02	0.14	−0.08	1.00		
BCES-CRS	−0.06	0.05	0.04	−0.07	−0.44	−0.65	−0.03	−0.11	0.07	−0.26	−0.27	0.05	−0.04	0.23	−0.29	1.00	
BCES-NIRS	0.17	−0.14	−0.12	0.18	0.24	0.25	−0.10	0.39	−0.38	0.73	0.91	0.13	0.12	−0.47	0.24	−0.21	1.00

Abbreviations: BCES-CRS stands for bias-corrected output efficiency scores assuming constant returns to scale (CRS). BCES-NIRS stands for bias-corrected efficiency scores assuming non-increasing returns to scale (NIRS).
Source: Own calculations from BankFocus, World Bank regulatory databases.

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TABLE 5 | Impact of bank regulation on bank performance (when using ROA as the dependent variable).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank size	−3.072***	−2.871***	−2.994***	−2.720***	−3.082***	−2.702***	−2.998***	−2.771***
	(0.40)	(0.39)	(0.34)	(0.36)	(0.43)	(0.39)	(0.36)	(0.37)
Equity ratio	43.964***	39.910***	42.180***	41.683***	44.238***	40.267***	42.098***	42.000***
	(4.74)	(3.41)	(3.29)	(3.33)	(4.78)	(3.37)	(3.32)	(3.31)
Staff expense ratio	−168.369***	−160.357***	−166.142***	−162.027***	−168.449***	−159.896***	−166.161***	−163.510***
	(10.38)	(10.08)	(9.59)	(9.67)	(10.58)	(9.96)	(9.71)	(9.64)
Risk	−1.260***	−1.237***	−1.298***	−1.292***	−1.252***	−1.300***	−1.304***	−1.320***
	(0.26)	(0.25)	(0.24)	(0.25)	(0.26)	(0.25)	(0.24)	(0.24)
CSI	−0.238***				−0.252***			
	(0.06)				(0.06)			
ARI		0.155				0.345**		
		(0.11)				(0.15)		
SPI			−0.132***				−0.129***	
			(0.03)				(0.03)	
MDI				0.773***				0.916***
				(0.21)				(0.23)
Inflation					−0.007	0.120**	0.018	0.060
					(0.07)	(0.06)	(0.06)	(0.06)
GDP growth					−0.060	−0.090	−0.007	−0.088
					(0.08)	(0.07)	(0.06)	(0.06)
Constant	48.158***	43.519***	47.659***	34.772***	48.503***	39.451***	47.603***	34.075***
	(6.22)	(6.41)	(5.48)	(6.53)	(6.84)	(6.56)	(5.87)	(6.52)
Observations	163	181	181	181	163	181	181	181
R-squared	0.722	0.682	0.713	0.705	0.723	0.695	0.713	0.713
F-statistic	71.64***	67.03***	77.33***	74.42***	50.76***	50.06***	54.60***	54.70***

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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TABLE 6 | Impact of bank regulation on bank performance (when using ROE as the dependent variable).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank size	−4.018**	−3.099	−6.112***	−4.490**	−2.173	−1.965	−3.458*	−3.014
	(2.02)	(1.93)	(1.90)	(1.90)	(2.10)	(1.92)	(1.87)	(1.87)
Equity ratio	58.900**	34.273**	32.506*	38.790**	53.149**	32.211*	29.446*	32.980*
	(24.15)	(16.97)	(18.18)	(17.55)	(23.57)	(16.52)	(17.12)	(16.96)
Staff expense ratio	−239.041***	−237.510***	−268.841***	−262.212***	−217.773***	−229.566***	−241.393***	−242.356***
	(52.90)	(50.20)	(52.93)	(50.98)	(52.19)	(48.79)	(50.02)	(49.36)
Risk	−4.991***	−5.222***	−5.083***	−5.310***	−5.415***	−5.664***	−5.511***	−5.595***
	(1.33)	(1.26)	(1.33)	(1.29)	(1.30)	(1.24)	(1.26)	(1.25)
CSI	−0.661**				−0.347			
	(0.29)				(0.30)			
ARI		2.371***				1.833**		
		(0.54)				(0.71)		
SPI			−0.222				−0.086	
			(0.17)				(0.17)	
MDI				3.822***				1.880
				(1.09)				(1.17)
Inflation					0.931**	0.825***	0.647**	0.624**
					(0.36)	(0.29)	(0.31)	(0.29)
GDP growth					0.720*	0.786**	1.361***	1.155***
					(0.37)	(0.36)	(0.29)	(0.31)
Constant	79.017**	52.262	114.174***	50.845	43.381	32.612	66.564**	41.568
	(31.72)	(31.90)	(30.28)	(34.41)	(33.72)	(32.13)	(30.24)	(33.35)
Observations	163	181	181	181	163	181	181	181
R-squared	0.217	0.266	0.183	0.234	0.270	0.318	0.290	0.300
F-statistic	7.630***	11.33***	7.00***	9.552***	7.17***	10.24***	8.97***	9.43***

Note: Standard errors are in parentheses
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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used for the study are derived from a number of sources. The financial information on South Africa's commercial banks was sourced from the BankFocus database, which is provided by Bureau van Dijk and Fitch Ratings. The database provides detailed information from each bank's financial statements (balance sheets, profit and loss accounts and cash flow statements). The information is also standardised, ensuring that the results from the study can be easily compared with other country studies that use the BankFocus database. The data on bank regulation were sourced from Barth, Caprio, and Levine (2013) and the World Bank regulatory databases. The macroeconomic variables such as inflation and economic growth were sourced from Statistics South Africa and the World Development Indicators database.

Table A1 in the Annexure shows all the variables used in the study. We use and follow the approach of Barth, Caprio, and Levine (2013) and Barth, Caprio, and Levine (2013) to measure bank regulation, focusing on four indices: the activity restriction index (ARI), capital stringency index (CSI), supervisory power index (SPI) and market discipline index (MDI).[6] The ARI measures the extent to which banks are allowed to engage in non-core banking activities (Barth, Caprio, and Levine 2013; Barth, Caprio, and Levine 2013) such as securities activities, real estate activities and insurance activities. Higher ARI values indicate stricter regimes, in which banks' involvement in non-core activities is minimised. The CSI measures the extent of capital stringency imposed on banks by the regulator. The index focuses on the amount of capital banks are mandated to hold and on restrictions on the nature and source of capital raised by banks (Barth, Caprio, and Levine 2013). Higher CSI values indicate regimes with higher capital stringency. The SPI considers the measures the regulator is allowed to enforce against banks. More specifically, it

TABLE 7 | Impact of bank regulation on bank performance (when using NIM as the dependent variable).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank size	−3.945***	−3.797***	−3.521***	−3.505***	−4.025***	−3.648***	−3.572***	−3.508***
	(0.45)	(0.44)	(0.40)	(0.42)	(0.48)	(0.45)	(0.42)	(0.43)
Equity ratio	22.898***	17.852***	19.876***	18.699***	22.948***	17.923***	19.542***	18.868***
	(5.36)	(3.83)	(3.86)	(3.90)	(5.41)	(3.84)	(3.86)	(3.88)
Staff expense ratio	−42.819***	−35.412***	−36.109***	−33.664***	−43.770***	−34.737***	−36.580***	−34.764***
	(11.73)	(11.34)	(11.23)	(11.33)	(11.98)	(11.33)	(11.29)	(11.30)
Risk	−2.266***	−2.344***	−2.410***	−2.377***	−2.253***	−2.401***	−2.430***	−2.425***
	(0.30)	(0.29)	(0.28)	(0.29)	(0.30)	(0.29)	(0.28)	(0.29)
CSI	−0.104				−0.108			
	(0.07)				(0.07)			
ARI		−0.172				−0.103		
		(0.12)				(0.17)		
SPI			−0.077**				−0.065*	
			(0.04)				(0.04)	
MDI				0.139				0.243
				(0.24)				(0.27)
Inflation					−0.039	0.107	0.075	0.105
					(0.08)	(0.07)	(0.07)	(0.07)
GDP growth					0.014	−0.003	−0.051	−0.066
					(0.08)	(0.08)	(0.06)	(0.07)
Constant	64.522***	63.796***	59.379***	57.022***	65.944***	60.615***	59.789***	55.716***
	(7.04)	(7.20)	(6.43)	(7.65)	(7.74)	(7.46)	(6.82)	(7.64)
Observations	163	181	181	181	163	181	181	181
R-squared	0.573	0.586	0.593	0.582	0.573	0.593	0.600	0.594
F-statistic	36.96***	44.21***	45.46***	43.40***	26.10***	32.06***	32.97***	32.21***

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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measures the extent to which the regulator has supervisory powers. A high SPI score indicates that the supervisory authorities have greater supervisory powers over banks (Barth, Caprio, and Levine 2013; Barth, Caprio, and Levine 2013). The MDI measures the extent to which regulatory authorities require banks to disclose information so that private investors can efficiently monitor and govern them (Barth, Caprio, and Levine 2013; Barth, Caprio, and Levine 2013). Higher MDI values indicate that the regulator requires more bank transparency, ensuring a high probability of market discipline. We measure bank performance using five indicators prevalent in the existing literature: ROA, ROE, NIM, GLR and efficiency scores.[7] Tables 3 and 4 show the descriptive statistics and correlation matrix for the variables used in the study. Table 4 shows a high correlation between bank performance measures and bank-specific factors.

8 | Analysis of Results

The main study objective is to investigate the impact of bank regulation on bank performance. In line with the existing literature, we measure bank performance using ROA, ROE, NIM, GLR and efficiency scores. Bank regulation is measured using the following indices: ARI, CSI, SPI and MDI.

Our results are interesting for a number of reasons. First, they show that the various bank regulations have differential effects on bank performance. Bank regulation should therefore not be regarded as a single act, as its different forms have different impacts on bank performance—some have positive effects and others have negative effects. The positive impact of bank regulation implies that bank regulation may be good not only for the public (as argued by the public interest view

TABLE 8 | Impact of bank regulation on bank performance (when using GLR as the dependent variable).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank size	−0.012	−0.001	−0.010	−0.003	−0.012	0.002	−0.006	−0.002
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Equity ratio	1.340***	1.002***	1.024***	1.033***	1.341***	1.004***	1.022***	1.029***
	(0.25)	(0.18)	(0.19)	(0.18)	(0.25)	(0.18)	(0.19)	(0.19)
Staff expense ratio	0.605	0.479	0.343	0.405	0.604	0.493	0.384	0.417
	(0.55)	(0.54)	(0.54)	(0.53)	(0.56)	(0.54)	(0.55)	(0.54)
Risk	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
CSI	−0.004				−0.004			
	(0.00)				(0.00)			
ARI		0.007				0.009		
		(0.01)				(0.01)		
SPI			−0.002				−0.002	
			(0.00)				(0.00)	
MDI				0.017				0.016
				(0.01)				(0.01)
Inflation					−0.000	0.002	0.000	0.001
					(0.00)	(0.00)	(0.00)	(0.00)
GDP growth					−0.000	−0.000	0.002	0.001
					(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.564*	0.406	0.593*	0.303	0.566	0.342	0.523	0.290
	(0.33)	(0.34)	(0.31)	(0.36)	(0.36)	(0.36)	(0.33)	(0.37)
Observations	163	181	181	181	163	181	181	181
R-squared	0.231	0.277	0.276	0.281	0.231	0.279	0.279	0.281
F-statistic	8.292	11.96	11.92	12.18	5.838	8.528	8.510	8.610

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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on regulation) but also for the banks being regulated. Where bank regulation negatively affects performance, it is also worth contemplating the consequences of the absence of such regulations.

The results on the relationship between bank regulation and performance (when using ROA, ROE, NIM and GLR) are shown in Tables 5, 6, 7 and 8. Tables 9, 10 and 11 use various efficiency scores as performance indicators. Table 5 shows the results when using ROA as the dependent variable. Tables 6, 7 and 8 use ROE, NIM and GLR as dependent variables, respectively. In the models, we include bank-specific control variables (bank size, equity ratio, staff expenses ratio and risk) and macroeconomic variables (GDP growth and inflation). Models 1–4 only use bank-specific variables, whereas Models 4–8 combine bank-specific and macroeconomic variables. Given that bank regulation takes various forms, with each type of regulation affecting particular bank activities, we use various measures of bank regulation.

We find a consistent and significant negative relationship between CSI and bank performance. For example, Table 5 shows that an increase in CSI reduces bank profitability (as measured by ROA). The estimated coefficient for CSI was found

TABLE 9 | Impact of bank regulation on bank efficiency (bank efficiency measured using the DEA-based Malmquist total factor productivity index).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank size	0.019	0.015	0.022	0.006	0.104	0.044	0.105	0.084
	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.08)	(0.07)
Staff expense ratio	5.845*	4.423	6.004**	5.140*	8.090**	5.561*	8.070***	7.539**
	(3.08)	(2.94)	(2.94)	(2.92)	(3.15)	(2.98)	(3.01)	(3.01)
Risk	0.273**	0.217*	0.266**	0.257**	0.265**	0.205	0.259**	0.238*
	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)	(0.13)	(0.12)	(0.12)
Equity to total assets ratio	−0.011	−0.007	−0.012	−0.012	−0.014*	−0.010	−0.014*	−0.015*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
CSI	0.024**				0.041***			
	(0.01)				(0.02)			
ARI		−0.010				−0.015		
		(0.02)				(0.03)		
SPI			0.014**				0.022***	
			(0.01)				(0.01)	
MDI				−0.073*				−0.151***
				(0.04)				(0.06)
GFC					0.072	−0.081	0.071	0.091
					(0.11)	(0.09)	(0.09)	(0.10)
Inflation					0.019	0.026*	0.018	0.012
					(0.02)	(0.02)	(0.01)	(0.01)
GDP growth					0.018	0.008	0.015	0.028**
					(0.02)	(0.02)	(0.01)	(0.01)
Constant	0.284	0.621	0.280	1.386	−1.286	0.075	−1.244	0.790
	(1.18)	(1.18)	(1.11)	(1.21)	(1.31)	(1.23)	(1.24)	(1.23)
Observations	147	156	156	156	147	156	156	156
R-squared	0.113	0.073	0.114	0.097	0.164	0.108	0.164	0.150
F-statistic	3.188***	2.115***	3.444***	2.886***	2.984***	1.977***	3.210***	2.900***

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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to be negative and significant at the 1% level (see Models 1 and 5 in Table 5). We also find this negative relationship when using ROE as a measure of bank performance. See Model 1 in Table 6 where the coefficient for CSI is negative and significant at the 5% level. In the majority of specifications, more or less similar results were found when using efficiency scores as the performance measure (see Tables 9, 10, 11 and 14).[8] The negative relationship between capital stringency and bank performance implies that increased capital requirements force banks to increase their reserves (which are essentially implicit taxes), adversely affecting the performance of commercial banks in South Africa. High capital stringency can also force banks to take fewer risks and be more careful when lending (reducing excessive lending). To the extent that a bank is highly dependent on interest revenue, this can negatively affect its performance. Because of competition in the banking sector, banks may also not be able to transfer the opportunity cost of the increased reserves to the customer (Naceur and Omran 2011). The CSI regulation measure is not significant when using the NIM, GLR or bias-corrected efficiency scores as dependent variables (see results in Tables 7, 8, 10 and 12).

We find a consistently positive relationship between ARI and bank performance across various models and across different measures of bank performance. Table 5 shows a positive and significant coefficient for ARI (see Model 6 in Table 5); the

TABLE 10 | Impact of bank regulation on bank performance (when using bias-corrected output-oriented efficiency scores under NIRS).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank size	0.005	0.017	0.026	0.028	0.006	0.024	0.016	0.019
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Staff expense ratio	−0.361	0.175	−0.025	0.279	−0.367	0.104	−0.181	−0.143
	(0.99)	(1.10)	(1.14)	(1.12)	(1.02)	(1.10)	(1.17)	(1.16)
Risk	0.406***	0.364***	0.344***	0.356***	0.409***	0.360***	0.355***	0.356***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)
Equity to total assets	0.002	−0.002	−0.000	−0.001	0.001	−0.002	−0.002	−0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CSI	0.002				−0.003			
	(0.00)				(0.00)			
ARI		−0.009				0.001		
		(0.01)				(0.01)		
SPI			−0.002				−0.002	
			(0.00)				(0.00)	
MDI				−0.004				0.014
				(0.01)				(0.02)
GFC					−0.063*	−0.026	−0.039	−0.043
					(0.04)	(0.04)	(0.04)	(0.04)
Inflation					0.012**	0.012**	0.012**	0.013**
					(0.01)	(0.01)	(0.00)	(0.01)
GDP growth					−0.008	−0.003	−0.004	−0.005
					(0.01)	(0.01)	(0.00)	(0.01)
Constant	0.187	0.131	−0.025	−0.046	0.169	−0.087	0.076	−0.121
	(0.36)	(0.44)	(0.42)	(0.45)	(0.41)	(0.45)	(0.49)	(0.45)
Observations	157	175	175	175	157	175	175	175
R-squared	0.498	0.399	0.394	0.391	0.515	0.425	0.427	0.426
F-statistic	26.59***	20.14***	19.76***	19.50***	17.39***	13.75***	13.87***	13.84***

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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coefficient is significant at the 5% level. When using ROE as the dependent variable (Table 6), we also find a positive and significant relationship between bank performance and bank regulation (see Models 2 and 6 in Table 6, where the ARI coefficients are significant at 1% and 5% levels of significance, respectively). The positive relationship between bank performance and activity restrictions indicates that this kind of regulation, which may well be good for the public (as argued by the public interest view of regulation), is also good for the regulated banks. Naceur and Omran (2011) argue that allowing banks to be involved in many activities can incentivise them to create very large and complex entities that are difficult to monitor. Restricting their activities thus enhances monitoring, ensuring banking sector stability and enhanced performance.

The relationship between SPI and bank performance is found to be negative in the majority of specifications, particularly where ROA and NIM are used as measures of bank performance. The SPI coefficient is found to be negative and significant at the 1% level when using ROA as the dependent variable (see Models 3 and 7 in Table 5). We find similar results when using NIM as the measure of bank performance (see Models 3 and 7 in Table 7). This is contrary to our expectation that more supervisory power brings more stability and enhances bank performance. We find mixed results when using bank efficiency as the performance indicator.

TABLE 11 | Impact of bank regulation on bank performance (when using bias-corrected output-oriented efficiency scores under VRS).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank size	−0.034	0.026	0.014	0.045	−0.000	0.082	0.050	0.066
	(0.02)	(0.07)	(0.06)	(0.06)	(0.03)	(0.07)	(0.07)	(0.07)
Staff expense ratio	−2.669***	−0.230	−2.113	−0.810	−1.929*	−0.021	−1.276	−0.861
	(1.01)	(2.67)	(2.68)	(2.67)	(1.02)	(2.61)	(2.76)	(2.76)
Risk	0.038	0.082	0.009	0.032	0.039	0.046	0.026	0.034
	(0.04)	(0.11)	(0.11)	(0.11)	(0.04)	(0.11)	(0.11)	(0.11)
Equity to total assets	0.001	−0.001	0.006	0.003	0.001	0.002	0.004	0.003
	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
CSI	−0.010***				−0.004			
	(0.00)				(0.00)			
ARI		−0.007				−0.009		
		(0.02)				(0.03)		
SPI			−0.014***				−0.008	
			(0.00)				(0.01)	
MDI				0.054				0.041
				(0.03)				(0.05)
GFC					0.043	0.119	0.041	0.047
					(0.04)	(0.08)	(0.08)	(0.10)
Inflation					0.005	0.015	0.020*	0.022*
					(0.01)	(0.01)	(0.01)	(0.01)
GDP growth					0.005	0.012	0.003	0.000
					(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.867**	−0.143	0.174	−0.969	0.261	−1.117	−0.562	−1.294
	(0.37)	(1.08)	(1.00)	(1.08)	(0.41)	(1.07)	(1.16)	(1.06)
Observations	157	175	175	175	157	175	175	175
R-squared	0.115	0.008	0.059	0.024	0.178	0.097	0.105	0.100
F-statistic	3.490**	0.240	1.914*	0.743	3.545***	2.001**	2.194**	2.074**

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, SPI stands for supervisory power index, and VRS stands for variable returns to scale.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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We find a positive and significant relationship between MDI and bank performance in the majority of specifications.[9] This is especially true when using ROA and ROE as dependent variables. The bank regulation coefficient is significant at the 1% level of significance, when using ROA (see Models 4 and 8 in Table 5), and more or less similar results are found when using ROE as the dependent variable (see Model 4 in Table 6). Results in Tables 7 and 8 indicate the absence of a significant relationship between MDI on the one hand and NIM and gross loans on the other. The positive relationship between bank performance and MDI suggests that environments characterised by high market discipline enhance the ability and incentives of private investors to efficiently monitor, and even govern, banks. This may ensure better management of banks and ultimately increase performance. We also interacted the various measures of bank regulation with GDP and find no significant changes in the results. The coefficients of the interaction terms are either insignificant or marginally significant (see Table 15 for more details).

When it comes to the effect of control variables, we find consistent results across models and across the different bank

TABLE 12 | Robustness using GMM (when using NIM and GLR as dependent variables).

Variables	NIM as dependent variable				GLR as dependent variable			
Lagged gross loans to TA					0.163	0.177	0.214	0.162
					(0.15)	(0.15)	(0.16)	(0.15)
Lagged NIM	0.665***	0.674**	0.543	0.521*				
	(0.17)	(0.34)	(0.52)	(0.31)				
Bank size	−2.286	−1.928	−3.113	−3.655	0.031	0.042	0.058	0.012
	(1.95)	(3.30)	(5.04)	(3.25)	(0.04)	(0.05)	(0.05)	(0.05)
Equity ratio	21.000	26.494	24.016	2.589	0.591	0.687	0.748	0.758
	(58.27)	(143.81)	(138.57)	(47.10)	(0.53)	(0.66)	(0.57)	(0.52)
Staff expense ratio	−41.639	−31.383	−52.245	−59.684	3.824	3.867	4.391	2.464
	(30.06)	(58.27)	(89.24)	(48.44)	(3.96)	(4.01)	(3.61)	(3.79)
Risk	1.302	1.155	1.130	0.962	0.070	0.090	0.091	0.066
	(1.35)	(4.59)	(2.28)	(1.74)	(0.15)	(0.16)	(0.14)	(0.16)
Inflation	0.125	0.024	−0.052	0.147	0.002	0.002	0.002	0.001
	(0.14)	(0.39)	(0.07)	(0.30)	(0.00)	(0.00)	(0.00)	(0.00)
GDP growth	0.279	0.339	−0.017	−0.113	0.005	0.004	0.004	0.003
	(0.32)	(1.56)	(1.07)	(0.52)	(0.00)	(0.00)	(0.00)	(0.01)
CSI		0.182				0.003		
		(0.45)				(0.00)		
ARI			−0.001				0.006	
			(1.13)				(0.00)	
SPI				0.148				−0.002
				(0.22)				(0.02)
MDI	−1.329				−0.019			
	(1.05)				(0.02)			
Constant	44.368	25.828	47.073	55.582	−0.038	−0.449	−0.757	0.102
	(44.46)	(62.79)	(95.87)	(60.21)	(0.67)	(0.85)	(0.76)	(0.78)
Observations	163	153	163	163	161	161	151	161
AR(2) Hansen statistic	0.8051	0.9383	0.9007	0.2386	0.7560	0.5728	0.7126	0.6873
Sargan tests for overidentification	0.0600	0.0500	0.2439	0.0014	0.7459	0.7230	0.5675	0.7130

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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performance measures. This is especially so when looking at the bank-specific factors. For example, equity ratio, which indicates a buffer for a bank, tends to increase bank performance. This positive and significant relationship is found to be consistent across various measures of bank performance and across the majority of specifications (see Models 1–8 in Tables 5, 6, 7 and 8). This implies that an increase in the equity ratio increases a bank's capital, which increases its buffer. This reduces the bank's risk and may allow it to participate in various activities requiring funds (increased diversification), improving its performance. Staff expenses and risk are found to be negatively related to various bank performance measures (ROA, ROE and NIM—see Tables 5, 6 and 7).[10] We find a negative relationship between bank size and bank performance

TABLE 13 | Robustness using GMM (when using ROA and ROE as dependent variables).

	ROA as dependent variable				ROE as dependent variable			
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Lagged ROA	−0.681**	−0.395	−0.232	−0.462*				
	(0.32)	(0.50)	(0.40)	(0.25)				
Bank size	−6.190***	−6.494***	−4.621***	−5.591***	2.909	−1.547	3.673	8.794
	(1.25)	(0.61)	(1.61)	(0.56)	(11.04)	(9.20)	(31.35)	(12.28)
Equity ratio	67.659**	23.315	55.327***	53.333***	−257.114**	−180.111*	−46.031	−316.942
	(28.41)	(67.34)	(20.74)	(14.51)	(106.10)	(106.75)	(157.80)	(294.07)
Staff expense ratio	−148.254***	−191.784***	−183.449***	−169.716***	−144.280	−231.407	−123.127	25.497
	(29.63)	(68.74)	(34.44)	(30.45)	(304.91)	(264.10)	(695.04)	(404.69)
Risk	−7.830*	−1.305	−0.879	−3.309	47.315**	32.865**	20.053	62.058
	(4.60)	(7.86)	(3.40)	(3.72)	(23.25)	(15.94)	(28.37)	(40.43)
Inflation	−0.345	−0.260	−0.001	−0.267**	2.356*	1.408	−0.112	0.900
	(0.25)	(0.44)	(0.12)	(0.10)	(1.41)	(1.76)	(1.23)	(2.20)
GDP growth	−0.345**	−0.378*	−0.519**	−0.403***	1.119	0.870	1.455	3.233
	(0.17)	(0.21)	(0.22)	(0.11)	(1.73)	(1.27)	(2.58)	(2.06)
CSI	−0.514*				3.388			
	(0.30)				(2.09)			
SPI		−0.154				1.413		
		(0.30)				(1.01)		
ARI			1.175*				−0.393	
			(0.60)				(4.62)	
MDI				2.108***				−18.521
				(0.62)				(17.74)
Lagged ROE					0.488	0.568	0.612	1.255***
					(0.65)	(0.54)	(1.30)	(0.49)
Constant	104.181***	104.088***	63.747**	66.021***	−79.284	7.899	−58.800	19.416
	(20.60)	(9.70)	(29.40)	(12.81)	(183.94)	(148.61)	(521.79)	(299.07)
Observations	153	163	163	163	153	163	163	163
AR(2) Hansen statistic	0.4336	0.5422	0.113	0.2964	0.4735	0.4283	0.3753	0.2446
Sargan tests for overidentification	0.5648	0.6142	0.5185	0.6204	0.9398	0.2849	0.0361	0.3628

Note: Standard errors are in parentheses.
Abbreviations: ARI stands for activity restrictions index, CSI stands for capital stringency index, MDI stands for market discipline index, and SPI stands for supervisory power index.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

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TABLE 14 | GMM robustness checks when using various efficiency scores as performance measures.

	TFP change				Bias-corrected output efficiency scores (CRS)				Bias-corrected efficiency scores (NIRS)			
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Lagged TFP change	0.420***	0.448*	0.370**	0.354*								
	(0.16)	(0.23)	(0.17)	(0.20)								
Lagged efficiency score 1					0.088	0.083	0.054	0.083*				
					(0.06)	(0.06)	(0.05)	(0.04)				
Lagged efficiency score 2									0.136	0.213*	0.127	0.138
									(0.23)	(0.13)	(0.12)	(0.19)
Bank size	0.287	0.118	0.115	0.214	−0.024	−0.026	−0.029	−0.048	0.012	0.026	0.026	−0.000
	(0.26)	(0.29)	(0.33)	(0.29)	(0.04)	(0.05)	(0.03)	(0.04)	(0.08)	(0.05)	(0.04)	(0.04)
Equity ratio	−0.796	−0.312	1.437	−1.378	−0.660	−0.299	−0.859**	−0.768	−0.122	0.552	−0.152	0.342
	(1.31)	(2.11)	(2.98)	(1.69)	(0.56)	(0.52)	(0.42)	(0.48)	(0.54)	(0.91)	(0.43)	(0.58)
Staff expense ratio	13.020*	5.450	8.037	11.356	−1.456	−2.287	−0.042	−0.659	−0.404	−1.105	0.531	−1.965
	(7.07)	(8.38)	(9.84)	(8.94)	(3.04)	(3.63)	(2.92)	(2.92)	(3.51)	(2.49)	(1.59)	(3.80)
Risk	0.261	0.224	0.205	0.296	−0.013	−0.007	−0.074	−0.087	0.365***	0.303***	0.376***	0.348***
	(0.23)	(0.39)	(0.42)	(0.29)	(0.10)	(0.16)	(0.13)	(0.12)	(0.09)	(0.09)	(0.09)	(0.09)
Inflation	0.037*	0.020	0.025	0.034	0.012**	0.011**	0.013***	0.010**	0.003	0.001	0.000	0.001
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
GDP growth	0.009	0.019	0.008	0.010	0.002	0.000	0.007**	0.006*	0.001	−0.001	0.001	0.002
	(0.02)	(0.01)	(0.01)	(0.02)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
CSI	−0.026*				−0.002				−0.007*			
	(0.01)				(0.01)				(0.00)			
ARI		−0.044				0.022				0.010		
		(0.05)				(0.02)				(0.03)		
SPI			0.007				−0.001				0.005	
			(0.01)				(0.00)				(0.00)	

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TABLE 14 | (Continued)

Variables	TFP change				Bias-corrected output efficiency scores (CRS)			Bias-corrected efficiency scores (NIRS)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MDI				−0.116***				0.004				−0.004
				(0.04)				(0.02)				(0.03)
Constant	−4.736	−1.465	−1.979	−2.148	0.655	0.551	0.753	1.028	−0.002	−0.210	−0.242	0.307
	(4.48)	(5.09)	(5.57)	(4.88)	(0.67)	(0.86)	(0.48)	(0.74)	(1.40)	(0.94)	(0.63)	(0.71)
Observations	135	139	139	139	147	157	157	157	147	157	157	157
AR(2) Hansen statistic	0.7461	0.6728	0.406	0.3735	0.0619	0.054	0.0977	0.0774	0.5808	0.2859	0.7672	0.4227
Sargan tests for overidentification	0.1496	0.1496	0.9039	0.6832	0.9547	0.8815	0.9438	0.9313	0.9342	0.829	0.9502	0.8865

Note: Standard errors are in parentheses.
*, ** and *** stand for 10%, 5% and 1% levels of significance, respectively.

in most specifications (Tables 5, 6 and 7), suggesting that an average bank in South Africa maybe experiencing diseconomies of scale.

When it comes to the effect of macroeconomic variables on bank performance, we find a positive relationship between the macroeconomic variables (inflation and GDP growth) and bank performance indicators (ROA and ROE) (see Model 6 in Table 5 and Models 5–8 in Table 6). From a theoretical point of view, the relationship between inflation and bank profitability depends on whether banks can fully anticipate inflation (Naceur and Omran 2011). If they can fully anticipate inflation, they can adjust their product prices to keep revenue increases above inflation increases (Naceur and Omran 2011). If not fully anticipated, inflation increases can result in a fall in bank profitability. These results suggest that South African commercial banks can fully anticipate inflation. Our findings on the relationship between inflation and bank profitability corroborate findings by Bourke (1989), Claessens, Demirguc-Kunt, and Huizinga (2001) and Molyneux and Thornton (1992).

We find a positive relationship between economic growth and bank profitability (see Models 5–8 in Table 6). In Models 5–8, the coefficient of GDP growth is positive and significant at the 1% level. This is in line with the view that episodes of economic recovery and strong economic performance are associated with high-quality loans, whereas poor macroeconomic performance (such as during a recession) is usually associated with a deterioration in the quality of loans held by banks (Bernanke and Gertler 1989). It is thus not surprising that economic growth should be associated with high profitability. We also interact bank regulation measures and economic performance and find that, in the majority of cases, the coefficient for the interaction terms is insignificant, indicating that the impact of bank regulation may not change across business cycle phases. In the majority of models, the macroeconomic variables (inflation and GDP growth) are found to be insignificant. Where they are significant (see Models 5–8 in Table 6 and Model 6 in Table 5), we find a positive relationship between the macroeconomic variable and bank performance measures. The positive coefficient between GDP growth and bank performance indicates that a growing economy is good for commercial banks in South Africa.

9 | Robustness Checks Using the GMM Estimator

The GMM has a number of advantages; it addresses a number of challenges that a normal ordinary least squares (OLS) or fixed effects model might fail to address. These include endogeneity, heteroskedasticity and autocorrelation. We therefore use the GMM approach for robustness checks. The results are shown in Tables 12, 13 and 14. The relationship between bank performance and ARI, which was found to be positive in the previous section, is confirmed using the GMM estimator (see Model 3 in Table 13). The GMM results also show that past bank performance affects current performance. For example, the coefficients of the lagged ROA in Table 13 are significant in Models 1 and 4. This is also true for efficiency scores (see Models 1–4 and 8 in Table 14). The negative relationship

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TABLE 15 | Impact of bank regulation on bank performance (when using interactions between bank regulation and economic growth).

	ROA as dependent variable				ROE as dependent variable				NIM as dependent variable			
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Bank size	−3.081***	−2.765***	−3.081***	−2.864***	−2.139	−1.735	−2.139	−2.031	−4.029***	−3.727***	−4.029***	−3.733***
	(0.43)	(0.39)	(0.43)	(0.38)	(2.10)	(1.93)	(2.10)	(1.94)	(0.48)	(0.45)	(0.48)	(0.44)
Equity ratio	44.258***	40.486***	44.258***	42.212***	53.612**	31.414*	53.612**	30.742*	22.889***	18.197***	22.889***	19.380***
	(4.79)	(3.36)	(4.79)	(3.33)	(23.58)	(16.52)	(23.58)	(16.89)	(5.42)	(3.82)	(5.42)	(3.87)
Staff expense ratio	−168.568***	−160.686***	−168.568***	−164.940***	−220.478***	−226.700***	−220.478***	−227.269***	−43.424***	−35.722***	−43.424***	−38.216***
	(10.63)	(9.93)	(10.63)	(9.79)	(52.29)	(48.80)	(52.29)	(49.71)	(12.03)	(11.27)	(12.03)	(11.38)
Risk	−1.250***	−1.313***	−1.250***	−1.314***	−5.388***	−5.618***	−5.388***	−5.657***	−2.256***	−2.417***	−2.256***	−2.411***
	(0.27)	(0.25)	(0.27)	(0.24)	(1.30)	(1.23)	(1.30)	(1.24)	(0.30)	(0.29)	(0.30)	(0.28)
Inflation	−0.010	0.112*	−0.010	0.036	0.873**	0.852***	0.873**	0.872***	−0.031	0.098	−0.031	0.048
	(0.08)	(0.06)	(0.08)	(0.06)	(0.37)	(0.29)	(0.37)	(0.32)	(0.08)	(0.07)	(0.08)	(0.07)
GDP growth	−0.100	−2.241	−0.113	0.124	−0.187	8.597	−0.497	−1.081	0.131	−2.687*	0.170	0.446
	(0.21)	(1.38)	(0.27)	(0.25)	(1.03)	(6.81)	(1.34)	(1.28)	(0.24)	(1.57)	(0.31)	(0.29)
CSI	−0.267***				−0.690				−0.064			
	(0.10)				(0.47)				(0.11)			
ARI		0.117				2.662***				−0.388*		
		(0.21)				(1.01)				(0.23)		
SPI			−0.152***				−0.394				−0.037	
			(0.05)				(0.27)				(0.06)	
MDI				1.013***				0.858				0.477
				(0.26)				(1.30)				(0.30)
SPI × GDP growth	0.005				0.113				−0.014			
	(0.02)				(0.12)				(0.03)			
MDI × GDP growth		0.222				−0.808				0.278*		
		(0.14)				(0.70)				(0.16)		
CSI × GDP growth			0.009				0.198				−0.025	
			(0.04)				(0.21)				(0.05)	

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TABLE 15 | (Continued)

Variables	ROA as dependent variable				ROE as dependent variable				NIM as dependent variable			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ARI×GDP growth				−0.031				0.332*				−0.076*
				(0.04)				(0.18)				(0.04)
Constant	48.596***	41.773***	48.176***	34.670***	45.485	24.177	44.400	35.296	65.674***	63.512***	65.574***	57.151***
	(6.87)	(6.70)	(6.87)	(6.56)	(33.81)	(32.93)	(33.76)	(33.29)	(7.78)	(7.61)	(7.77)	(7.62)
Observations	163	181	163	181	163	181	163	181	163	181	163	181
R-squared	0.723	0.699	0.723	0.715	0.274	0.324	0.274	0.315	0.574	0.601	0.574	0.603
F-statistic	44.11	44.50	44.11	47.88	6.382	9.147	6.382	8.780	22.75	28.77	22.75	29.00

Note: Standard errors are in parentheses. SPI×GDP growth is the interaction between SPI and GDP growth, MDI×GDP growth is the interaction between MDI and GDP growth, CSI×GDP growth is the interaction between CSI and GDP growth, and ARI×GDP growth is the interaction between ARI and GDP growth.

*, ** and *** stand for 10%, 5% and 1% levels of significance respectively.

between CSI and bank performance is also confirmed when using the two-step GMM estimator (see Model 1 in Table 13 and Models 1 and 9 in Table 14). In the previous section, SPI was found to be negatively related to bank performance, but robustness check results suggest no significant relationship between the two. We find mixed results when looking at the relationship between MDI and bank performance: ROA and MDI are found to be positively related (see Model 4 in Table 13), whereas TFP indices and MDI are found to be positively related (see Model 4 in Table 14).

10 | Conclusion

The debate on the role and efficacy of bank regulation was reignited during and just after the GFC. Prior to 2008, most policymakers and researchers leaned heavily towards minimal bank regulation. The increased emphasis on bank regulation by policymakers and international organisations such as the IMF has led to an increase in research on the impact of bank regulation. This study uses data on the South African banking sector to investigate the relationship between bank performance and bank regulation. Our results are consistent despite some mixed results using certain measures of bank performance and/or bank regulation. First, we find a negative relationship between CSI and bank performance, suggesting that increased capital requirements force banks to increase their reserves, adversely affecting their performance. Second, we find a positive relationship between ARI and bank performance, indicating that this kind of regulation may well be good for the public (as argued by the public interest view of regulation) and is also good for regulated banks. Third, we find a negative relationship between SPI and bank performance, a finding contrary to our hypothesis. Fourth, we find a positive and significant relationship between MDI and bank performance, suggesting that, by creating environments characterised by high market discipline, the regulatory regime enhances the ability and incentives of private investors to efficiently monitor banks. This may ensure better management of banks, ultimately increasing their profitability.

The above results are robust to various model specifications, as well as to various measures of bank performance. Bank regulation comes in various forms, and the impact of such regulations is not uniform. Our results are interesting for policymakers because they show that the various bank regulations matter for bank performance. More importantly, they show that bank regulations have differential effects on bank performance. Bank regulation is thus not a uniform act, and its different forms have different impacts on bank performance. Even where bank regulation negatively affects performance, the implications of the absence of such regulation should be considered. Indeed, the counterfactual may be associated with high costs emanating from financial system and banking sector instability.

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Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

The data are available on the BankFocus Database provided by Bureau van Dijk and Moody's Investors Service.

Endnotes

[1] See, for example, the following papers published after the GFC that investigate the need for and impact of bank regulation: Bitar, Pakthuanthong, and Walker (2018), Barth et al. (2013), Berger et al. (2014) and Lee and Hsieh (2013).

[2] As argued by the private interest view, the costs associated with regulation should be minimised to ensure that the benefits of regulation far outweigh the costs.

[3] See, for example, the recently enacted African Continental Free Trade Area (AfCFTA).

[4] See also https://www.resbank.co.za/en/home/what-we-do/Prudentialregulation/functions-of-the-prudential-authority.

[5] See Table A1 in the Annexure for more information on the variables used in the study.

[6] See Barth, Caprio, and Levine (2013) for a more detailed explanation of the bank regulation indices.

[7] See, for example, Naceur and Omran (2011), Molyneux and Thornton (1992), Kohlscheen, Murcia, and Contreras (2018, Kosmidou, Pasiouras, and Tsaklanganos (2005).

[8] But note that Table 9 shows a positive and significant relationship between CSI and bank performance.

[9] But note that Table 9 shows a negative relationship between bank efficiency and MDI.

[10] Results in Table 9 however show a positive relationship between staff expenses and efficiency. Tables 9 and 10 also show a positive relationship between risk and efficiency.

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Appendix A

TABLE A1 | Definition of variables.

Variables	Definition	Data source
Bank regulation measures		
Activity restrictions index (ARI)	The ARI measures the extent to which banks are allowed to engage in non-core banking activities (Barth, Caprio and Levine, 2006; 2013) such as securities activities, real estate activities and insurance activities. Higher ARI values indicate stricter regimes, in which banks have increased restrictions when engaging in such activities. The index ranges from 3 to 12 and has four categories of restrictions: unrestricted (score = 1), permitted (score = 2); restricted (score = 3) and prohibited (score = 4). The overall score is derived from the sum of the restrictiveness scores of the three activity categories.	Barth, Caprio, and Levine (2006, 2013) World Bank regulatory surveys database
Capital stringency index (CSI)	The CSI measures the overall stringency of the capital regulation regime (Barth, Caprio and Levine, 2006; 2013). It is calculated from the sum of eight questions that capture the regulator's ability to impose risk-based capital requirements on banks, verify bank sources of start-up capital, require banks to deduct losses arising from holdings of market-valued assets and determine whether borrowed funds can be used as start-up capital for a bank. The index is based on responses to the following questions (yes = 1 and no = 0 for questions 1–6 and yes = 0 and no = 1 for questions 7 and 8): (1) As of the end of 2016, which Basel capital framework was applicable in your country? (a) Basel 1; (b) Basel 2; (c) Basel 3 (2–3) Is (i) Credit risk; and (ii) Market risk covered by the existing regulatory capital framework in your jurisdiction? (4) Do banks deduct unrealised losses in fair-valued exposures from Tier 1 regulatory capital? (5) What is the proportion (percentage) of gains arising out of revaluation of assets that is permitted to be treated as part of capital? (6) Do regulatory authorities verify start-up capital funds for banks? (7) Apart from cash and government securities, are other assets permissible to be used as start-up capital? (8) Are investors/shareholders allowed to use borrowed funds as start-up capital for a bank?	Barth, Caprio, and Levine (2006, 2013) World Bank regulatory surveys database

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TABLE A1 | (Continued)

Variables	Definition	Data source
Supervisory power index (SPI)	The SPI considers the measures the regulator is allowed to enforce against banks. More specifically, it measures the extent to which the regulator has supervisory powers. A high SPI score indicates that the supervisory authorities have more supervisory powers over banks (Barth, Caprio and Levine, 2006; 2013) It captures the mandate of the supervisory authority to direct or impose certain actions or sanctions on a bank, its shareholders, directors, management officials or external auditors. The index ranges from 0 to 14 and is derived from the sum of the responses to the following questions (yes = 1; 0 otherwise): (1) Can external auditors report bank directors or senior managers to the supervisory authority in cases where the latter are suspected to be involved in financial crimes such as insider abuse or money laundering? (2) Can the supervisory agency meet and discuss bank examination reports with external auditors without the approval of the bank? (3) Can the supervisor impose sanctions or take action on an external auditor if the supervisor establishes that the scope or depth of external audit of a bank is inadequate? (4) Is it a requirement for banks to report and disclose off-balance sheet items to the regulator? For each of the following, please indicate if the regulator has the relevant mandate or powers: (5) Direct additional provisions to be made by banks on impaired loans or other potential losses? (6) Direct banks to reduce or suspend dividends to shareholders? (7) Direct banks to reduce or suspend bonuses and other remuneration to bank directors and managers? (8) Does the supervisory authority have powers to direct that the organisational structure of a bank be reviewed or changed? (9–11) In terms of problem bank resolution mandate, which agency or authority has powers to: (a) declare insolvency; (b) supersede shareholder's rights; (c) direct the removal of bank senior management and directors?	Barth, Caprio, and Levine (2006, 2013) World Bank regulatory surveys database

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TABLE A1 | (Continued)

Variables	Definition	Data source
Market discipline index (MDI)	The MDI measures the extent to which regulatory authorities require information disclosure by banks to ensure that private investors can efficiently monitor and govern the banks (Barth, Caprio and Levine, 2006; 2013) Higher values of the index indicate that the regulator requires more transparency by banks, ensuring a high probability of market discipline. The index ranges from 0 to 14 and captures aspects pertaining to the engagement of a certified external auditor; whether the 10 largest banks are rated by credit rating agencies; whether there is explicit deposit insurance; and whether banks adopt international accounting standards on treatment of unpaid interest, non-performing loans and consolidated financial statements. The indicator is derived from the sum of the responses to the following questions (yes = 1, no = 0 for questions 1–10 and yes = 0, no = 1 for questions 11–14). (1a) Is it a regulatory requirement for every bank to have an external auditor in your country? (1b) If yes, does the external auditor have to obtain a professional certification or pass a specific exam to qualify as such? (2) Of the top 10 banks based on asset size, how many (in terms of percentage) are internationally rated? (3) Of the top 10 banks based on asset size, how many (in terms of percentage) are rated by domestic credit rating agencies? (4) Does the country have an explicit deposit insurance system for banks? (5) In previous cases of bank failures, were insured depositors wholly compensated in line with the legal payout coverage limits? (6) Is accrued, but not yet paid interest/principal recognised in the income statement of a bank when the loan is still performing? (7) Is accrued, but not yet paid interest/principal recognised in the bank's income statement while the loan is classified as non-performing? (8) Is preparation of consolidated accounts for accounting purposes mandatory for banks? (9) Are bank directors legally liable if information disclosed is erroneous or misleading? (10) Is subordinated debt allowed as part of Tier 1 capital and in what percentages? (11) Is subordinated debt allowed as part of Tier 2 capital and in what percentages? Do banks disclose to the public: (12) Off-balance sheet items? (13) Governance and risk management framework? (14) Are bank regulators/supervisors required to make public formal enforcement actions, which include cease and desist orders and written agreements between a bank regulatory/supervisory body and a banking organisation?	Barth, Caprio, and Levine (2006, 2013) World Bank regulatory surveys database

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TABLE A1 | (Continued)

Variables	Definition	Data source
Bank-specific variables		
Return on assets (ROA)	Earnings before interest and tax divided by average total assets	BankFocus database
Return on equity (ROE)	Earnings before interest and tax divided by average total equity	BankFocus database
Net interest margin (NIM)	(Interest received less interest paid) divided by total assets	BankFocus database
TFP index	DEA-based Malmquist total factor productivity index	BankFocus database
BCES-CRS	Bias-corrected efficiency scores when assuming constant returns to scale	BankFocus database
BCES-NIRS	Bias-corrected efficiency scores when assuming non-increasing returns to scale	BankFocus database
BCES-VRS	Bias-corrected efficiency scores when assuming variable returns to scale	BankFocus database
Bank size	The natural log of total assets	BankFocus database
Equity ratio	The ratio of total equity to total assets	BankFocus database
Risk	The ratio of gross loans to total deposits	BankFocus database
Gross loan ratio	The ratio of gross loans to total assets	BankFocus database
Macro variables		
GDP growth	Real GDP growth rate	StatsSA and World Development Indicators
Inflation	Consumer price index growth rate	StatsSA and World Development Indicators

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