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assessment using the Boone Indicator and
Panzar–Rosse approaches**

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Competition in South African Banking: An assessment using the Boone Indicator and Panzar–Rosse approaches

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Abstract

This paper uses the Boone indicator and the Panzar-Rosse H-statistic to assess competition in the South African banking sector. Results point to substantial exercise of market power by South African banks. More precisely, we find evidence of ‘monopoly’ or ‘cartel’ tendency when using either the Boone indicator or the Panzar-Rosse approaches. The results are robust to different model specifications. We thus conclude that over the period 2008–2018, the nature of conduct by South African banks was ‘monopoly’ in the sense that banks’ market shares or revenues are little affected by the behaviour or actions of other banks. Given the role of banks in the transmission of monetary policy, and for economic growth more generally, the weak competition in the sector may have negatively affected the efficacy of monetary policy during this period, and may partly explain South Africa’s weak economic growth performance post the GFC.

Jel codes: C33, D40, G21, L11, L13

Keywords: Competition, banking sector, South Africa, Boone indicator, Panzar-Rosse, monopoly, monetary policy

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1 Introduction

Competition is a fundamental driver of innovation, economic growth and consumer welfare (Howitt (2009)). Competition forces efficiency in production, competitive prices, better quality and variety for consumers, and where the sector, good or service, is an input to other sectors or businesses, a low cost structure for the economy, thus enhancing national competitiveness. For these reasons and more, efforts have been heightened by governments the world over to enhance competition in the various national (and global) markets. These considerations apply equally to the banking sector, and perhaps even more so (see for instance, Simbanegavi et al. (2015)). Banks carry out a key function in the economy – they intermediate between savers and borrowers. This service, among others, positions the banking sector in particular, and the financial sector more generally, as the ‘brains’ of the economy, providing ‘efficient’ pricing of risk and facilitating the allocation of scarce resources across the economy. Robust competition in the banking sector can enhance efficiency of resource allocation in the economy, thus delivering better development outcomes.

At the macro level, banks are an important conduit for monetary policy, allowing the monetary authority (in the case of South Africa, the South African Reserve Bank (SARB)) to influence economic behaviour and thus economic outcomes. There are several channels through which monetary policy can influence output, namely, the interest rate channel, the credit channel, the asset price channel, and the exchange rate channel (Smal and De Jager (2001); Das (2015); (Fungáčová et al. (2014)). The interest rate channel and the credit channel are of particular interest when considering how competition in the banking sector can impact monetary policy. This is especially important for inflation targeting countries such as South Africa.¹ In implementing monetary policy, the presumption on the part of the monetary authorities would be that the sector is sufficiently competitive and therefore pass-through is close to ‘complete’ (see Smal and De Jager (2001)). In addition to the interest rate channel, monetary policy affects bank lending through its effect on loan supply, and thus availability of credit in the economy. Tightening of monetary policy should reduce banks’ loan supply if the market is competitive, thereby enhancing the transmission of the monetary policy impulse (Fungacova et al., 2013). The opposite is true in less competitive banking markets.² The possibility of incomplete pass-through, or weakened relationship between monetary policy and loans supply, occasioned by weak competition is not implausible in the South African case, particularly given the high degree of concentration in the banking sector (top four banks control over 80 per cent of the market), and earlier findings of monopolistic com-

¹The country adopted the inflation targeting regime as the monetary policy framework in 2000 and monetary authorities have since then primarily manipulated short term interest rates (through the repurchase rate (repo rate)) to steer the economy in one direction or the other.

²When banks wield substantial market power, monetary policy has less bite on their ability to raise resources for loans, and hence can possibly expand lending in the face of monetary contraction.

petition in the sector (Bikker and Spierdijk (2012); Simbanegavi et al. (2015)).

Bikker (2003) notes that the impacts of monetary policy on financial prices and quantities depend importantly on the competitive conditions in the loans and deposit markets (i.e., on the extent to which banks can exercise pricing power in these markets). If banks are fully competitive, they respond to policy pronouncements by the monetary authorities in the expected way. In particular, there is ‘full’ pass-through of repo rate changes, allowing for the envisaged behaviour change by economic agents. In the case of monetary tightening, interest (lending and deposit) rates increase, constraining credit extension and respectively encouraging saving, and thus constraining consumption or demand, putting downward pressure on inflation. Similarly, when monetary policy is expansionary, lending and deposit rates decrease, relaxing credit extension, and thus raising consumption or demand and hopefully output. This way, the policy rate provides a clear and informative price signal to the economy, allowing for efficient resource allocations across the economy. Instead, when the banking sector is not competitive, the price signal is distorted. In the extreme case of an effective cartel in the banking sector, pass-through would depend on the nature of the demand curve faced by the cartel. Specifically, pass-through of costs to prices for a monopolist or cartel can be any number greater than zero, including more than complete pass-through (i.e., pass-through greater than the shock) (Bulow and Pfleiderer (1983); Weyl and Fabinger (2013)). If pass-through is too low, the policy rate would need to adjust substantially to induce the desired economic behaviour change. If, instead, pass-through is too high (more than complete pass-through), the policy rate needs to adjust only marginally to avoid overshooting the policy goal.³ Thus, in an uncompetitive banking market, and in the absence of information on the industry demand curve, monetary policy would amount to shooting in the dark, rendering it less effective.

Various studies have shown that banking sector competition carries important implications for the broader economy. Claessens and Laeven (2005), in their cross country study, find (after controlling for the overall effect of financial sector development on growth) that banking sector competition positively affects industrial growth particularly for those sectors that are more dependent on external sources of financing. Claessens and Laeven (2005) conclude thus "the findings suggest that the degree of competition is an important aspect of financial sector development and, in turn, economic growth". Cetorelli and Gambera (2001) also find a similar result, though their study assessed the effect of banking sector concentration (and not competition) on growth. Their approach is immersed in the so-called structure–conduct–performance (SCP) paradigm. They find that high banking sector concentration depresses economic growth in general, and in addition, has a larger negative impact on sectors that are more dependent on external sources of financing. It is thus possible that the anaemic growth experienced in South

³It is likely that market power may introduce asymmetries in pass-through in a way that favours the incumbents (i.e., high pass-through for repo rate increases and low pass-through for repo rate cuts).

Africa since the global financial crisis could, at least in part, be related to competition (or lack thereof) in the banking sector.

Given the importance of the banking sector for the proper functioning of the economy more generally, and for the effectiveness of SARB's monetary policy in particular, a sound understanding of the competitive nature of the South African banking sector is essential, as it allows policymakers to better infer policy pass-through, and thus optimal policy design. There are two main approaches used in the literature to measure banking sector competition—the SCP and the non-structure measures. The SCP approach assumes a causal relationship between market structure and competition (and ultimately performance). Many studies have used proxies for competition (e.g., market concentration) to infer the degree of competition in the banking sector Okeahalam (2002) or to assess how banking sector competition affects economic growth (e.g., Cetorelli and Gambera (2001). However, market structure variables are in general poor indicators of effective competition. As noted by Claessens and Laeven (2005), effective competition depends on the contestability of the banking market, not mere concentration. This recognition (see for instance, Baumol (1982) has lead to the ascendancy of non-structure measures of competition as the dominant approaches to evaluating competitiveness of markets. Non-structure approaches directly measure banks' ability to effectively exercise market power (see Simbanegavi et al. (2015) for a discussion).⁴ The non-structure measures are theoretically founded.

A number of studies have directly sought to measure competition in the South African banking sector, including Simbanegavi et al. (2015), Simatele (2015) and Moyo (2018). International studies that have South Africa as one of the study countries include Claessens and Laeven (2003) and Bikker and Spierdijk (2012). Most studies assessing the degree of competition in the South African banking sector have examined the periods prior to the global financial crisis (GFC) (except for Moyo who examined competition over the period 2004-2015). Equally, different studies have used different methodologies, with Claessens and Laeven (2003), Bikker and Spierdijk (2012), Simatele (2015) and Simbanegavi et al. (2015) using the Panzar–Rosse approach,⁵ while Moyo (2018) employed the Boone indicator and Lerner index methods. Because of its well-developed banking sector, South Africa is one of the few developing countries that have wholesomely implemented Basel III recommendations on bank capital requirements following the GFC.⁶ Given the important changes to the banking market, there is need to assess whether these developments have had a bearing on the competitive-

⁴The SCP asserts that highly concentrated banking markets (structure) allow incumbents to exercise market power (conduct), and thus to realise higher profits (performance). Unlike the SCP, the new empirical industrial organisation (NEIO) emphasises the distinction between *having market power* and *exercising market power*.

⁵Simbanegavi et al. (2015) used both the Panzar–Rosse and Bresnahan–Lau methodologies.

⁶There has also been rapid innovations in the financial sector, including the emergence of branchless banks. We however will not pursue this here.

ness of the South African banking sector. This paper is a contribution in this regard. In this paper, we adopt the Boone indicator and the Panzar–Rosse methodologies to measure the degree of competition in the banking market in South Africa over the period 2008–2018. These two non-structure measures are theoretically sound as measures of competitive conduct and they have modest data requirements—hence their appeal. Indeed, the Panzar–Rosse approach is arguably the most popular empirical method for assessing competition in banking markets. Furthermore, using these methodologies allows us to compare our findings to previous South African studies as cited above. We focus on the post global financial crisis period.

Our results are at best indicative of weak competition in the banking sector. Specifically, the Boone indicator is negative (as expected) and small (in the order of -0.6) suggesting strong market power by South African banks. The results are robust to whether we use marginal costs (as estimated from the translog cost function) or average variable costs (as proposed by Boone (2008)). Consistent with the Boone indicator results, the Panzar–Rosse approach also suggests conduct akin to ‘monopoly’ or ‘cartel’, with the H-statistic marginally negative (-0.06). Overall, the findings from this study suggest that the conduct of South African banks over the period 2008–2018 can be characterised as ‘monopoly’ rather than monopolistic competition as found in earlier studies. Perhaps the implementation of Basel III regulations may partly explain the apparent dampening of competition in the sector, at least compared to the findings of previous studies. A possible implication of our findings is that the efficacy of monetary policy over the study period may have been compromised by the weak competition in the banking market, with the effects transmitted through weaker pass-through of repo rate changes to effective interest rates facing economic agents or through the bank lending channel. We, however, caution that there is need for more studies to better understand the pass-through and transmission mechanism, and how these are affected by the nature of competition in banking.

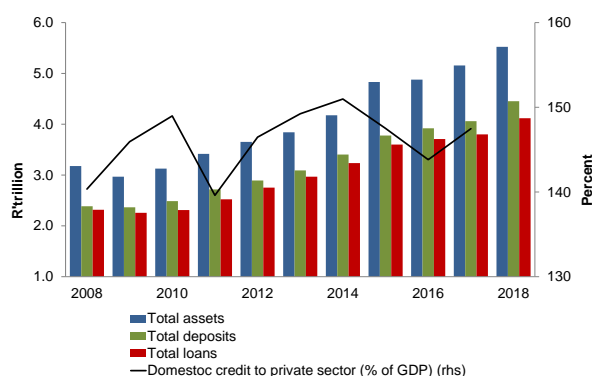
The paper is structured as follows: Section 2 briefly discusses the South African banking sector, Section 3 reviews prior studies on the banking sector while Section 4 discusses the two competition measures that form the core of this paper. Section 5 is on data and methodology while Section 6 reports the results and Section 7 concludes the paper.

2 The South African Banking Sector

According to SARB BA900 forms there are 36 banks in South Africa, comprising of 33 commercial banks and 3 mutual banks. Of the 33 commercial banks, 15 are registered banks and 18 are local branches of foreign banks. Total assets of the sector (domestic and foreign) reached R5.5 trillion in 2018, up from R3.2 trillion in 2008 (Figure 1). Of the R5.5 trillion in assets, 87 per cent are domestic assets. Total deposits increased from

R2 trillion in 2008 to R3.7 trillion in 2018, while total loans grew from R1.7 trillion in 2008 to R2.8 trillion in 2017. Real private sector credit extension as a share of gross domestic product (GDP) stood at 147.5 per cent in 2017, against 140.4 per cent in 2008 (World Bank Data).

Figure 1: Banking sector assets, loans and deposits

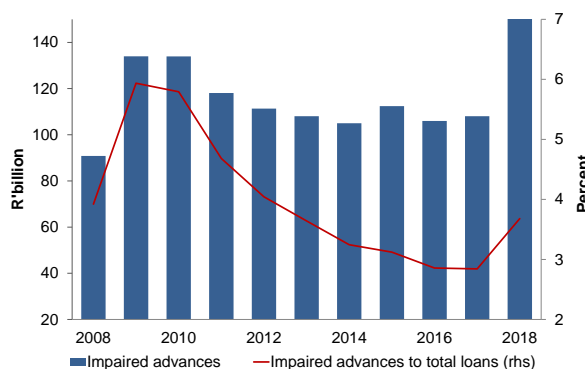


Source: SARB BA900 and the World Bank.

Impaired loans and advances increased sharply to R151 billion in 2018 from about R100 billion the previous year, following the implementation of the new expected credit-loss accounting standard of the International Financial Reporting Standard 9 (IFRS 9) (Figure 2).⁷ The ratio of impaired advances to total loans and advances also increased from 2.84 per cent in 2017 to 3.68 per cent in 2018, after declining for close to six years. While the increase in impaired advances can be attributed to the accounting standard of the IFRS 9, it can also be reflective of increasing risk in the sector's credit portfolios.

⁷The IFRS 9 was implemented in January 2018 and requires banks and other reporting entities to account for impairments on loans by applying the expected credit loss model versus the incurred loss model used previously.

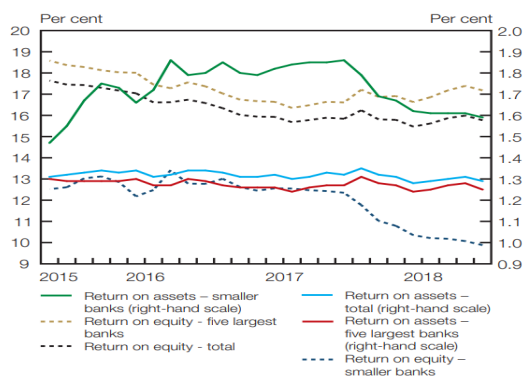
Figure 2: Impaired advances in the banking sector



Source: SARB BA100 and BA200, author calculations.

The banking sector seems to be performing well. Figure 3 depicts the return on assets (ROA) and return on equity (ROE) of the five largest banks against smaller banks and the sector as a whole. The ROA of the top five banks remained relatively constant over the last four years, while the ROE decreased marginally from an average of 18.5 per cent in 2015 to 17.3 per cent in 2018. Nevertheless, the top five banks remained relatively profitable. In contrast, the profitability of smaller banks took a knock, with both the ROE and ROA declining rather sharply from the second half of 2017 to 2018. The decrease can be attributed to credit losses, increased operating expenses and lower non-interest income resulting from foreign exchange and debt securities trading losses (The South African Reserve Bank (2019)).

Figure 3: Banking sector profitability



Source: SARB Financial Stability Review, 2019.

South African banks are well capitalised, with the capital adequacy ratios (CARs) well above the Basel minimum statutory requirements of 10 per cent of risk-weighted assets, indicating that banks have been holding more capital relative to risk-weighted assets in line with Basel regulations (Figure 4). The liquidity coverage ratio (LCR) has also been increasing steadily, as banks increase their holdings of high-quality liquid assets. The LCR minimum requirement was set at 90 per cent in January 2018 and later increased to 100 per cent in January 2019. The ratio was 128.1 per cent in 2018, well above the minimum requirement. While holding of capital buffers well above the prescribed minimum is good for stability of the banking sector, it raises questions regarding the extent of credit extension. In particular, are banks being overly risk averse, thus unnecessarily constraining credit extension or is it indicative of weak demand for credit forcing banks to hold additional reserves or could this behaviour be indicative of weak competition in the sector (cartel-like output restriction)?

Figure 4: Banking sector capital position

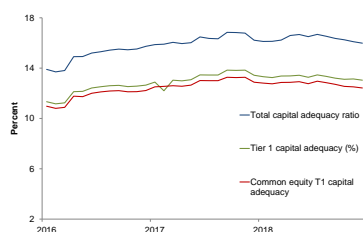
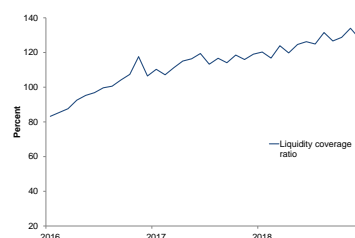


Figure 5: Banking sector liquidity position



Source: SARB Prudential Authority.

Although there are 36 operational banks in South Africa, the sector can best be characterised as a 4-firm oligopoly with a competitive fringe. Among the oligopolists (Standard Bank, Amalgamated Bank of South Africa (ABSA), Nedbank and First National Bank (FNB)), market shares have changed only marginally over the period 2008-2018. The four banks jointly controlled 85.6 per cent of the market by assets in 2008 and this has marginally declined to 82.4 per cent in 2018.⁸ This suggests that the ‘competitive fringe’ has not been very successful at nibbling market share from the leader firms.⁹ Among the top four banks, FNB appears to have made the most gains in market share over the sample period, while ABSA appears to have lost the most market share, whether measured by deposits, loans or total assets (Figures 6).¹⁰ Among the fringe

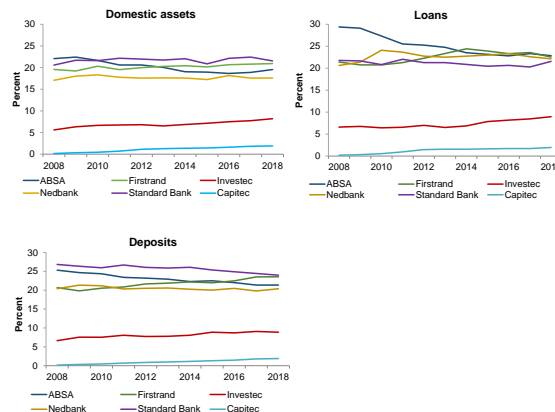
⁸The 4-firm concentration ratios for deposits and loans were respectively 92.6 per cent and 92.7 per cent in 2008, and these declined to 88 per cent and respectively 88.9 per cent in 2018.

⁹As measured by the Herfindhal-Hirschman Index (HHI), concentration moderated from about 1900 in 2009 to 1778 in 2018, suggesting moderate concentration (The HHI is measured as the sum of the squares of the market shares, with HHI below 1500 suggesting a competitive market; HHI between 1500 and 2500 suggesting moderate concentration and HHI above 2500 indicating high concentration).

¹⁰ABSA’s market share for loans, for instance, fell from about 29 per cent in 2008 to 23 per cent in

banks, Investec managed to claw some market share, growing its share from about 6.5 per cent in 2008 to about 8.5 per cent in 2018, while Capitec achieved a market share of around 2 per cent in 2018, up from about 0.2 per cent in 2008.

Figure 6: Bank market share by domestic assets



Source: SARB BA900, author calculations.

3 Prior studies of the South African Banking Sector

Previous studies on the South African banking sector have mostly concluded that the market exhibits high concentration, with some finding evidence of monopolistic competition. In the Banking Enquiry by the Competition Commission of South Africa (Jali et al. (2008)), it was concluded that the South African banks were not acting as a cartel. Despite this conclusion, the authors recommended a raft of measures to reduce anticompetitive conduct, some of them questionable (see Simbanegavi et al. (2015) for a discussion).¹¹ Other studies include Okeahalam (2002) who, using the structure-conduct-performance (SCP) framework, concludes that the South African banking sector is highly concentrated. He however could not draw stronger conclusions than that given the limitations of the framework of analysis adopted in their study. Falkena et al. (2004), who served on the task group for the National Treasury and South African Reserve Bank that sought to unpack the competitiveness of the South African banking sector, also concluded that the sector indeed suffered from high concentration, but argued that the ‘level of competition’ may not be the main reason behind the high cost

2017.

¹¹The proposals include engendering greater transparency and disclosure of product and pricing information, reducing search costs for consumers, enhancing comparability between products and reducing switching costs.

and lack of access to banking services for small and micro-enterprises (Falkena et al. (2004)).

Recently, Buthelezi et al. (2019) undertook a study to assess the extent of market concentration in the ‘priority’ sectors as defined by the Competition Commission of South Africa, finding that the financial services sector is among the sectors characterised by high industry concentration, with an HHI of 2788.¹² In addition, the financial services sector leads in terms of average market shares for firms defined as ‘presumptively dominant’. While high market shares are not necessarily indicative of non-competitive conduct in an industry, they should raise curiosity regarding the nature of competitive conduct in the concerned market as high concentration could allow incumbent banks to profit from exploitation of incumbency, rather than from their superior efficiencies and customer satisfaction.¹³

A common feature of the above studies is that they do not directly measure the degree of competition, but rather attempt to infer competition from market structure variables. A few studies (as discussed below) have sought to directly measure competition in the banking sector. Claessens and Laeven (2003) use the Panzar and Rosse approach to measure the level of competition in the banking sectors of 50 countries across the world, including South Africa, for the period 1994–2001. They find that the South African banking sector faces a high level of competition. Using an improved model specification Bikker and Spierdijk (2012) find evidence of monopolistic competition in the South African banking sector. Simbanegavi et al. (2015) find evidence of monopolistic competition using the Panzar-Rose methodology but evidence consistent with perfect competition when using the Bresnahan approach. Other recent studies include Simatele (2015) who finds monopolistic competition in the South African banking sector and Moyo (2018) who assesses the relationship between competition, efficiency and soundness of South African banks using the Lerner index and the Boone indicator respectively.

4 Measuring competition in the banking sector

The competition literature has used various measures or indicators to assess the degree of competition in an industry or market. Among the widely applied measures are: the Herfindhal-Hirschman Index (HHI), the now less popular structure-conduct-performance paradigm (SCP), the Panzar-Rosse H-statistic, the Bresnahan-Lau conjec-

¹²The slight discrepancies with the data presented in Section 2 is due to the fact that the CCSA study looks at the broader financial services sector whereas we focus here on the banking sector alone.

¹³We should hasten to point out here that concerns around market concentration and dominance are not informed by the desire to discourage large banks. Banks can increase market share due to their superior efficiency and innovativeness, and this is consistent with competition and better value for money for the consumers.

tural variations measure, and the price cost margin (PCM). Recently, Boone (2008) developed a new measure which, at least in theory, is an improvement over most of the existing measures due its theoretical robustness and modest data requirements.

The HHI has been widely applied in the empirical literature (Bikker and Haaf (2002)). Part of its appeal lies in the fact that it takes into account the size distribution of the banks through its weighting procedure, assigning greater weight to the larger banks. In addition, data to compute the HHI is readily available. The HHI is not, strictly speaking, a measure of competition but an indicator of concentration. For this reason, the HHI is typically used as a preliminary screening measure, with the more direct competition measures employed to test for competition in situations where the HHI is suggestive of uncompetitive conduct.¹⁴

The SCP is a structural measure of competition, and is similar to the concentration ratios and the HHI in terms of its underpinnings. The SCP relies on the idea that there is a direct correlation between market structure of the banking sector, the conduct of the banks and their performance (profitability). In particular, highly concentrated banking sectors allow the incumbent banks to exercise market power (oligopoly/monopoly conduct) and thus enables the banks to earn supra-normal profits. This argument, however, is not theoretically robust. In particular, high concentration is not necessarily an indicator of weak competition.¹⁵ Baumol (1982) shows that what matters for competition is the degree of contestability in the market, not necessarily the number of competing firms. Furthermore, market structure is typically endogenous.

The Bresnahan (1982) model and the price-cost margin (also known as Lerner index) have also been widely applied in the literature and are based of robust theoretical underpinnings. These are non-structural measures of competition.¹⁶ The Bresnahan-Lau model identifies the degree of market power by examining how price and quantity of banking services react to changes in exogenous factors.¹⁷ The PCM is a measure of market power at the bank level, i.e., it measures the bank's ability to raise prices of its offerings above the marginal cost. PCM is higher the higher is the bank's market share and the lower is demand elasticity. A higher demand elasticity implies greater

¹⁴For example, the HHI is used by the US Department of Justice as part of its merger guidelines, providing critical thresholds for decision making (see U.S. Department of Justice and the Federal Trade Commission, 2010). For example, a merger between two or more banks would be approved without further investigation if the combined HHI does not exceed 1800 and the change in the HHI post-merger does not exceed 200 (Cetorelli et al. (1999); as referenced in Bikker and Haaf (2002).

¹⁵The classic counter-example is the Bertrand model, where perfect competition can be achieved with only two firms in the market. The Bertrand model has itself been criticised for this apparent simplicity. However, the idea is more general than that as was shown by (Baumol (1982)). In particular, under the ideal conditions for a hit and run (i.e., perfectly contestable market), it is possible to realise close to perfectly competitive pricing under monopoly.

¹⁶Non-structure measures are theoretically sound as they are derived from profit-maximising equilibrium conditions.

¹⁷See Bresnahan (1982) or Bikker (2003).

sensitivity of consumers to price changes (either because of availability of substitutes or because the good in question is not a necessity or for other reasons) and this weakens the bank's pricing power. One of the major drawbacks of PCM as a measure of competition is its non-monotonicity in the intensity of competition at the industry level (see Boone (2008) and the references therein).

Below we briefly discuss the Boone indicator and the Panzar-Rosse H-statistic as measures of competition, pointing out how they (at least in theory) measure competition, their main strengths and shortfalls. The appeal of these two measures of competition is two-fold. First, they have strong theoretical appeal. Second, they have modest data requirements, which make them feasible in the South African context where the market is characterised by relatively few banks. Indeed, the Panzar-Rosse approach is arguably the most popular empirical method for assessing competition in banking markets. Furthermore, applying similar methodologies allows us to compare our findings to previous South African studies as cited above. In this study, the Boone indicator is the primary competition measure of interest as it hasn't had much application in the South African context Moyo (2018) is the only application we are aware of).

4.1 The Boone indicator

Boone (2008) develops a new indicator of competition, called the *relative profit differences* which, at least in theory, is an improvement over most of the existing measures. The idea behind the Boone indicator is the intuitive argument that competition penalises inefficient banks more than it penalises efficient banks, and as a consequence, there is output reallocation from the less efficient banks to the more efficient banks as competition intensifies. This implies that more efficient banks will realise higher profits or higher market shares as competition intensifies.¹⁸ Thus relative profit differences is monotonic in the intensity of competition, which makes it a sufficient statistic for competition.

Boone (2008) builds a competition model based of fairly reasonable assumptions. He considers a symmetric oligopoly model with I banks producing a homogenous good but with differing levels of efficiency. The efficiency parameter for bank i , n_i , is assumed to be one dimensional, with $n_i; i = 1, 2, \dots, I$ decreasing in i , that is, $n_1 \geq n_2 \geq \dots \geq n_I$.¹⁹ Banks choose a vector of strategic variables $a_i \in R_+^L$ and these result in the output vector $q(a_i, a_{-i}, \theta)$ and price vector $p(a_i, a_{-i}, \theta)$, where θ is a conduct parameter (intensity of competition among the banks). A standard cost function is assumed. In particular, the production cost for bank i , with efficiency level n_i , is given by $c[q(a_i, a_{-i}, \theta); n_i]$.

To impose regularities, Boone (2008) makes the following assumptions:

¹⁸This of course implicitly assumes idle capacity, or more generally absence of capacity constraints, on the part of the more efficient banks, otherwise output reallocation would not be feasible.

¹⁹The one dimensionality assumption allows Boone to derive an aggregate efficiency index, N , as a function of the efficiency levels of all the banks in the banking sector.

$$\frac{\partial c(q, n)}{\partial q_l} > 0, \quad (1)$$

$$\frac{\partial c(q, n)}{\partial n} \leq 0, \quad (2)$$

$$\frac{\partial \left[\frac{\partial c(q, n)}{\partial q_l} \right]}{\partial n} \leq 0; \quad l = 1, 2, \dots, L; \quad (3)$$

where L is the number of products produced by bank i . Assumption (1) relates total costs to the output level. Specifically, it states that for given efficiency level, total costs are increasing in the output level. That is, costs are monotonic in output (marginal cost is positive). Assumption (2), which relates total production costs to the efficiency level of the bank, states that, other things being equal, total costs are non-increasing in the efficiency level. In other words, more efficient (higher n) banks can produce the same output level q at a lower total cost than their less efficient counterparts. Assumption (3) relates the marginal cost of production to the bank's efficiency level. Specifically, marginal costs are non-increasing in the level of bank efficiency, and strictly decreasing for at least one output component. Intuitively, this simply says that higher n banks can produce output at weakly lower marginal cost for each output q_l relative to the low n banks (and strictly lower for at least one output component). These assumptions jointly speak to the output reallocation effect arising from the intensification of competition.

In terms of timing of the game, Boone considers a two stage game where banks decide whether or not to enter in the first stage, and those entering choose their strategic actions a_i in the second stage, but also incur an entry cost of γ_i , where the i subscript points to the fact that entry costs potentially vary with a bank's efficiency level. Boone considers two ways in which competition could intensify, namely, (i) more aggressive interaction between the banks (denoted as $d\theta > 0$), which could for instance happen if banks moved from Cournot to Bertrand competition; and (ii) a reduction in entry cost into banking, perhaps due to technological changes (parameterised as $d(-\varepsilon) > 0$).²⁰ From the output and price vectors, as well as bank costs, equilibrium output and price vectors are derived, and equilibrium profits computed. With this, Boone (2008) introduces his measure of the intensity of competition, the relative profit differences

²⁰One driver of reduction in entry costs into banking is the increasing reliance by banks and their customers on online banking, allowing banks to significantly reduce fixed or entry costs. South Africa has recently witnessed entry into the market by two branchless banks, namely, Discovery Bank and Tyme Digital Bank. Indeed, technology is forcing incumbents to rationalise their banking models (for instance, Standard Bank has recently closed a large number of branches). Although not that important in South Africa, fintechs such as mobile money are changing the nature of banking in the continent, increasing financial inclusion, and enhancing competition among banks, and between banks and non-bank institutions.

(RPD), defined as

$$RPD \equiv \frac{\pi(n^{**}, N, I, \theta) - \pi(n, N, I, \theta)}{\pi(n^*, N, I, \theta) - \pi(n, N, I, \theta)} > 0, \quad (4)$$

for any three banks with efficiency levels $n^{**} > n^* > n$. Hence,

Theorem: (*Boone (2008)*) An increase in competition raises RPD for any three banks with $n^{**} > n^* > n$.

That is,

$$\frac{d \left[\frac{\pi(n^{**}, N, I, \theta) - \pi(n, N, I, \theta)}{\pi(n^*, N, I, \theta) - \pi(n, N, I, \theta)} \right]}{d\theta} > 0, \quad (5)$$

where θ is a conduct parameter, and

$$\frac{d \left[\frac{\pi(n^{**}, N, I, \theta) - \pi(n, N, I, \theta)}{\pi(n^*, N, I, \theta) - \pi(n, N, I, \theta)} \right]}{d(-\varepsilon)} > 0, \quad (6)$$

where ε denotes intensification of competition through entry.

To reiterate, the Boone indicator is attractive as a measure of competition given its theoretical underpinnings²¹ and modest data requirements (i.e., indicator can be computed from same kind of data as other popular competition measures, including the Panzar–Rose and the Lerner index approaches).

4.2 The Panzar-Rosse H-statistic

Panzar and Rosse (1987) develop a competition indicator that measures the level of competition by establishing how each of the individual banks' revenues react to proportionate changes in input prices. They show, using the comparative statics property of the equilibrium, that for a monopolist, the sum of the input price elasticities are non-positive; that is, $H \leq 0$. In other words, if banks are acting as a 'monopolist' or 'cartel', a proportionate increase in bank input prices will increase marginal costs and result in a reduction in the total revenue. This is because price and quantity move in opposite directions following an increase in the marginal cost. A finding of a positive sum of the input price elasticities therefore refutes the hypothesis of "monopoly", implying that the revenues of the banks in question are influenced by the actions of other banks (p.

²¹The Boone indicator correctly identifies competition (at least in theory) both when competition increases through the intensification of interaction among banks (increase in product substitutability, for instance), as in equation (5), and when competition intensifies through entry of new banks (a decrease in entry costs), as in equation (6); i.e., it is monotone in competition.

447).²²

For monopolistic and perfect competition, equilibrium is characterised by two properties, namely, (1) marginal revenue equal marginal cost, and (2) banks make zero profit in long-run equilibrium. Property (1) defines the equilibrium output of the bank while property (2) gives the size of the banking sector, i.e., number of banks in the market in long-run equilibrium. Property (1) is derived from profit maximisation at the bank level, and is characterised as

$$R'_i(y_i, n, z_i) - C'_i(y_i, w_i, t_i) = 0, \quad i = 1, 2, \dots, I$$

where $R'_i(y_i, n, z_i)$ and $C'_i(y_i, w_i, t_i)$ are the marginal revenue and marginal cost of bank i respectively, and I is the total number of banks in the industry. The marginal revenue of bank i is a function of their output (y_i) and a vector of variables that shift the banks' revenue function exogenously (z_i), as well as the number of banks (n). The marginal cost of bank i is a function of their output, a vector of m factor input prices faced by the bank (w_i), and a vector of variables that shift their cost function exogenously (t_i). The optimal number of banks in long-run equilibrium is determined by the zero profit constraint that must hold at the industry level.²³ This is given by

$$R_i^*(y^*, n^*, z) - C_i^*(y^*, w, t) = 0,$$

where y^* is the equilibrium output and n^* is the equilibrium number of banks (endogenously determined).

Carrying out the comparative statics with respect to a proportionate change in factor input prices, Panzar and Rosse (1987) derive a statistic, their measure of market competition, as the sum of the factor price elasticities of the banks' reduced form revenue function. The H-statistic is defined as

$$H = \sum_{k=1}^m \left[\frac{\delta R_i^*}{\delta w_{k_i}} \cdot \frac{w_{k_i}}{R_i^*} \right], \quad (7)$$

where R_i^* is the equilibrium revenue for bank i and w_{k_i} is the input price of factor k for bank i .

In a perfectly competitive environment, a proportionate increase in input prices leads to a proportionate rise in both marginal and average variable costs, with no change in the optimal output for the individual banks.²⁴ There is full pass-through of factor input

²²Panzar and Rosse (1987) define "monopoly" as a bank whose revenue is not influenced by the actions of other banks, not necessarily in the sense of the bank being the sole producer of a given good or service.

²³If this condition does not hold at the industry level, banks will realise potential profits (losses) and enter (leave) the market until the equilibrium number of banks is obtained.

²⁴In theory, some banks should exit the market, allowing the demand faced by the remaining banks to increase.

price increases to consumers under perfect competition. There is thus a proportionate increase in the revenues. Thus, in terms of testable implications, one would expect that the H-statistic equals unity under perfect competition; that is, $H = 1$.²⁵ In the case of monopolistic competition, a proportionate increase in input prices will increase the banks' revenues (by the same mechanism as under perfect competition), but not by as much as the increase in the marginal cost. This is because the demand (and thus marginal revenue) curve is downward sloping, implying that the bank will respond to increasing marginal costs by reducing output and increasing price. These opposing forces mean that revenue increases, but not by as much as the increase in marginal costs. The more competitive the market, the more the revenues will increase as a result of an increase in input prices. Therefore, the H-statistic under monopolistic competition lies between zero and unity; i.e., $0 < H < 1$.²⁶

5 Data and Methodology

Data for this study is sourced primarily from the SARB BA900 surveys, which capture balance sheet items of banks and mutual banks, and from bank income statement data acquired from annual financial reports (for various years). One of the challenges that empirical studies of banking sector competition have to confront is defining the output(s) of the bank. Views in the literatures have tended to differ, but the intermediation model of banking (see Shaffer (2004); Bikker and Spierdijk (2012); and references therein), wherein banks employ labour and physical capital to attract deposits seems to dominate. However, as Shaffer (2004) points out, other empirical evidence suggests that deposits behave more as inputs and not outputs (p. 292). While some authors have used bank deposits to proxy for bank output, others have used total assets to proxy for bank output (see for instance, Weill (2013) and Daglish et al. (2015)).²⁷ In this study

²⁵However, if banks in a competitive market face constant average costs, it is possible that revenues will decrease following an increase in input prices, thus negatively impacting the discriminating power of the Panzar–Rosse H-statistic (Bikker and Spierdijk (2012)).

²⁶The interpretation of the H-statistic is not that clear-cut, however, which limits the robustness of the Panzar–Rosse approach as a measure of competition. In particular, $H \leq 0$ may indicate either monopoly behaviour, a cartel, profit maximising oligopoly conduct or short run competition; $H = 1$ suggests either perfect competition (long run competitive equilibrium), sales maximisation subject to a break-even constraint or a sample of natural monopolies under contestability, while a finding of $0 < H < 1$ indicates monopolistic competition (Bikker and Spierdijk (2012)). See Simbanegavi et al. (2015) for a detailed discussion.

²⁷Just like the use of deposits as proxy for bank output has limitations, so is the use of total assets. In particular, bank assets are made up of various components and some of these are not closely correlated with bank output at least from a banking services perspective. Examples include redemptions and impairments, whose maturity can affect bank total assets but not necessarily bank output (stock versus flow); and trading assets (about 15 per cent of total assets across the sector) which also do not necessarily represent bank output from a banking services perspective (we thank Vafa Anvari for pointing this to us).

we proxy bank output by total assets, notwithstanding the limitations of this measure. The variables of interest include bank costs, bank outputs (proxied by total assets), bank revenues (interest income and noninterest income), personnel expenses, capital expenditures, equity, loans, among others. The sample period for this study is 2008 to 2018 – the post global financial crisis period. Data frequency is annual. As indicated earlier, there are 36 registered and operational banks in South Africa. However, not all of them have a full data series to span the entire sample period. Indeed some of these banks are fairly young, with two or so data points. The youngest banks include Discovery bank, Tyme Digital bank, ICICI, and Finbond. We focus on retail, commercial and savings banks and remove institutions with very few observations from the sample. All variables are adjusted to real 2008 prices using headline consumer price index (CPI). Our sample consists of 15 banks and 165 observations.

Although banks typically have multiple outputs, in this study we assume a single output for tractability reasons, and, as already explained, this output is proxied by total assets. Banks incur costs in the form of hiring and retaining personnel, attracting deposits, fixed assets such as buildings or space rentals, and other operating expenses. The primary cost factors associated with a bank's production function are thus: personnel expenses, interest expenses, and other non-interest expenses. Below we describe the empirical strategy of the paper, following the two models elucidated above. To account for potential heterogeneity in the way banks with different sizes and characteristics respond to changes in business costs, we exploit the panel structure of our dataset.

5.1 Boone indicator

To compute the RPD measure, Boone (2008) suggests that one could use either average variable costs or marginal costs. Together with Van Leuvensteijn et al. (2008), we use marginal costs for our main results.²⁸ We compute the marginal costs of banks from the translog cost function (Daglish et al. (2015))²⁹ as given below:

$$\ln TC = \gamma_0 + \gamma_1 \ln q + \frac{1}{2} \gamma_2 (\ln q)^2 + \sum_{j=1} \delta_j \ln w_j + \frac{1}{2} \sum_j \sum_k \delta_{jk} \ln w_j \ln w_k + \sum_j \lambda_j \ln q \ln w_j, \quad (8)$$

where TC denotes the total cost, q is output (total assets) and w_j, w_k denote input prices that enter the bank's production function. The γ 's, δ_j, δ_{jk} and λ_j are cost function parameters to be estimated. Differentiating (8) with respect to q , and then multiplying

²⁸In addition, we use average variable costs to check robustness.

²⁹We suppress here the bank subscript for tractability reasons.

both sides of the resulting expression by TC gives

$$\frac{\partial TC_i}{\partial q_i} = \frac{TC_i}{q_i} \left(\gamma_1 + \gamma_2 \ln q_i + \sum_j \lambda_j \ln w_j \right) \quad (9)$$

as bank i 's marginal cost.

To ensure consistency and theoretical appeal of the cost function parameters, we do not directly estimate (8), but rather normalise the translog cost function with respect to one of the input prices (precisely, the price of fixed assets). This allows us to apply regularity conditions for a cost function, and thus pin down the cost parameter estimates (see also Van Leuvensteijn et al. (2008), Weill (2013); and Daglish et al. (2015)). The standard properties of a cost function are linear homogeneity in input prices and cost-exhaustion. These imply the restrictions $\sum_j \delta_j = 1$, $\sum_{j,k} \delta_{jk} = 0$, and $\sum_j \lambda_j = 0$. We thus estimate the following translog function:³⁰

$$\ln \left(\frac{TC}{w_i} \right) = \gamma_0 + \gamma_1 \ln q + \frac{1}{2} \gamma_2 (\ln q)^2 + \sum_{j \neq i} \delta_j \ln \left(\frac{w_j}{w_i} \right) + \frac{1}{2} \sum_{j \neq i} \sum_{k \neq i} \delta_{jk} \ln \left(\frac{w_j}{w_i} \right) \ln \left(\frac{w_k}{w_i} \right) + \sum_{j \neq i} \lambda_j \ln q \ln \left(\frac{w_j}{w_i} \right) \quad (10)$$

Once all the parameters of the cost function are estimated or recovered, we then proceed to estimate the banks' marginal costs using (9), setting ourselves for the assessment of competition in the South African banking sector.³¹

Although the Boone indicator is defined as relative profit differences (see eqn 4), and other studies have applied the model this way (e.g., Schiersch and Schmidt-Ehmcke (2010)), Van Leuvensteijn et al. (2008) argue that there is a direct correlation between profits and market shares. As argued by Boone (2008), the RPD measure works through the reallocation of output (and thus market shares) to more efficient firms as competition intensifies. This suggests changes in market share as a natural measure of intensification of competition in this model. The additional appeal of market shares is that they can be easily and correctly measured, unlike profits. For this study, we follow Van Leuvensteijn et al. (2008), and estimate the following equation to assess the degree of competition in South Africa's banking market.

$$\ln s_{it} = \alpha_i + \beta \ln mc_{it} + \eta \ln(Z_{it}) + \varepsilon_{it}, \quad (11)$$

³⁰The literature has typically estimated cross section regressions to recover the cost parameters for each year (see for instance Daglish et al. (2015); Van Leuvensteijn et al. (2008)). However, given the small sample (15 banks only), we would have run out of degrees of freedom pretty quickly. Hence we estimate a panel model to recover the parameters of the cost function.

³¹The parameters that are not directly estimated in (10) are recovered through the relationships implied by the restrictions (linear homogeneity and cost-exhaustion) on the cost function.

where s_{it} denotes the market share of bank i at time t ; α_i is the bank fixed effect, mc_{it} is the marginal cost of bank i at time t (estimated from equation (9)), Z are control variables (e.g., credit risk or leverage); and ε_{it} is an error term (white noise). The parameter β is the Boone indicator, and is expected to be negative.³² The idea is that the market shares of banks with lower marginal costs should increase when competition intensifies. This is the output reallocation effect. The controls account for the fact that leverage and credit risk are likely to influence bank conduct. Equation (11) is estimated using fixed effects.³³

5.2 Panzar and Rosse

As discussed earlier the Panzar-Rosse model measures competition by assessing the elasticity of the banks' revenues with respect to input prices. For this purpose, we estimate the following equation

$$\ln(IINC_{it}) = \alpha_i + \beta_1 \ln(AFR_{it}) + \beta_2 \ln(PPE_{it}) + \beta_3 \ln(PCE_{it}) + \delta \ln(X_{it}) + \varepsilon_{it}, \quad (12)$$

where $IINC_{it}$ is interest income for bank i at time t , and is used to capture intermediary services which are banks' main operational activities.³⁴ AFR is the average funding rate or price of deposits defined as the ratio of interest expenses to total deposits, PPE is the wage rate defined as wage costs divided by total assets, and PCE is the price of capital measured as ratio of capital costs to fixed assets. X_{it} is a vector of control variables and include a number of bank-specific factors as controls, including non-interest income or other income (OI) to account for revenue coming from fee-based products and off-balance sheet activities, the loan to total assets ratio as well as equity to total assets ratio to reflect banks' credit risk (CR) and leverage (L) respectively. The individual-specific intercept, α_i , controls for other bank specific characteristics that differ across banks but remain constant over time, and ε_{it} is the error term. The H -statistic is given by the sum of the β coefficients. We estimate a fixed-effects regression, and use Huber-White robust standard errors to account for heteroscedasticity across clusters.³⁵

³² β is the elasticity of market share with respect to the marginal cost. The higher the absolute value of β the greater is implied competition.

³³We assume that heterogeneity across banks is non-random as it is likely a function of deliberate strategies adopted by individual banks (e.g., Investec targeting graduates) and that these bank specific effects are time invariant.

³⁴Since our interest here is to capture how the intermediation activities of banks respond to changes in costs, we have used interest income as dependent variable (see for instance, Bikker and Spierdijk (2012)), and controlled for non-interest income. We do, however, also consider total revenue as dependent variable as a robustness check. Results are qualitatively similar.

³⁵For similar reasons as in the Boone indicator model, we assume that heterogeneity across banks is non-random time invariant.

6 Results and discussion

In this section we present and discuss the results of our analyses. Rather than estimating a cross-section translog cost function as is normally the case in similar studies, we instead estimate the cost function for the whole panel to bake out the cost function parameters, and then use these to deduce the marginal costs (as per equations (8) and (9)). Some marginal costs turned out to be negative, suggesting scale and or scope economies in banking.

6.1 Descriptive statistics

Table A1 in the Appendix summarises the data and key variables used in our empirical analysis. Total costs are defined as the sum of interest expenses, personnel expenses and fixed capital expenses. The price of deposits or average funding rate is defined as the ratio of interest expenses to total deposits, the price of labour or the wage rate is defined as wage costs to total assets and the price of capital is defined as capital costs to fixed assets. Total revenue is on average larger than total costs, suggesting that South African banks are profitable. Table A1 confirms the oligopoly structure (with competitive fringe) discussed in section 2, with ABSA, FNB, Nedbank and Standard Bank dominating in terms of assets, costs and revenue. Investec is a distant fifth, followed by Capitec in sixth, and then the rest. Indeed, while the average total assets across the banks and over the period 2008-2018 is R164,646 million, the median is only R47,682 million.³⁶ The average funding rate is 5.5 per cent; the wage rate is 2.7 per cent of total assets, and capital expenses are 3.7 per cent of total assets.³⁷ Banks' credit risk, proxied by the loans to assets ratio, is at 56.7 per cent, suggesting that South African banks have moderate exposure to default risk.³⁸ Finally, the equity to assets ratio is on average 13.9 per cent.

6.2 Regression results

We first report the results for the Boone indicator, followed by the Panzar-Rosse model and then wrap up with a discussion of the result.

³⁶The standard deviation (sd) show substantial variation across banks than within a bank. For total assets, the between sd. is 248884 while the within sd. is 18175. For total costs, between sd. is 23614 while the within sd. is 3628.

³⁷The ratio of personnel expenses to total assets is used as a proxy for the wage rate, as data on the number of staff is not available for most banks.

³⁸Van Leuvensteijn et al. (2008) find average loan to assets ratios between 53 per cent and 63 per cent for eight EU countries (their Table 4.2). Indeed, Figure 2 shows that impairments in the South African banking sector are well-contained, despite the noticeable jump in 2018 (largely due to the change in reporting standards).

6 Boone Indicator

As discussed earlier, the Boone indicator measures the degree of competition by quantifying the output reallocation effect. We run three fixed effects regressions to assess how market shares respond to changes in marginal costs. The three relate to bank market shares by total assets, deposits and loans.³⁹ Since equation (11) is log-log, and some marginal costs are negative, we used $\log(1 + mc)$, instead of $\log(mc)$, as the main explanatory variable. The results are presented in Table 2. The coefficients of leverage for all measures of the market share (total assets, total deposits and total loans) is negative. Given the way we measure leverage (the ratio of equity to total assets), this is the theoretically correct sign (Baker (1973)). This suggests that highly leveraged firms (i.e., high debt to total assets) tend to be more aggressive and thus realise higher market shares. The coefficient for credit risk is negative, except for the deposits model, again suggesting that firms with higher credit risk tend to have higher market shares (more aggressive conduct).

The parameter of interest, the coefficient for marginal cost, is small and negative for all three market share measures. The β coefficient is -0.60 when using assets as proxy for market share, and respectively -0.49 for deposits and -0.60 for loans. The negative sign is as one would expect: higher marginal cost banks should expect to realise lower market shares as competition intensifies. The small (and negative) marginal cost coefficients suggest that banks' market shares do not respond strongly to changes in marginal costs—suggesting a weaker output reallocation effect from intensification of competition. This points to strong market power in the South African banking sector. That is, South African banks do exercise market power in their conduct.

The finding of a weak degree of competition in the banking sector is consistent with the descriptive statistics illustrated earlier where the banking sector is found to be highly concentrated and can thus be characterised as a tight knit oligopoly with a competitive fringe. Typically, as competition intensifies one would expect volatility of market shares to increase (consistent with output reallocation). This however is not what we see in Figure 6.⁴⁰

³⁹The industry totals are based on a subsample of 15 banks. However, given the high concentration as shown by Figure 6, restricting to the sample banks is without loss of generality.

⁴⁰Of course in theory competition could increase without any changes in market shares, particularly if the firms are symmetric and are effectively countering each other. However, this should not be the case in a market with such a long tail.

Table 1: Fixed-effects estimation results using marginal costs

Dependent variable:	Total assets	Total deposits	Total loans
Constant	-7.69*** (0.30)	-7.68** (0.32)	-7.31*** (0.32)
leverage	-0.55*** (0.13)	-0.64*** (0.14)	-0.55*** (0.13)
Credit risk	-0.16 (0.14)	-0.21 (0.14)	0.78*** (0.09)
Marginal cost	-0.60*** (0.11)	-0.49*** (0.11)	-0.60*** (0.12)
Number of observations	165	165	165
Adjusted R-squared	0.38	0.36	0.36
σ_u	2.50	2.51	2.73
σ_e	0.26	0.26	0.26
rho	0.99	0.99	0.99

Note: Standard errors are reported in parentheses. ***, **, * denote statistically significant

As mentioned earlier, to recover the cost function parameters we estimate one translog cost function for the entire sample period instead of estimating cross-section by cross section as in Weill (2013); Van Leuvensteijn et al. (2008), or Daglish et al. (2015). This is done to avoid running out of degrees of freedom as our cross-section sample is small (15 banks). Given this computational constraint, it is possible that the results presented in Table 1 could have been tempered. We therefore consider an alternative approach where we use average variable costs as a proxy for marginal costs (Boone (2008)) as a robustness check. The results are presented in Table 2. The *beta* coefficients for average variable cost are small and negative for all three market share proxies, and in fact quite close in magnitude to the coefficients derived from the marginal cost. Thus the finding using marginal cost is corroborated. For both proxies of bank efficiency (marginal cost and average variable cost), we find evidence of monopoly type conduct. We therefore conclude that the Boone indicator suggests that South African banks do wield substantial market power.

Table 2: Fixed effects estimation results using average variable costs

Dependent variable:	Total assets	Total deposits	Total loans
Constant	-7.60*** (0.47)	-7.93*** (0.39)	-7.50*** (0.48)
leverage	-0.56*** (0.14)	-0.64*** (0.12)	-0.56** (0.14)
Credit risk	-0.26*** (0.06)	-0.26*** (0.0.10)	-0.71*** (0.06)
Average variable cost	-0.57*** (0.10)	-0.50*** (0.09)	-0.56*** (0.11)
Number of observations	165	165	165
Adjusted R-squared	0.38	0.36	0.29
σ_u	2.54	2.50	2.70
σ_e	0.26	0.26	0.26
rho	0.99	0.99	0.99

Note: Standard errors are reported in parentheses. ***, **, * denote statistically significant

6 Panzar-Rosse

As mentioned earlier, several prior studies assessing competition in the South African banking sector have applied the Panzar–Rosse model. Therefore, as a robustness check for our main model (Boone indicator), we test for competition using the Panzar–Rosse approach. This also allows us to better compare our finding to earlier studies.

We estimate the Panzar-Rosse H-statistic (12) using the fixed-effects approach.⁴¹ We estimate two model specifications, the first is conducted using only the cost variables (funding rate, wage rate and fixed capital price), and the second one include the controls (other income, credit risk and leverage). The results are summarised in Table 3. For both model specifications, the coefficients of the cost variables are statistically significant, except for the price of capital.⁴² The impact of the average funding rate on interest income is positive, suggesting that higher average funding rates results in increased interest income. Intuitively, higher funding rates may facilitate the attraction of deposits and through the lending channel, result in higher interest income. Other income is negative and statistically significant, suggesting a trade-off between interest income and income banks acquire from their non-intermediary activities. As resource constrained banks increase resource allocation to non-interest generating activities, they reduce resources allocated to interest bearing assets. Leverage has a positive and sta-

⁴¹Hausman tests were run to test whether a random-effects specification would be appropriate instead, but fixed-effects specifications were preferred.

⁴²This is similar to the findings of many prior studies (see Simbanegavi et al. (2015) and references therein).

tistically significant (at 10 per cent level) coefficient. Credit risk is not statistically significant. A priori, credit risk is expected to be positively correlated with interest income as banks generally compensate themselves for the risk by means of a surcharge on the prime lending rate, which increases interest income (see for example Bikker and Spierdijk (2012)). The insignificant result here could be because of the measure that we use to proxy for credit risk – the share of loans to total assets. Ideally, impairments may be a better indicator of credit risk.

The H-statistic, calculated as the sum of the three cost coefficients, is negative for both model specifications, though the magnitudes differ. In model I (no controls), $H = -0.35$, while $H = -0.06$ in model II (with controls). The Wald test fails to reject the null hypothesis that the H-statistic is non-positive and thus we conclude that $H \leq 0$. We also adopt an alternative model specification where we regress total revenue (instead of interest income) on input prices and controls (Table 3). We obtain similar results, with H -values of -0.23 in the model without controls and respectively -0.31 in the model with controls. Since $H \leq 0$, we conclude that according to the Panzar-Rosse methodology, the banking sector in South Africa can be best described as ‘monopoly’. Banks seem to be exercising market power in this market.

Comparing our results with other studies, we find that South African banks operate in a less competitive market compared to banks in other jurisdictions. Studies using the Panzar–Rosse methodology have generally found evidence of monopolistic competition in banking. Claessens and Laeven (2003) find H-statistics of 0.53, 0.58 and 0.83 for India, Kenya and Brazil, respectively. Bikker and Spierdijk (2012), using an improved model specification relative to Claessens and Laeven (2003), find H-statistics of 0.22 for Western Europe, 0.38 for Latin America, and 0.48 for Africa (includes South Africa). Aktan and Masood (2010) find an H-statistic of 0.75 for Turkey while Fosu (2013) finds evidence of monopolistic competition (H-statistics range from 0.36 to 0.64) for the sub-Saharan Africa sub-regions. Barbosa et al. (2015), using an extended Panzar–Rosse model, find evidence of ‘monopoly’ tendency by Brazilian banks, with banks that offer a wider range of products and services exercising more market power than the ones offering only classic products (loans and credit).

Table 3: Panzar-Rosse empirical results

Dependent variable:	II (no controls)	II (with controls)	TR (no controls)	TR (with controls)
Constant	7.83*** (0.44)	7.77*** (0.29)	8.69*** (0.33)	8.73*** (0.33)
Funding rate (AFR)	0.54*** (0.09)	0.54*** (0.06)	0.40*** (0.05)	0.40*** (0.06)
Wage rate (PPE)	-0.87*** (0.10)	-0.65*** (0.13)	-0.64*** (0.05)	-0.71*** (0.13)
Fixed capital price (PCE)	-0.02 (0.05)	0.05 (0.04)	-0.01 (0.04)	0.01 (0.03)
Other income	-	-0.41*** (0.08)	-	-
Credit risk	-	0.01 (0.11)	-	-0.09 (0.14)
Leverage	-	0.27* (0.16)	-	0.20 (0.13)
H-statistic.	-0.35	-0.06	-0.23	-0.31
Number of observations	164	164	164	164
Adjusted R-squared	0.40	0.49	0.30	0.31
σ_u	2.54	0.54	2.49	2.49
σ_e	0.26	0.24	0.24	0.24
rho	0.99	0.99	0.99	0.99
Wald: $H \leq 0$	0.00	0.38	0.01	0.03

Note: II is interest income, and TR is total revenue. Standard errors are reported in parentheses. ***, **, * denote statistically significant at the 1%, 5%, 10%, respectively. The p-values of the Wald test are reported. We use Huber-White robust standard errors to deal with heteroskedasticity in the clusters.

6.3 Discussion

The present study finds ‘monopoly’ type conduct, in the sense that banks’ market shares or revenues are little affected by the behaviour of competitors, in the South African banking sector. Earlier studies relying on the structure–conduct–performance paradigm have typically found high concentration in the sector, leading to conclude that competition was weak, though they shied away from pronouncing cartel conduct (Okeahalam (2002); Falkena et al. (2004); Jali et al. (2008)). High concentration is a persisting feature of the South African banking market as we have demonstrated in this study (see also Buthelezi et al. (2019)). Studies that directly measure the degree of competitive conduct (Claessens and Laeven (2003), Simbanegavi et al. (2015), Simatele (2015) and Moyo (2018)) generally find monopolistic competition in the South African banking sector. A possible explanation for the different findings on the intensity of competition may relate to the study period—the post GFC period. The GFC and its aftermath brought about major changes to the banking sector, most of which focused on strengthening the resilience of banks to shocks (Basel III), and these may have had the effect of softening competition in the sector. Indeed, de Ramon et al. (2018) show rising concentration (HHI) and declining competition (Boone indicator) in the United Kingdom banking sector post the

GFC. Habte (2012) also finds, using the Boone indicator model, softening competition (with 'monopoly' tendency) for the Swedish banking sector post the GFC.

One of the challenges with assessing competitive conduct in the banking sector is the dearth of granular data that would enable more reliable estimates. The measures adopted here (and most of the South African literature) rely on more aggregated. Banks in our sample do not compete in the same markets at all times. For instance, some offer mortgages or vehicle finance and some don't, while some specialise in certain segments of the market (Investec focuses on college graduates while Capitec focuses on the lower end of the market). Although the big four span the entire range of banking sector products, they have strengths in different products (FNB is strong in vehicle finance, while Standard Bank leads in home loans). These nuances call for parsimony with regard to conclusions and policy recommendations. Carrying out similar analyses but at product level should improve precision of estimates and thus sharpness of policy recommendations.

7 Conclusions and policy implications

Banks play an important role in the functioning of any modern economy. In addition to intermediating between savers and borrowers, they also serve as the primary conduit for monetary policy. Therefore competitive conduct in the banking sector is not only important for credit extension and growth, but also for the soundness of monetary policy. In particular, the degree of competition in banking affects the degree of pass-through of repo rate changes to interest rates faced by economic agents, and the responsiveness of loans supply to monetary policy shocks, both of which affect the effectiveness of monetary policy.

Using the Boone indicator and the Panzar-Rosse methodologies, we find evidence of weak competition in the banking sector in South Africa over the period 2008–2018, with 'monopoly' tendency. The Boone indicator turns out small and negative values, suggesting that banks' market shares are not much affected by changes in efficiencies (proxied by marginal costs or average variable costs). The Panzar-Rosse methodology turns out negative H-statistics, indicative of 'monopoly' conduct in the banking sector. Indeed, market shares of the top four banks hardly changed over the study period, despite facing competition from thirty-two other banks. While our results differ with earlier studies who generally find monopolistic competition in the South African banking sector pre-GFC, they are in line with studies in other jurisdictions, namely, the UK and Sweden, who find less competition in banking post the GFC.

The foregoing has two immediate implications: First, the weak competition in the banking sector may have (i) impeded the efficacy of monetary policy during the period under study; and (ii) negatively impacted the economy's recovery from the GFC due to sub-optimal credit extension. We however caution that these findings should be viewed

as 'strong indication' of possible non-competitive conduct, rather than conclusive evidence, particularly given the aggregated nature of the analyses.

Future research could consider the following avenues: First, assessing how competition affects repo rate pass-through into market interest rates can help illuminate on the impact of competition on monetary policy. Second, work that delves into submarkets and product level analyses should provide further insights into bank conduct, and third, analyses that look at the impacts of regulation (e.g., Basel III) on competition and stability in the banking sector should help inform policy.

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A Appendix: Key variables used in the analysis

Table A1: Key variables by bank for the period 2008 - 2018

Bank	Total Assets (R'm)	Total Costs (R'm)	Total Revenue (R'm)	Funding rate (%)	Wage rate (%)	Fixed capital (%)	Loans to Assets (%)	Equity to Assets (%)
ABSA	560,974	50,554	59,646	5.8	1.8	2.4	74.1	7.9
Albraka	3,072	227	261	4.7	1.7	1.6	63.7	10.2
Bidvest	3,288	581	841	3.7	5.9	9.3	26.9	39.8
Capitec	31,301	5,530	7,001	5.4	4.3	11.1	68.9	20.8
Firstand	561,334	45,334	56,772	4.8	2.1	2.3	66.5	7.8
GBS	758	65	70	7.4	1.5	0.8	81.2	13.69
Grindrod	5,743	359	422	5.6	1.7	1.0	45.4	10.0
Habib	762	51	57	2.6	2.6	2.1	28.7	8.4
HBZ	2,587	151	211 U	2.6	1.1	2.0	31.2	8.2
Investec	192,910	14,805	16,958	7.0	1.1	0.8	62.7	8.5
Mercantile	5,858	535	710	5.3	2.4	2.6	81.9	24.5
Nedbank	491,457	44,729	52,445	6.3	1.7	2.2	76.8	7.5
Sasfin	3,000	531	628	13.3	5.4	5.7	57.0	18.5
Standard Bank	603,493	67,087	71,199	6.3	1.9	3.9	58.1	8.5
Ubank	3,146	444	471	1.5	5.5	7.4	27.6	13.9
Average	164,646	15,399	17,847	5.5	2.7	3.7	56.7	13.9

Source: BA900 and banks' financial statements, author calculations.