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Simbanegavi, Witness and Greenberg, Josh and Gwatidzo, Tendai

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Witness Simbanegvi[‡], Josh Greenberg[§] and Tendai Gwatidzo[¶]

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Abstract

This paper employs the Panzar and Rosse and the Bresnahan models to determine the level of competition in the South African banking sector. This level of competition was tested during the period 1998 to 2008 for the Panzar and Rosse approach and from 1992 to 2008 for the Bresnahan model. We find evidence of monopolistic competition in the South African banking sector. Our findings are consistent with those of Bikker et al (2012) for South Africa.

Jel classification: C33, D4, G21, L1

Key words: banking industry, competition, South Africa, Panzar-Rosse model, Bresnahan model

1 Introduction

A competitive banking sector is important for the proper functioning of the economy. Indeed, the banking sector is the cornerstone of any properly functioning modern economy. At a micro level, banks, just like any other firms,

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[†]The views expressed herein are solely those of the authors - they do not reflect the views of the authors' respective institutions.

[‡]National Treasury, Republic of South Africa.

[§]Competition Commission South Africa.

[¶]Wits University, South Africa.

sell products to consumers - hence we need to worry about efficiency implications if the banking sector is not competitive. However, banks are much more important than this at a macro level. Firstly, banks advance credit or loans to both firms and consumers and thus an uncompetitive banking sector will lead to an underprovision of such credit or loans (Claessens & Laeven, 2005). This may negatively impact the overall economic performance of the country. Secondly, banks act as the primary conduit of monetary policy. To this regard, a low level of competition in the banking sector may hamper the effectiveness of monetary policy as banks may not respond appropriately to monetary tightening and/or easing (Van Leuvensteijn et al., 2008).[1]

It is for these and other reasons that the issue of determining the level of competition in the banking sector has been a topic of interest to academics, policy makers as well as the general public. Despite the importance of such competition research, there has historically been very few studies of the level of competition in the South African banking sector. Looking at prior structural studies of the South African banking sector, authors such as Falkena *et al.* (2004) and Okeahalam (2001) have generally concluded that the sector is highly concentrated. This high level of concentration is due to a few large banks dominating the market. Some economists believe that a high level of concentration shows that the banking sector is suffering from a low level of competition - the so-called structure-conduct-performance paradigm. This paper is an attempt at a comprehensive study of the nature of competition in the South African banking sector.

Many authors[2] have given much criticism to using structural methods when measuring competition in the banking sector. This paper therefore focuses on non-structural forms of measurement which takes into account that banks behave differently depending on the market structure in which they operate (Baumol, 1982). The non-structural models used are the Panzar and Rosse (1987) approach and the Bresnahan (1982) model. Our results

[1] Indeed, Kot (2004), in his study of the interest rate pass-through in the new EU-member states, finds that increases in the degree of competition in the banking sector coincides with faster transmission of the monetary policy impulses to the consumer credit prices.

[2] Including Demsetz (1973); Berger (1995); and Mullineux & Sinclair (2000).

suggest that the South African banking sector is monopolistic in nature. A similar study by Bikker et al (2012) reaches a similar conclusion. Studies that estimate scaled revenue equations such as Claessens & Laeven (2003) tend to find much higher levels of competition in the South African banking sector – a result of the upward bias in these models.

This paper is organised as follows: Section 2 discusses the various theories and methods used to measure competition and gives an overview of the South African banking sector. Section 3 discusses the Panzar and Rosse approach in detail while section 4 provides the analysis and results of the Bresnahan methodology. Section 5 makes a comparison of the results of this paper to outcomes found in comparable developing countries and section 6 concludes the paper.

2 Literature Review

2.1 Banking Competition Theory

There have traditionally been two main methods for determining the level of competition in the banking sector, namely tests on structural and non-structural characteristics of banks.

The structural tests focus on characteristics such as the level of concentration in the industry, the number of banks, market share, etc (Bain, 1951). There are two main structural theories, the structure-conduct-performance (SCP) framework and the efficiency hypothesis (EH) (Bikker & Haaf, 2001). The SCP framework says that in highly concentrated markets, banks use market power to increase profits through higher loan prices and lower deposits rates - leading to a low level of competition (Bain, 1951). This is a commonly used structural test for competition.

There are many criticisms to the SCP framework. One theoretical criticism was originally put forth by Demsetz (1973) and later by Berger (1995). They postulate that, contrary to the SCP approach, the larger market shares which lead to a high level of concentration, are a result of better efficiency and lower costs rather than a low level of competition. Other arguments against the use of concentration as a measure of the level of competition includes the theory introduced by Mullineux & Sinclair (2000). They argue that although higher concentration may lead to higher prices, and as a result lower demand, it does not necessarily result in higher profits for a highly concentrated banking sector. Indeed, the modern (New Empirical Industrial Organization (NEIO)) view is that both industry structure and industry performance are endogenous - being driven by some other factors. As Schmalensee (1989) puts it, "*...except in textbook competitive markets, derived market structure is clearly affected by market conduct in the long run*" (p. 954). The NEIO thus does not assume a causal relationship between market structure and performance, but rather, the approach tests competition and the use of market power (Bikker & Haaf, 2002: 21; Bresnahan, 1989).

The most commonly used non-structural models in banking sector studies are the Panzar and Rosse approach (Rosse & Panzar, 1977; Panzar & Rosse, 1987) and the Bresnahan model[3] (Bresnahan, 1982).[4] These models recognise that banks behave differently depending on the market structures in which they operate (Baumol, 1982). They also do not ignore the relationship between market contestability and revenue behaviour at the firm level, which the structural methods do (Perera *et al.*, 2006).

2.2 Overview of the South African Banking Sector

In the recent Banking Enquiry carried out by the Enquiry Panel of the Competition Commission (Jali *et al.*, 2008), it was concluded that the South African banks were not acting as a cartel.[5] Despite this, the panel also believes that the cost and trouble involved for customers to switch banks weakens the competitive effect of price differences between banks. They stated that this "*allows supra-competitive pricing to be maintained.*" (Jali

[3] Added to by Lau (1982).

[4] The third model, the Iwata model (Iwata, 1974), is less utilised due to its rigid data requirements (Perera *et al.*, 2006). The Bresnahan model is an improved version of the Iwata model and has been used in numerous studies.

[5] This conclusion is arrived at based on qualitative (as opposed to quantitative) analyses of the banking sector.

et al., 2008. p.28). The Competition Commission's Enquiry Panel therefore suggests that although there is competition in the banking sector, there is still need for intervention in certain aspects of the banks' conduct. They recommend that banks should have to ensure greater transparency and disclose product and pricing information; reduce search costs and improve comparability between products; and reduce the actual cost of switching and assist consumers in doing so. This would result in greater ease for customers to switch between banks and prevent them from being *locked in* once they have joined a bank. The panel believes that this will in turn raise the level of competition in the banking sector. There is no guarantee of this improvement in competition though. Increasing the market transparency on the products and prices offered by banks may actually help facilitate collusion in the market (See for instance Tirole, 1988).[6]

Table 1 below shows how important the South African banking sector is to the economy.

Table 1 about here.

The table illustrates that banks in South Africa play an important role as major lenders, especially to the private sector. They also receive a huge amount of deposits. They therefore play an important role towards the facilitation of the credit process.

In the banking sector, the measure of market share can be approximately calculated by the bank's total assets (a proxy for total loans) or total deposits as a percentage of industry totals. It can be seen in Tables 2 and 3 below that the total deposits and total assets in 2007 are dominated by the four main banks, Standard Bank, Firstrand, Nedbank and ABSA. These four banks have market share in excess of 90%. This high market share should potentially allow them to partake in collusive practices, raising their lending

[6] A case where increased market transparency was harmful to competition is the famous case in Danish Cement industry whereby the competition authority decided to intervene to enhance the competition by requiring a daily price list (for two grades of ready-mixed concrete) to be revealed but this had an adverse effect on the competition and rather encouraged collusion. The requirement to publish a price list resulted in substantially reduced price dispersion and average prices of reported grades increased by 15 - 20 percent within one year (Albaek, Mollegard and Overgaard, 2003).

rates and lowering their deposit rates.

Table 2 about here

Table 3 about here

The South African banking sector has a total of 22 registered banks including locally owned banks, foreign owned banks and mutual banks (Reserve Bank, 2008a; 2008b; 2008c). It can be seen that the majority of the banks hold a very small portion of the market share. The South African banking sector can therefore be characterised as highly concentrated (Okeahalam, 2001).

2.3 Prior South African Banking Competition Research

Okeahalam (2001) attempts to measure the level of competition in the South African banking sector by means of analysing the concentration in the industry. Okeahalam (2001) follows the structure-conduct-performance (SCP) framework[7] and concludes that the South African banking sector is highly concentrated - which normally leads to a high likelihood that there will be a collusive oligopoly in the industry.

Another study of the concentration in the South African banking sector was carried out by Falkena *et al.* (2004) as part of a Task Group Report for The National Treasury and the South African Reserve Bank. They used various methods including the Herfindahl-Hirschman Index to determine the concentration in the sector. They concluded that there was in fact high concentration in the South African banking sector, but that "*The high cost and lack of access to banking services for small and micro-enterprises may have more to do with a number of structural factors than [to] the level of competition in banking.*" (Falkena *et al.*, 2004. p.151).

Claessens & Laeven (2003) use the Panzar and Rosse approach to measure the level of competition in the banking sector of fifty countries across the world for the period 1994 to 2001. The South African banking sector

[7] See also Berger & Hannan (1989) and Okeahalam (1998).

was included in their study. They found that the South African banking sector faces a high level of competition. The methodology of Claessens & Laeven (2003) however suffers from incorrect specification which tends to result in an upwardly biased H-statistic (Bikker et al, 2012). Bikker et al (2012) examine the nature of competition in the banking sectors of 63 countries (including South Africa) for the period 1994 - 2004. They find evidence consistent with imperfect competition.

This paper adds to the study of Claessens & Laeven (2003) by testing the level of competition using the Panzar and Rosse approach for a longer period (1998 to 2007), and using the specification proposed by Bikker et al (2012), as well as using a second model, the Bresnahan model.

3 The Panzar and Rosse Approach

3.1 Methodology

3.1.1 The Theoretical Model

The first approach we use for measuring competition in the South African banking sector is the Panzar and Rosse Approach - Rosse and Panzar (1977) and Panzar and Rosse (1987). This approach measures competition on panel data by comparing the properties of each bank's reduced form revenue equation across time. Two of the important assumptions underpinning this model are (i) that banks operate in their long run equilibrium and (ii) that all banks hold a homogeneous cost structure.[8]

This model measures the level of competition by establishing how each of the individual banks' revenues react to proportionate changes in input prices. If the banks act as monopolies or at least in a monopolistic manner, and face positive marginal costs, they will produce where demand is elastic. An increase in input prices will increase marginal costs, causing equilibrium output to decrease and equilibrium price to increase. Given that their elasticity of demand is greater than unity, the increase in prices will result in a

[8]However, the long run equilibrium hypothesis is not a prerequisite when testing for monopoly (Panzar and Rosse (1987: 446)).

reduction in the total revenue of the bank. This reduction in revenue reveals that banks are acting in an anticompetitive manner.

In a perfectly competitive environment however, an increase in input prices leads to a rise in both marginal and average costs, with no change in the optimal output for the individual banks.[9] Theoretically, some banks should exit the market, allowing the demand faced by the remaining banks to increase. This should result in a proportionate increase in prices and revenues. The percentage increase in revenues should be exactly equal to the percentage increase in marginal costs in the case of a perfectly competitive market (Bikker & Haaf, 2002). However, as shown by Bikker et al (2012), if firms face constant average costs, it is possible that revenues will decrease following an increase in input prices – negatively impacting the discriminating power of the P-R methodology. Should the industry environment be that of monopolistic competition, the revenue will still increase by the same mechanism as in perfect competition, but by not as much as the marginal cost. The more competitive the market, the more the revenues will increase as a result of an increase in input prices.[10]

By maximising profits at both the individual bank and industry level, the equilibrium output and equilibrium number of banks can be found. At the bank level, marginal revenues must equal marginal costs in order to maximise each bank's individual profits, therefore

$$R_i'(x_i, n, z_i) - C_i'(x_i, w_i, t_i) = 0,$$

where R_i' and C_i' are the marginal revenue and marginal cost of bank i respectively. The marginal revenue of bank i is a function of their output (x_i) and a vector of variables that shift their 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

[9] This hinges on the assumptions of linear homogeneity of the cost function and long run equilibrium.

[10] This however must be qualified as the cost structure may disallow full pass-through of input prices to revenues even for firms in long-run competitive equilibrium, as shown by Bikker et al. (2012). Thus the extent of pass-through is not necessarily that informative regarding the nature of competition.

(w_i), and a vector of variables that shift their cost function exogenously (t_i).

Furthermore, in order to determine the optimal number of banks,[11] the zero profit constraint must also hold at the industry level. Therefore

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

where the superscript * denotes equilibrium values.

Panzar and Rosse have defined an H-statistic as the sum of the elasticity of the banks' revenue with respect to a change in each of m factor input prices. The H-statistic is therefore

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

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

The H-statistic derived by Panzar and Rosse is positively related to the level of competition in the banking sector. The interpretation of the H-statistic is a bit complicated however, in the sense that several situations may arise. For instance, $H \leq 0$ may indicate either monopoly behaviour, a cartel, profit maximising oligopoly conduct or short run competition (Bikker et al, 2012). Therefore, a finding of $H < 0$ on its own does not have discriminating power. $H = 1$ suggests either perfect competition (long run competitive equilibrium), sales maximisation subject to a break-even constraint, or a sample of natural monopolies under contestability[12]; and $0 < H < 1$ indicates monopolistic competition (Claessens et al. 2004). However, as noted by Shaffer (2004; p.297), and further developed by Bikker et al (2012), outside of long run competitive equilibrium, the value of H carries an ambiguous interpretation.[13] While Panzar and Rosse (1987) show that H is a decreas-

[11] If 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. This zero profit constraint holds at this equilibrium.

[12] Ibid.

[13] Bikker et al. (2012) show in their Proposition 3.6 that $H < 1$ or even $H < 0$ is possible for firms in long-run competitive equilibrium with constant average costs (p. 13).

ing function of the Lerner index for a pure monopoly, Shaffer (1983) show that H is an increasing function of market power for an oligopolist facing fixed demand. Thus, outside of the long run competitive equilibrium where firms face U-shaped average costs, the sign of H is more informative than the value of H.

3.1.2 The Empirical Model

The theoretical model described above has been interpreted by many authors in different ways. This paper will follow the methodology of Bikker et al (2012). The reduced form revenue equation is

$$\begin{aligned} \ln INTR &= \alpha + (\beta \ln AFR + \gamma \ln PPE + \delta \ln PCE) + \zeta \ln BSF \\ &\quad + \eta \ln OI + e, \end{aligned} \tag{1}$$

where *INTR* is total interest revenue; *AFR* is the ratio of annual interest expenses to total balance sheet; *PPE* is the ratio of personnel/staff expenses to total balance sheet; *PCE* is the ratio of physical capital expenditure and other expenses to fixed assets; *BSF* are Bank Specific Factors (loans to total assets and equity to total assets); *OI* is the ratio of other income to the total balance sheet; and e is the stochastic error term.[14]

Given this structure of the reduced form revenue equation, the H-statistic can be represented as $\beta + \gamma + \delta$.

3.1.3 Data

All of the data are available from individual banks' annual reports and financial statements. A list of registered banks in South Africa was obtained from the South African Reserve Bank. These registered banks include locally controlled banks (Reserve Bank, 2008a); foreign controlled banks (Reserve Bank, 2008b); and mutual banks (Reserve Bank, 2008c). Of these 22 registered banks, a number of them are in the process of liquidation. Others are

See also their Table 2.

[14] For the theoretical priors, see Bikker et al (2012).

not listed on the JSE Securities Exchange, making attainment of the key variables difficult. Of the registered banks included in this study, some of the years annual reports and financial statements are not available or do not disclose all of the key variables. Some of the banks therefore have missing years in the dataset used - reducing the number of observations. Given that this is panel data, the few missing observations do not significantly impact the results of this model.

The annual reports and financial statements were obtained from McGregor BFA while other data were obtained from the South African Quarterly bulletin – Money and Banking (various issues). The dataset was made up of data from fourteen banks over the period 1998 to 2008. With missing data from some banks in some of the time periods, the panel regression includes 114 observations. We only consider the South African portion of the banks' operations. As Shaffer (2001, 2004) pointed out, this may introduce biases to the estimated conduct parameter if a substantial portion of banking business comes outside of the country or important competitors are omitted from the estimation. In South Africa however, the portion of banking business coming from outside the country is quite small – which would reduce the potential for bias.

The BSF variable includes bank specific exogenous factors. These bank specific factors are other explanatory variables that reflect differences in risks, costs, size and structure of banks (Bikker & Haaf, 2002). In this study we use two bank specific ratios: Equity to Total Assets (BSF-EQ) and Loans to Total Assets (BSF-LO).[15] The inclusion of the non-performing loans ratio reduces the sample size to half. It was decided that the benefit of this gain in a control variable does not outweigh the loss of power of the model. This variable was therefore excluded from the regression.

[15] Bikker and Haaf (2001) used, in addition to the risk component, the differences in deposit mix control and the divergent correspondent activities control. However, due to the unavailability of data, these variables cannot be computed for South Africa.

3.2 Empirical Results

We estimate the unscaled revenue equation as proposed by Bikker et al. (2012) using the feasible generalised least squares (FGLS) method. Total interest income is regressed on bank input prices (price of deposits (AFR), wage rate (PPE), and price of capital (PCE)), and control variables (credit risk (BSF-LO), leverage (BSF-EQ), and other income (OI)). We first estimate the unscaled revenue equation as given in (1) above. The results are reported in Table 4a. The coefficient on the average funding rate is negative (-0.134) but insignificant, the wage rate is positive (0.50) and significant at the 5% level; the price of physical capital is also positive (0.32) and significant at the 5% level. All the control variables are significant and the signs are consistent with the theory. In particular, BSF-LO is positive, suggesting that a higher loans to total assets ratio raises interest income, BSF-EQ carries a negative sign, indicating that lower leverage reduces interest income, and OI has a negative impact on interest income as expected. The associated P-R statistic – which is given by the summation of the input elasticities – is given by $H = 0.69$.

Table 4a about here.

A concern raised in Bikker et al (2012) is that even though the estimated equation is an unscaled equation, there are implicit scale effects as some of the right hand variables such as BSF-LO and BSF-EQ have total assets as a denominator. To address this concern, we check for correlations between these 'implicitly' scaled variables and total assets. We then regress interest income on the explanatory variables, but correcting all explanatory variables for scale (i.e., replacing the explanatory variables with residuals (Bikker et al (2012; p. 24))).[16] This constitutes our preferred model. We report the

[16] We also ran another regression where only AFR was not corrected for scale as it had a correlation of 0.39 – which is below the cut-off of 0.48 as used in Bikker et al (2012). In this case we found an an H statistic of 0.61.

results in Table 4b.[17]

Table 4b about here.

Again, we find that AFR is insignificant, while PPE is significant at the 5 percent level and carries a positive sign as expected, PCE is significant at the 10 percent level, but carries a negative sign suggesting that an increase in capital expenses lowers interest income for banks in South Africa. Both BSF-LO and BSF-EQ are insignificant at the 10 percent level while OI is significant at the one percent level and carries a negative sign as expected from theory – indicating that as banks increase their share of non-interest earning assets, interest income decreases. Summing the input price elasticities yields an H statistic of 0.53, which is lower than in the uncorrected regression – suggesting the upward bias effect of the "implicit" scale factors.

We test the following three null hypotheses: (i) $H_0 : \beta_{AFR} + \gamma_{PPE} + \delta_{PCE} \leq 0$; (ii) $H_0 : 0 < \beta_{AFR} + \gamma_{PPE} + \delta_{PCE} < 1$; and (iii) $H_0 : \beta_{AFR}+\gamma_{PPE}+\delta_{PCE} = 1$ to determine the nature of competition in the South African banking sector. These three hypotheses test for monopoly/oligopoly/cartel or short run competitive equilibrium; monopolistic competition; and long-run competitive equilibrium /contestable monopolies or sales maximisation subject to break-even constraint respectively (Bikker et al (2012)). The null hypothesis $H_0 : \beta_{AFR} + \gamma_{PPE} + \delta_{PCE} \leq 0$ is rejected at the 5 percent level, with a positive t-value of 2.38 (one tailed test). Monopoly/oligopoly/cartel or short run competitive equilibrium is thus rejected for the South African baking sector. The null hypothesis $H_0 : \beta_{AFR} + \gamma_{PPE} + \delta_{PCE} = 1$ is also rejected at the 5% level ($p = 0.019$), implying that the H-statistic is statistically different from one (more precisely, smaller than unit, as it is a one-tailed test). However, without information on the cost structure of the banking sector, there is not sufficient information for us to conclude that long run competitive equilibrium is rejected. We also tested for the null hypothesis of monopolistic competition, $H_0 : 0 < \beta_{AFR}+\gamma_{PPE}+\delta_{PCE} < 1$, and we cannot reject this null hypothesis. We thus conclude that the South

[17] We also conducted a ROA test to test whether or not the observations are in long run equilibrium. We cannot reject the null hypothesis of long-run equilibrium.

African banks face monopolistic competition.

The result of this application of the Panzar and Rosse approach reveals that, with regard to interest income, the South African banking sector is monopolistic in nature. Thus banks appear to posses some degree of market power, but do not operate as 'absolute' monopolies. The results of our study are relatively similar to the findings of Bikker et al (2012) who find an $H-$statistic of 0.46 for South Africa.[18]

That personnel costs significantly explain interest income is interesting. There are debates currently in South Africa around financialisation of the economy. Concerns are that the financial sector is growing too fast, and at the expense of other sectors, as it has been able to attract skills from other sectors through its ability to pay higher wages. The high degree of concentration and the and the high switching costs and complex bank products help explain the monopolistic outcome (Jali et al (2008)). Indeed, despite the high concentration, non-price competition appears to be significant, for example, advertising.

4 The Bresnahan Model

4.1 Methodology

4.1.1 The Theoretical Model

The second model that is used to measure competition in the South African banking sector is the Bresnahan Model (Bresnahan (1982)). This is a non-structural test for the degree of competitiveness, such that this model can be used even when there is no cost or profit data available. This can be done by using industry aggregate data to measure this competition.

The idea behind this model is to see how price and quantity react to changes in exogenous variables - revealing the degree of market power of the average bank, and hence the level of competition in the banking industry.

[18] A caveat is in order. As discussed on pages 9-10, any value of H different from 1 is difficult to interpret as different levels of market power are consistent with such values. See for instance, Shaffer (2004); Bikker et al (2012). In particular, the relationship between H and the degree of competition is non-monotonic.

The profit function for the average bank takes the form of

$$\Pi_i = px_i - c_i(x_i, EX_S) - F_i,$$

where Π_i is profit; x_i is the quantity of output of the bank; p is the output price; c_i are the variable costs; and F_i are the fixed costs faced by bank i. The variable costs are a function of the output of the bank, as well as the exogenous variables that affect marginal costs, but not the industry demand function (EX_S).

The inverse of the demand function faced by the banks is

$$p = f(X, EX_D) = f(x_1 + x_2 + \ldots + x_n, EX_D),$$

such that prices are a function of exogenous variables that affect the industry demand but not the marginal cost (EX_D) and each of the n banks' outputs. The first order conditions for profit maximization of bank i is

$$\frac{d\Pi_i}{dx_i} = p + f'(X, EX_D)\frac{dX}{dx_i}x_i - c'(x_i, EX_S) = 0.$$

Summing over all banks gives

$$p + f'(X, EX_D)\frac{dX}{dx_i}\frac{1}{n}X - c'(x_i, EX_S) = 0,$$

such that

$$p = -\lambda f'(X, EX_D)X + c'(x_i, EX_S), \tag{2}$$

where λ is the measure of the level of competition in the banking sector and is equal to

$$\lambda = \frac{dX}{dx_i}\frac{1}{n} = \left(1 + \frac{d\sum_{j\neq i} x_j}{dx_i}\right)\frac{1}{n}.$$

In this case, λ is a "*function of the conjectural variation*[19] *of the average firm in the market*" (Bikker & Haaf, 2001). In a perfectly competitive industry, an increase in the output of bank i should result in a decrease of all other

[19]Conjectural variation is the change in output of the other banks, anticipated by bank i as a response to an initial change in its own output.

banks' outputs totalling the same magnitude as the initial increase in bank i's output. Thus $\lambda = \left(1 + \frac{d\sum_{j\neq i} x_j}{dx_i}\right)\frac{1}{n} = (1-1)\frac{1}{n} = 0$, irrespective of the number of banks, n. If there is perfect collusion in the industry, an increase in bank i's output will result in an equal increase in the output of all the other banks in the industry. This means that $\frac{d\sum_{j\neq i} x_j}{dx_i} = \frac{X - x_i}{x_i}$ and as a result $\lambda = \frac{X}{x_i n} = 1$. For a single monopolist, there are no other banks in the industry and thus $\frac{d\sum_{j\neq i} x_j}{dx_i} = 0$. Therefore $\lambda = \frac{1}{n}$ where $n = 1$, from which $\lambda = 1$. Under the usual assumptions, these are the two extreme values of λ corresponding to opposite levels of competition in the industry. The conduct parameter λ is restricted between 0 and 1, and is proportional to the level of competition in the industry.

4.1.2 The Empirical Model

As is standard in the literature, we consider deposits as an input rather than an output of the bank. We consider the banks output to be loans, and the demand for loans is given by,

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 EX_D + \alpha_3 EX_D P + \epsilon, \tag{3}$$

where Q is the real value of total assets (a proxy for loans) in the industry (used to measure banking services or output); P is the price of the banking services; EX_D are the exogenous variables that affect industry demand for banking services, but not the marginal costs - including disposable income, number of bank branches and interest rates for alternative investments (the money market rate and the government bond rate); and ϵ is the error term. The interaction terms $EX_D P$ are included to ensure the identifiability of the conduct parameter, λ. Without the interaction terms, one cannot distinguish competition from monopoly (Bresnahan 1982: 152-153).

On the supply side, Bikker and Haaf as well as Shaffer (1993) postulate the following marginal cost function:[20]

$$MC = \beta_0 + \beta_1 InQ_i + \Sigma_j \beta_j \ln EX_{S_j}, \tag{4}$$

where MC is the marginal cost for each bank; EX_S are the exogenous variables that influence the supply of loans, including the cost of input factors for the production of loans - wages, deposit rate and price of physical capital. The cost function as specified, is a legitimate marginal cost function as it satisfies all the requisite properties.

Rearranging the demand function yields,

$$P = \frac{1}{\alpha_1 + \alpha_3 EX_D} \left[Q - \alpha_0 - \alpha_2 EX_D - \epsilon\right]. \tag{5}$$

The total revenue for each bank can be obtained by multiplying the above rearranged demand equation by bank i's output, Q,

$$TR_i = \frac{1}{\alpha_1 + \alpha_3 EX_D} \left[Q - \alpha_0 - \alpha_2 EX_D - \epsilon\right] Q. \tag{6}$$

Differentiating this total revenue with respect to bank i's output will give the bank's marginal revenue,

$$\begin{aligned} MR_i &= \frac{dTR_i}{dQ_i} = \frac{1}{\alpha_1 + \alpha_3 EX_D} \left[Q - \alpha_0 - \alpha_2 EX_D - \epsilon\right] \\ &\quad + \frac{1}{\alpha_1 + \alpha_3 EX_D} \frac{dQ}{dQ_i} Q_i \\ &= P + \frac{\lambda n}{\alpha_1 + \alpha_3 EX_D} Q_i. \end{aligned} \tag{7}$$

Equating the marginal revenue and marginal cost of each bank to obtain the market equilibrium,

$$P + \frac{\lambda n}{\alpha_1 + \alpha_3 EX_D} Q = \beta_0 + \beta_1 \ln Q + \Sigma_j \beta_j \ln EX_{S_j} + v_i. \tag{8}$$

[20] There is no requirement that the "true" marginal cost be linear. We can view (4) as a linear approximation of the marginal cost function.

Rearranging and averaging to obtain the supply of loan facilities by the banks yields:

$$P = -\lambda \frac{Q}{\alpha_1 + \alpha_3 EX_D} + \beta_0 + \beta_1 \ln Q + \Sigma_j \beta_j \ln EX_{S_j} + v. \qquad (9)$$

Equations (3) and (9) constitute a system of two equations which we need to estimate to determine the λ statistic.[21] We thus have a simultaneous equation system and because of the possible endogeneity problem, equations (3) and (9) are estimated simultaneously to identify λ.

4.1.3 The λ Statistic

This coefficient λ is the value that determines the level of competition in the banking sector. Specifically, λ indexes the degree of market power of the average bank (Shaffer, 2001). If $\lambda = 0$, the outcome is competitive while $\lambda = 1$ if the outcome is perfectly collusive. For $\lambda \in (0, 1)$, the banking market is imperfectly competitive, and allows for all forms of oligopoly behaviour (see Shaffer (2001) for further explanations).

The estimated equations are:

$$Q = a_0 + a_1 P + a_2 gdp + a_3 Pgdp + a_4 govt\_r + a_5 Pgovt\_r + \epsilon, \qquad (10)$$

$$P = \frac{-\lambda Q}{a_1 + a_3 gdp + a_5 govt\_r} + b_0 + b_1 \ln Q + b_2 \ln wage + b_4 \ln r + b_5 \ln pce + v, \qquad (11)$$

where Q is the quantity of banking services measured as the dollar value of total assets and P is the pricing of banking services measured by the interest rate earned on the assets; gdp is the real gross domestic product, $govt\_r$ is the 3 month government treasury bill rate, $Pgovt\_r$ and $Pgdp$ are interaction terms; $wage$ is the average real wage in banking sector and r is the deposit rate and pce is the price of physical capital. The variable, $Q \times \frac{1}{a_1 + a_3 gdp + a_5 govt\_r}$ is the conduct variable and its coefficient, $-\lambda$, is the parameter of interest. The parameters ϵ and v are the respective error terms.

[21] Identification of λ requires that both $\alpha_1 \neq 0$ and $\alpha_3 \neq 0$ holds.

The specification of the λ parameter implicitly assumes that banks are input-price takers – which is plausible for labour and physical capital since in South Africa banks compete with other firms for labour and capital. For deposits however, the case may be different. It is possible that the deposit rate may be exogenous, if there is stiff competition for deposits (Shaffer, 1993, 2004). In that case the above assumptions still hold and banks would still be input price-takers even when it comes to deposits. However if banks have market power in deposits then the λ as specified in the model may overstate the degree of market power and thus be biased against the competitive case (Shaffer, 1993).

4.1.4 Data

The data required for the Bresnahan model are all macroeconomic (industry level) time series variables. Macroeconomic data is generally easier to obtain than microeconomic data. This is one of the benefits of using the Bresnahan model versus models that use bank specific data such as the Panzar and Rosse approach. In the case of a developing country such as South Africa however, this data is not always readily available. For example, there is not sufficient data to enable us to test directly competition for the loans market. Following Shaffer (1993) we use the value of total assets as a proxy for output since we do not have sufficient information on loans.

Unfortunately, historical unemployment data is not readily available for South Africa. The longest range was available from the International Monetary Fund's International Financial Statistics (IFS) database which contained quarterly data from Q1 of 1992 until Q4 of 2008. This dataset has a two year gap from Q1 of 1998 until Q4 of 1999. This therefore would restrict the study to 57 periods. Since our sample is already small, we decided to drop the unemployment variable from the sample in order to raise the number of observations. Most of the remaining variables were also obtained from the IFS database. The banking sector wage variable was obtained from the South African Reserve Bank online database. Disposable income data was only available annually from the South African Reserve Bank database. Imputing quarterly values would result in inaccurate data, therefore a proxy for the disposable income was used. The best proxy would be the Gross Domestic Product (GDP) at constant 2000 prices. This is because the disposable income is calculated from the GDP by subtracting aggregate taxes from this value.[22] There was insufficient time series data on the number of bank branches, therefore this variable was excluded from this study.

4.2 Empirical Results

The quantity of banking services is determined by the price of banking services and exogenous variables such as GDP and government treasury bill rate. The price coefficient should be consistent with a downward-sloping demand curve. The government debt rate, being a price of a substitute, should have a negative coefficient. GDP proxies for income and it is expected to be positive.

The supply equation (9) determines the price of banking services as a function of the volume of banking services (Q), the price of inputs (wage rate, price of physical capital and deposit rate), and the output times the first derivative of the demand function. The estimated coefficients of wages of bank employees, interest rate on deposits (r), and price of physical capital should be positive – showing that higher costs will be passed on to consumers in the form of higher price of loans. The coefficient on 'output times the inverse of the first derivative of the demand function' is the parameter of interest in this exercise. It gives a measure of competition on the banking sector.

We estimate equations (10) and (11) and the outputs are reported in the Table 5 below.[23] Given that P (an endogenous variable in the supply equation) appears as a regressor in the demand equation (10) and likewise Q (endogenous) appears as a regressor in the supply equation, we have a (possible) simultaneity problem. In this case, estimating by OLS may result

[22] Bikker & Haaf (2002) also used GDP as a proxy for disposable income.

[23] The Augmented Dickey-Fuller test identified that each variable is integrated at the first difference, with unit roots at the levels. The Pesaran-Shin-Smith ARDL showed a unique long-run relationship, allowing the conduct variable to be interpreted as if no time series characteristics exist.

in inconsistent and/or inefficient estimates for at least two reasons: First, one or more of the endogenous variables may be correlated with the error term and second, the error terms may themselves be correlated. We ran some endogeneity tests - specifically the Hausman test and the Durbin-Wu-Hausman test. The test results suggest no endogeneity. However, the identification conditions for the conduct parameter ($a_3 \neq 0$ and/or $a_5 \neq 0$) are only marginally met. The joint test of $a_3 = a_5 = 0$ cannot be rejected at the 10% level. However, individual tests show that $a_3 = 0$ is rejected at the 10% level (but not at the 5% level) while $a_5 = 0$ cannot be rejected at the 10% level. Given these weak identification results and our intuition on the equilibrium relationship between demand and supply, we proceeded to estimate the demand and supply equations simultaneously using a SAS programme.

Table 5 about here.

For the demand equation, GDP is positive and significant at the 1% level while the government rate ($Govt\_r$) is only significant at the 10% level, but carries the correct (negative) sign. Price carries the correct (negative) sign but is insignificant. The coefficients on the interaction terms $PGovt\_r$ and $PGDP$, are insignificant at the 10% level.

In the supply equation, the input price coefficients carry the expected (positive) signs – suggesting that higher prices of inputs raises the price of loans. However, only two coefficients are significant: wages are significant at the 10% level while price of capital is significant at the 1% level.

The parameter of interest in this exercise is the coefficient of the conduct variable, $-\lambda$. The estimation yields λ equal to 0.2, with a t-statistic of -0.08. The λ statistic is thus insignificant – implying that the coefficient is statistically equal to zero.[24] This insignificant coefficient means that $\lambda \approx 0$, and that according to the Bresnahan model, perfect competition cannot be rejected in the South African banking sector. This however does not imply competitive conduct by the South African banks as failure to reject perfect

[24] This insignificant coefficient does not seem to be a problem as the output for the Bresnahan model in Shaffer (1989) on the U.S banking sector, and the λ coefficients of all of the countries in Bikker & Haaf (2002) are also insignificant.

competition does not mean acceptance of competition or evidence of no market power.[25]

The results of the Bresnahan model should be interpreted with caution for a number of reasons. Among these are that the data are generally imprecise and fraught with measurement errors and our sample is too short. In addition, the Bresnahan methodology appears to have weak discriminating power in practice.

5 Comparison with other Developing Countries

Many studies have been conducted using different methods to find the level of competition in the banking sectors of numerous countries across the world. The two main approaches used are the two methods applied in this paper, the Panzar and Rosse approach and the Bresnahan model.[26]

Perera et al. (2006) have used the Panzar and Rosse approach on some developing Asian countries including Bangladesh, India, Pakistan and Sri Lanka. Claessens & Laeven (2003) have conducted the Panzar and Rosse approach on fifty countries around the world, of which thirty one are developing countries. The results of the Panzar and Rosse H-statistics from the developing countries of these two papers are shown in Table A in Appendix I. Recently, Bikker et al (2012) use a much larger sample to estimate the H-statistics for different countries – developing and developed. They find an H-statistic of 0.46 for South Africa.

The countries that are most comparable to South Africa in terms of their level of development include Argentina, Brazil, Chile and Turkey. The H-statistics for these range between 0.21 for Chile to 0.61 for Turkey. These results suggest that these five countries all have low to moderate level of competition in their respective banking sectors.

These results are however markedly different to those of Claessens & Laeven (2003) and earlier studies who estimate a scaled revenue equation.

[25] The authors thank an anonymous referee for highlighting this observation to us.

[26] Generally, the results of the Bresnahan approach are less robust than those of the Panzar-Rosse model, largely due to measurement errors in variables and weak discriminating power.

For instance, Claessens & Laeven (2003) find an H-statistic of 0.85 for South Africa, and fairly high H-values for Chile, Argentina and Brazil (0.66, 0.73 and 0.83 respectively), but a moderate H-value for Turkey (0.46).

6 Conclusion

Given the importance of the banking sector on the economic performance of any modern economy, it is imperative that the banking sector is competitive. This will help improve the efficiency required to create a fully functional credit system as well as strengthen the effectiveness of monetary policy.

This paper has used two models to test for the level of competition in the South African banking sector. The Panzar and Rosse model suggests imperfect competition in the South African banking sector while the Bresnahan model fails to reject perfect competition. These two non-structural models have been used extensively in the literature and hold a high level of credibility in giving an accurate result for the level of competition. The results of the models combined with support from other recent applications of these models, as well as the similar results for comparable developing countries, strongly suggests monopolistic competition in the South African banking sector.

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Appendices

Appendix I: Tables

TABLE 1 - Key Banking Values as a Percentage of GDP

	2003	*2004*	*2005*	*2006*	*2007*
Total Deposits[a]	72%	74%	80%	88%	93%
Loans to Public Sector[a]	6%	5%	5%	4%	3%
Loans to Private Sector[a]	58%	61%	67%	76%	81%

[a] As a percentage of GDP.

Source: The South African Reserve Bank Quarterly Bulletin - Money and Banking

TABLE 2 - Market Share by Deposits

Bank	*Total Deposits (R million)*	*% of Industry Deposits*
Standard Bank	705,843	36%
Firstrand	416,507	21%
Nedbank	384,541	19%
ABSA	368,545	19%
Other Banks	96,242	5%

TABLE 3 - Market Share by Total Assets

Bank	*Total Assets (R million)*	*% of Industry Assets*
Standard Bank	1,175,409	36%
Firstrand	717,257	22%
Nedbank	483,609	14%
ABSA	640,608	19%
Other Banks	290,227	9%

Table 4a: Regression output for the Panzar-Rosse methodology: independent variables not corrected for scale (i.e., impact of total assets on independent variables not corrected for).

(Using Total Interest Income as dependent variable)

Variable	Regression1[1]
AFR	-0.135
	(-0.71)
PPE	0.500**
	(2.21)
PCE	0.322***
	(3.06)
BSF-Equity	-0.802***
	(-2.67)
BSF-Loans	0.538***
	(3.18)
OI	-0.629***
	(-2.73)
Constant	13.930***
	(16.27)
Wald chi2(6)	256.72
Prob >chi2	0.0000
H-statistic	0.6865
Obs.	108

Table 4b: Regression output for the Panzar-Rosse methodology: independent variables corrected for scale (i.e., impact of total assets on independent variables corrected for).
(Using Total Interest Income as dependent variable)

Variable	Regression2
AFR	0.052
	(0.26)
PPE	0.711**
	(2.45)
PCE	-0.236*
	(-1.87)
BSF-Equity	0.411
	(-1.47)
BSF-Loans	0.166
	(0.84)

[1] Independent variables not corrected for scale – i.e., impact of total assets on independent variables not corrected for.

OI	-0.843***
	(-4.02)
Constant	14.413***
	(105.31)
Wald chi2(6)	38.20
Prob >chi2	0.0000
H-statistic	0.5281
Obs.	108

Table 5: Bresnahan Model Parameter Estimates

Parameter	Three factor Model Estimate
P	-3.292
	(-0.60)
Gdp	1.959***
	-8.47
Pgdp	0.000004
	-0.97
Gvt_r	-0.022*
	(-1.72)
Pgvt	-0.014
	(-0.09)
Constant1	-6.157*
	(-1.87)
TA	0.083
	-0.11
r	0.002
	-1.52
wage	0.001*
	-1.77
Pce	37.890***
	-4.67
Constant2	-0.488
	(-1.45)
Lambda	-0.218
	(-0.08)
R^2(1)	0.97
R^2(2)	0.54

Notes: the variable abbreviations are based on equations 10 and 11. $R^2(1)$ is the R-squared for the demand function and $R^2(2)$ is the R-squared for the supply function.

Table 6: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev	Min	Max
LogTotal Assets	68	20.53	0.42	19.92	21.26
LogGDP_2000	68	13.75	0.17	13.51	14.06
P	68	0.06	0.02	0.01	0.12
Pk	68	0.002	0.0005	0.001	0.003
Inflation	68	7.25	3.42	0.45	15.95
MM_r	68	11.26	3.24	6.53	20.53
Govt_r	68	12.33	3.07	7.33	17.05
r	68	11.07	3.18	5.91	19.85
Log of Wage	68	15.92	0.47	14.46	16.89
Intr	114	0.13	0.15	0	0.78
AFR	114	0.12	0.13	0	1.04
PPE	114	0.03	0.04	0	0.23
PCE	114	0.69	1.33	-1.01	12.09
OI	114	0.07	0.08	0	0.28
BSFEQ	114	0.21	0.27	0.03	1.17
BSFLO	114	0.31	0.25	0	0.85

Appendix II: List of H-statistics

TABLE A - *H*-statistics from Claessens & Laeven (2003)

Country	*H-statistic*	*Country*	*H-statistic*
Argentina	**0.73**	Malaysia	0.68
Bangladesh	0.69	Mexico	0.78
Brazil	**0.83**	Nigeria	0.67
Chile	0.66	Pakistan	0.48
Colombia	0.66	Panama	0.74
Costa Rica	0.92	Paraguay	0.60
Croatia	0.56	Peru	0.72
Dominican Republic	0.72	Philippines	0.66
Ecuador	0.68	Poland	0.77
Honduras	0.81	Russia	0.54
Hungary	0.75	**South Africa**	**0.85**
India[a]	**0.64**	Sri Lanka[a]	0.71
Indonesia	0.62	Turkey	0.46
Kenya	0.58	Ukraine	0.68
Latvia	**0.66**	Venezuela	0.74
Lebanon	**0.69**		

[a] *H*-statistics from Perera *et al.* (2006).