The Relationship between Regulation and Solvency Risk for the Top Five South African Banks

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Abstract: Objectives: the objectives of this paper were to analyse different types of risks that banks face, conduct in-depth analysis of the various types of bank regulatory measures, and determine whether there is a long run or short-run relationship between bank solvency and the implementation of bank regulation **Prior Work** this research builds up on studies about bank risk and regulation but include an African aspect **Approach** Secondary data from banks' financial statements was used to calculate solvency risk using a z-score model. The results of the z-score model represented solvency risk and performed as the dependent variable in the study. **Results** Logit Regression showed that the z-score for South African banks cannot be used to predict whether new regulation will be implemented in the future. However, an ARDL model indicated that there is a long-run relationship between the z-score for the top five South African banks and new regulation being implemented. **Implications** This study can be used by academic researchers as a comparison to their own academic work **Value** Based on the varying results from the different methodologies implemented in this study, it can be recommended that more regulation needs to be implemented that specifically looks into increasing the solvency levels of South African banks.

Keywords: z-score; Auto-Regressive Distributed Lag model; logistic regression

JEL Classification: C3; C5; G2

1. Introduction

There is no actual figure or measure set in place to determine the optimal level of banking regulation (Dermirguc-Kunt et al., 2008; Delis et al., 2011). As such, it is of concern for policymakers to choose between implementing stricter bank regulation or relax current regulation. Bank regulation has both desirable and non-desirable aspects attached to it (Wilf, 2016, p. 769). For example, loose, non-

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stringent regulation results in high growth but also brings high volatility. In contrast, more stringent regulation, such as strict capital requirements limit the risk-taking behaviours of banks, which could result in credit rationing (Dawid & van der Hoog, 2017, p. 1208). The costs of regulation include a restriction on risk-adjusted leverage and the benefits that come with it include cheaper-funding and insurance (Kim & Mangla, 2019, p. 485). On account of this, there are arguments for both stricter bank regulations and some for limited bank regulation (Beck et al., 2010, p. 1665; Chava et al., 2013, p. 767; Levine et al., 2014, p. 3).

Levine et al. (2014, p. 25) argue that bank deregulation can be used to ensure bank productivity, which can mean that the banking system can properly function with little or no regulation. Removal of some banking regulations, notably the Glass-Steagall Act of 1932, and relaxing some regulations such as the Mcfadden Act of 1927 in the United States (US) allowed commercial banks to grow rapidly at the beginning of the 1980s through to the early 2000s (DeYoung, 2010, p. 11). In response to this, there were various mergers and acquisitions within the US banking industry. In the 1980s, there were over 350 commercial bank mergers and acquisitions each year, 500 in the 1990s, and 300 in the early 2000s. However, there are some, such as (Laeven & Levine, 2009; De Haan & Klomp, 2015) who argue that implementing stricter banking regulations will reduce solvency risk within banks.

De Haan et al. (2013:2) suggest that good regulation counteracts failures that are inherent to the market and creates more opportunity for the market to function smoothly. As a result, it is important to determine whether any change in banking regulation can have an impact on the profits of banks. The reason for a study in this field is that in the event of corporate failures there are various economic costs to the society including economic downturns and recessions (Johnstone et al., 2016, p. 3).

In this study, a z-score measure will be used to determine if the banking regulation in South Africa (SA) has been favourable among the top five commercial banks in the country. A shock in the financial sector also affects other businesses that may not be in the finance area. Waterford Wedgewood, a glasswork maker, went bankrupt after the 2008 global financial crisis (Gepp & Kumar, 2015, p. 396). Even though the South African market was protected by sound financial regulation (Ikhide & Maredza, 2013, p. 553; Foggit et al., 2017, p. 3) during the crisis it also suffered the consequences with over a million jobs lost (National Treasury, 2011, p. 4). Based on the results that will be obtained, policy recommendations on South African banking regulation will be made.

The rest of the study is organised as follows: section two will provide a literature review on banking regulation and risk. Then proceed to provide the measures of bank failures in section three, while section four provides an overview of the South

African Banking landscape compared to its African and global counterparts. Section five will include the data description and methodology, it also details the results and discussion thereof. Thereafter section six will conclude the study and also provide recommendations.

2. Literature Review

2.1. Previous Studies on Regulation and Bank Performance

Banking regulation increases the flexibility of the financial sector so that it will not find itself in a strained situation (Bessis, 2017, p. 2). Additionally, banking regulation aims to obtain stability without sacrificing the market discipline of risky banks (Iyer et al., 2016, p. 2721). It is set in place to prevent bank crises as they are costly and affect not only the banking sector but numerous macroeconomic sectors (Tchana, 2008). Ultimately, bank regulation looks to provide financial stability, create equality amongst financial institutions, and mitigate any potential threat to the financial sector (Jacobs & Van Vuuren, 2014:268). Taking this into account, globally the banking sector is one of the most regulated and monitored sectors (PwC, 2019). Despite this, Demirgüc-Kunt and Detragiache (2011) could not identify any significant relationship between bank risk and regulation.

Furthermore, Angkinand (2009, p. 240) studied the relationship between regulation and banking crises using the sample period of 1970 to 2003, and a sample size of 35 economies. The objective was to determine whether strict banking regulations can reduce the effects of bank crises. The study concluded that there is no evidence to support bank supervision as a measure to decrease bank crises. It did, however, note that countries had lower cost crises if their banks provided deposit insurance coverage and enforced strict capital adequacy requirements. Delis et al. (2011) examined the relationship between regulation and the supervisory framework of banks from over 22 countries covering the period from 1999 to 2009. The study combined the Malmquist index estimates with bootstrap regression and concluded that there is a positive impact on bank productivity if the regulation in place promotes private monitoring.

Additionally, Barth et al. (2013) conducted an unbalanced panel analysis was conducted on 4050 banks from the year 1999 to 2007, to determine the effects of banking regulation and supervision on bank efficiency. It built upon three surveys on banking regulation by Barth et al. (2004; 2006; 2008) to which they concluded that strict banking restrictions are negatively correlated with efficiency in banks. They also concluded that an increase in capital regulation for banks results in a positive increase in bank efficiency. Similarly, Pasiouras et al. (2009) studied the impact of regulatory and supervisory frameworks on bank efficiency using data from 615 commercial banks in 74 countries from 2000 to 2004. Using a stochastic

frontier analysis, they found that regulation on market discipline leads to an increase in cost- and profit efficiency.

De Haan and Klomp (2014, p. 19) examined the effect of bank regulation and supervision on banking risk using data from 371 banks from non-industrialised countries for 2002 to 2008. Their results concluded that imposing strict banking regulation and supervision results in low risk for banks. However, Du Jardin et al. (2017:4) argued that these studies make use of accounting variables which only represent one aspect of insolvency prediction. To resolve this, De Haan and Klomp (2015) performed another study on the impact of regulation and supervision using z-scores on 1238 banks from 94 developed countries. They used data from the Bankscope of Bureau van Dijk and bank regulation and supervision surveys combined by Barth et al. (2004) and Barth et al. (2008) from 107 countries from the period of 1999 to 2008. The study concluded that the z-score measure increased when there was an increase in bank regulation and supervision. A low z-score means a relatively high level of risk whereby a high z-score means a relatively low-risk.

Another study done by Zeidan (2016) researched the effects of illegal financial activities in the US banking sector and whether or not regulation is effective in combating this. Using a sample of 80 US banks covering 20 years it was found that the enforcement of regulation on those banks did not have any effect on illegal banking activities. Costelllo et al. (2019) used US banks to determine if strict banking regulation improves financial reporting transparency. The results showed that regulations are important when it comes to financial reporting and even more so in periods before economic crises. Though much work has been done on the study of bank regulation and bank performance, to the best knowledge of the researcher, there has not been a study that looked at the relationship of regulation in South African banks to combat the risk of insolvency. This study will aim to fill this gap and share some light to policy developers on how banking regulation affects the solvency of South African banks. The following section will discuss several measures that can be used to predict whether a specific bank can fail due to insolvency.

Prediction of a company failure can be traced to the 1840s when the company Dun and Bradstreet was incorporated to provide independent creditworthiness of different companies (Jayasekera, 2018, p. 207). In 1966 Beaver (1966) presented univariate modelling to predict distress and Altman (1968) used discriminant analysis two years later to develop a prediction model (Appiah, 2011, p. 39; Gepp & Kumar, 2015, p. 397).

Some signals are implemented to assist in the prediction of the future financial situation in banks. Such signals are grouped into two measures namely market- and accounting-based measures (Chiaromonte et al., 2015, p. 112). These are part of

parametric models for bankruptcy prediction and make use of financial information to predict bankruptcy in banks (Mishra & Singh, 2016, p. 4). This study will make use of an accounting-based measure which is called the z-score. There is a higher level of risk-adjusted return when accounting-based models are implemented in bankruptcy prediction (Altman et al., 2017, p. 113). Apart from the z-score model, there are various other accounting-based models namely, Ohlson O-score and the Zmijewski X-score model (Mishra & Singh, 2016, p. 5). The difference between these models lies in their theoretical approaches and the information that they use to model bank insolvency.

Market-based measures are an alternative to the accounting-based measures and counter the criticisms that surround the accounting-based measures. These types of measures investigate the insolvency of both individual banks and the financial system as a whole (Tinoco & Wilson, 2013, p. 396). Advantages of the market-based models include the reflection of all available information in an efficient market; low likeliness of market variables being influenced by firms accounting policies and the reflection of future expected cash flows by market prices (Fu et al., 2014, p. 65). These models have to be able to provide in-depth information that is not already provided by banks on a firm-level when it comes to a driver of systemic risk (Cai et al., 2015, p. 1405). There are a few differences between market and accounting based predictive models but the use of accounting models allows for the use of higher risk-adjusted return on credit activity (Altman et al., 2017, p. 133).

The following section will provide an overview of the South African banking sector landscape. It also covers some scandals that faced the SA banking system and details some information regarding bank regulation in SA.

3. South African Banking Landscape

SA has the most advanced financial market in all of the Southern African Development Community (SADC) and has no close competitors in this regard (Bara & Le Roux, 2017:400). Since the early 1990s in SA, there has also been a rise in the introduction of new legislation, technology, and several new participants in the financial sector which has contributed to an increase in competition. Evident of the competition is the monopolistic competitive environment that banks in the country operate under (Simatele, 2015, p. 833).

In perspective, SA has 17 authorised local banks, two mutual banks, four local branches, two co-operatives, and 43 foreign banks (Chitamba, 2018, p. 1). The top five banks namely Standard Bank (SB), First National Bank, Nedbank, ABSA, and Capitec Bank own 90 percent of the total assets in the banking sector of SA (South African Reserve Bank, 2018:7). Outside investors have the highest bank ownership

in SA with 49 percent ownership, South African savings via mandated investment schemes own 34 percent, and other investors owning 17 percent (The Banking Association South Africa, 2017, p. 5). The US$ 5.5 billion purchase of 20 percent of Standard Bank by the Industrial and Commercial Bank of China is one such example of foreign ownership of SA banks (Ifeacho & Ngalawa, 2014:1184). The high number of foreign ownership indicates the likelihood that SA banks are highly regarded amongst their global peers.

Moreover, the banking system is considered developed, and in the 2012/13 in the World Economic Forum Competitiveness Survey, SA was rated 2nd out of 144 surveyed countries (Bany-Ariffin *et al.*, 2015:54). The recent 2018/19 survey lists SA as number 29 out of 141 surveyed countries which is a drop from the 2012/13 results (World Economic Forum, 2018). South African banks are high influencers in the African landscape with 42.4 percent of bank deposits, 49.9 percent of bank credit, 34.6 percent of net earnings, and 40.4 percent of total bank assets out of the top 200 African banks surveyed in 2008 (Kamarudin, & Sufian, 2016:521). This means that any financial shock experienced in South African markets can be felt across Africa and the different regions such as the Southern African Development Community (SADC).

Before the 2008 global financial crisis, from 2005 to 2007, commercial banks in SA had an increase in bank performance measured by profitability, liquidity, and credit quality (Kumbirai & Webb, 2010, p. 48). The progress was halted post-2008 due to the 2008 global financial crisis and a slowing economy. In 2011, the South African financial sector comprised of at least R6 trillion in assets, contributed over 10.5 percent of the Gross Domestic Product (GDP), and 15 percent of corporate income tax (National Treasury, 2011, p. 2). Furthermore, over the 10 years from 2000 to 2010, the sector grew at an annual rate of 9.1 percent which was three times more than the economic growth over the same period. Total banking assets to GDP of South African banks increased from 89.2 percent in 1999 to 136.8 percent in 2008 (Mlambo & Ncube, 2011, p. 6). Over the 2017/18 period the top four banks, excluding Capitec, had combined headline earnings of R40.4 billion which indicated a 12.1 percent year on year growth (PwC, 2018:4). Over the 2017/18 financial period, an excess amount of R336.8 million was paid to the National Treasury by four of the top five banks, as interest from tax and loan accounts (National Treasury, 2018, p. 20).

Surprisingly, there are a few controversial issues that have plagued the South African banking system. In 2014, African Bank Limited collapsed due to the issuance of multiple loans and credit cards mostly at high-interest rates for low-income customers whilst taking in a few deposits to match the outflow of cash through loans and credit cards (Foggitt *et al.*, 2017, p. 3). Similar to the cause of the 2008 global financial crisis, loans were granted to un-creditworthy individuals.

As a result, the South African Reserve Bank (SARB) provided a bailout to the amount of R17 billion (IMF, 2014b, p. 7). However, the regulatory environment of South African banks was put under the spotlight and prompted a review in supervisory procedures (The Banking Association South Africa, 2017:10). In 2017 there were price-fixing allegations by 17 banks of which three were from SA (Moyo, 2018, p. 2). Lastly, in March 2018 Venda Building Society (VBS) was placed under curatorship by the SARB as a result of their imprudent banking practices. This meant that the executive management and board of directors of VBS were all replaced by management appointed by the SARB (Chipatiso & Kawadza, 2018, p. 39). On 29 October 2018, an application was issued to the High Court of SA for the liquidation of VBS (SARB, 2018b).

In contrast, regulation in the South African banking landscape is to provide the establishment of principles that assist in the maintenance of effective risk management by banks (Government Gazzette, 2012, p. 10). Commercial banks are required to have cash reserve balances with the SARB which complies with the SARB Act of 90 of 1989 (SARB, 2017:92). In 2017 the reserve balance was below the required amount by R2 billion which they improved to R35.5 million below the required reserve in 2018 (SARB, 2018c, p. 41). SA introduced the Financial Sector Charter in 2004 which aimed to increased financial inclusion (The Banking Association South Africa, 2019). As a result, there has been an increase in financial inclusion in the country from 55 percent in 2005 to 85 percent in 2016 (Treasury, 2017, p. 165). This shows that most adults in the country have access to different types of finance-related products from financial institutions. The following section discusses the methods that were used to run and interpret the chosen data.

4. Methodology

Research Design

This study will make use of a quantitative research design to aid in examining the impact of banking regulation and supervision on solvency risk for South African banks. This research design will make use of the following analytical tools, logistic regression, and an Auto-Regressive Distributed Lag model (ARDL) and quantile regression. The main contributing factor to the use of this research design in this study is that the numerical data is readily available and it can be measurable.

Data Selection and Description

The sample will comprise of the top five South African commercial banks by market size. According to the South African Reserve Bank (2018), these banks make up 90.5 percent of the banking sector in South Africa and thus relatively represent the South African banking sector. These banks are Standard Bank (SB),

Amalgamated Banks of South Africa (ABSA), First Rand Bank, Nedbank and Capitec Bank.

The data will comprise, the return on assets and capital to asset ratio which is found on the banks' financial statements which are publicly available on the IRESS website. Therefore, secondary data will be used to calculate solvency risk using a z-score model. The data was published for stakeholders and shareholders of the banks to show the performance of the banks over time and will be used in the research because it fits into the z-score formula used in this study. The results of the z-score model will represent solvency risk and will be the dependent variable in the study. The period for data gathering will be from 2000 to 2017 because the period has data from pre-, during, and post the 2008 global financial crisis (GFC). Additionally, for a z-score to be calculated there needs to be at least four years' worth of data from the time of the study (Smit & Swanepoel, 2016, p. 116).

The other variables in this study will be bank regulations that were implemented in South Africa from 2000 to 2017. Specifically, the number of these implemented regulations. Government gazettes will be used as a reference for new bank regulations that were implemented.

5. Model Specification and procedure

To achieve the empirical objectives of this study, this study uses two different methods to run the chosen data. The two methods are logistic (Logit) regression and the Auto-Regressive Distributed Lag model (ARDL). For both models the Augmented Dicky-Fuller (ADF) unit root tests were conducted to determine if the variables are stationary. As a way to determine the probability of insolvency for South African banks, this study implements the z-score as a method of calculation. A z-score is a proxy for bank risk and indicates the standards deviation that the return on asset has to be before the equity runs out and a bank is deemed insolvent (De Haan & Klomp, 2015; Demirgüc¸-Kunt & Detragiache, 2011; Laeven & Levine, 2009). In both methods, the average z-scores of the chosen banks are the independent variables and the implementation of the new regulation is the independent variable.

Secondary data obtained from the Iress data site for the seventeen years from 2000 to 2017 was used in this study. There was no data for Capitec bank for 2000 and 2001 due to the bank commencing its operations on the 1st of March 2001 (Capitec Bank, 2019). To compensate for this lack of data zeros were put in place as placeholders for the Return on Assets (ROA) and Capital to Asset Ratio (CAR) values for 2000 and 2001. The following z-score formula is used as a measure:

$$Z = (CAR + ROA) / \sigma ROA, \quad (1)$$

Where CAR is the capital to assets ratio, ROA is the return on assets and σROA represents the standard deviation of the return on assets (Li *et al.*, 2017:12). Unlike the Altman z-score, there are no benchmarks, since this z-score is not complex and uses accounting information to indicate whether a bank may be nearing bankruptcy (Swanepoel, 2016:19). For a bank to be considered as insolvent the following condition needs to be present CAR + ROA $\leq$ 0 (Lepetit & Strobel, 2013:74). A high z-score value means that there is a relatively low level of bank risk and a low z-score means that there is a relatively high level of bank risk. Microsoft Excel was used to compute the individual z-scores of the five banks.

Secondly, the study used Logit Regression to determine the probability of the occurrence of new regulation as a result of increased volatility. This means that it studied whether an increase in the z-score can be related to the introduction of new banking regulation. The Logit Regression presents binary outcomes, which can either be an occurrence or non-occurrence of an event (Sperandei, 2014). As previously stated a Logit Regression is a binary regression and is thus represented by the following the probabilities of new regulations being implemented in SA and is represented by the following:

$$Y=\begin{cases} 1, \text{ if there was a new regulation} \\ 0, \text{ if there was no new regulation} \end{cases}$$

Y is the dependent variable and the values 1 and 0 represent the implementation and non-occurrence of a new banking regulation respectively. These variables were coded in the data analysis tool, E-views 11, and the Logit Regression equation is presented as the following:

$$ln\left(\frac{p}{1-p}\right)=\beta_0+\beta_1 X \quad (2)$$

Where:

$\left(\frac{p}{1-p}\right)$ = the odds ratio; P = the introduction of new regulation; 1-P = No new regulation introduced; β_0 = Coefficients; X = intercepts

Since this will be an estimate of the probability, an estimated regression model will be used which is represented by the following equation $ln\left(\frac{\hat{P}}{1-\hat{P}}\right) = b_0 + b_1 x$. All the variables retain their meaning with exception to the fact that they are now estimates. The focus of the results from this equation is on the sign and not the magnitude of the value obtained. Thus, if the value of the coefficient is greater than 0, it indicates that an increase in the coefficient increases the likelihood of the implementation of new bank regulation. Therefore, it would mean that an increase in the intercept X would increase the likelihood of new regulation being passed.

Alternatively, if the coefficient value is less than 0 then a decrease in the intercept X decreases the likelihood of the passing of new regulation.

If the values of the Logit Regression are statistically significant then the equation is represented as:

$$\ln\left(\frac{\hat{P}}{1-\hat{P}}\right) = \alpha_0 + b_0X_1 \text{ z-score} + b_1X_2 \text{ z-score} + b_2X_3 \text{ z-score} + b_3X_4 \text{ z-score}$$

$$+ b_4X_5 \text{ z-score} \quad (3)$$

Where: X_1 = ABSA, X_2 = Capitec, X_3= First Rand, X_4= Nedbank, X_5= SB

Lastly, to test whether there is a long run or short-run relationship between the variables, an autoregressive distributed lag model, known as the ARDL model, was used. The model is represented by the following equation:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-1} + \sum_{i=0}^{n} \delta_i \Delta X_{t-1} + \varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + \mu_t \quad (4)$$

Where:

β_1 & δ_i = Short-run equations; φ_1 & φ_2 = ARDL long-run coefficients; μ_t = Disturbance term

The variables are logged in the E-views programme and the first step is to determine the optimal number of lags. Thus, the analysis uses the lags chosen as the optimal number of lags. After the optimal lags are chosen the model is run using the following formula:

$$\Delta Regulation = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta Regulation(-1) + \sum_{i=0}^{n} \delta_i \Delta Average(-1) + \varphi_1 Regulation(1)$$

$$+ \varphi_2 Average(-1) + \mu_t \quad (5)$$

5. Results and Discussion

The data was initially tested for stationarity and all the variables were found to be stationary at level expect for the z-score values of Amalgamated Banks of South Africa (ABSA) and Capitec bank which were stationary after first differencing. The z-score results and their order of integration are listed in Tables 1 and 2 respectively.

Table 1. Z-Score Results Using Bank Data

Year	ABSA	Capitec bank	First Rand	Nedbank	SB	Average
2000	7.226	0.000	6.045	6.015	5.558	4.969
2001	7.144	0.000	5.988	5.350	6.947	5.086
2002	7.222	0.189	5.972	5.320	6.409	5.022
2003	7.108	0.190	5.979	5.435	-3.230	3.096
2004	7.007	0.191	5.900	5.344	9.382	5.565
2005	7.092	0.191	5.227	5.118	6.884	4.903
2006	6.869	0.191	5.067	5.166	6.822	4.823
2007	6.746	0.190	5.450	5.193	5.461	4.608
2008	6.798	0.188	5.948	5.255	7.252	5.088
2009	7.007	0.189	6.071	5.287	7.304	5.172
2010	6.989	0.186	5.471	5.289	7.188	5.024
2011	6.895	0.187	13.376	5.246	7.115	6.564
2012	6.949	0.187	5.287	5.196	7.147	4.953
2013	6.950	0.188	5.241	5.169	7.025	4.915
2014	6.935	0.189	5.193	5.138	7.062	4.903
2015	6.965	0.188	5.559	5.130	7.193	5.007
2016	7.018	0.188	5.787	5.165	6.987	5.029
2017	6.987	0.188	5.760	5.100	6.873	4.982
Average	6.995	0.168	6.073	5.273	6.410	

Table 2. Order of Integration

	ABSA	Capitec bank	First Rand	Nedbank	SB	Average
Order of Integration	I(1)	I(1)	I(0)	I(0)	I(0)	I(0)

Logit Regression Results

Thereafter, a binary Logit Regression was run to determine the level of significance and interpret to signs of the coefficients. The results of the regression p-values and unit root tests are summarized in Table 3. Variables that are significant under the 1, 5, and 10 percent significance level are the ones that were chosen for the forecasting of new regulation being implemented. However, none of the regressors were significant under all the significance levels. This led to the conclusion that there is no relationship between the new regulation being implemented in South African banks and the banks' z-score level. This result is contradictory to the results found by De Haan and Klomp (2015) who concluded that there is a positive relationship between bank regulation and bank risk measured by the z-score.

Table 3. Logit Regression and Unit-Root Results

Z-score Variable	P-value	Order of Integration
DAbsa	0.9274	I(1)
DCapitec	0.6692	I(1)
First Rand	0.1907	I(0)
Nedbank	0.2634	I(0)
SB	0.8098	I(0)

Thereafter, an ARDL model was done between the new regulations implemented and the average z-score movement for South African banks from 2000 to 2017. The ARDL model was relevant to this study because the z-score values are integrated of order 0 and 1 but not 2 as shown in Table 2. Based on the lag length criteria, the optimal number of lags to be used was 7 lags. The results of the ARDL regression are shown in Table 4:

Table 4. Regression Results

Variable	**P-value**
Short-run variables	
D(Regulation(-1))	0.5924
D(Average(-1))	0.3377
Long-run variables	
Regulation(-1)	0.0070
Average(-1)	0.2312
F-Statistic Probability value 0.0049	

Model diagnostic, in the form of a serial correlation test had to be performed before the results of the ARDL model were interpreted. The results of the Breusch-Godfrey serial correlation Langrange Multiplier (LM) test are shown in Table 5 below:

Table 5. Breusch-Godfrey Serial correlation LM Test

F-stat	0.2722	**P-Value**	0.9357
Obs*R-Squared	5.1634	**P-value Chi-Square**	0.5400

From Table 5, the p-value associated with the chi-square distribution was greater than the significance value of 0.05. Therefore, we do not reject the null hypothesis that there is evidence of serial correlation. Thereafter, model stability was done via a cumulative sum control chart (CUSUM chart) shown in Figure 2.1:

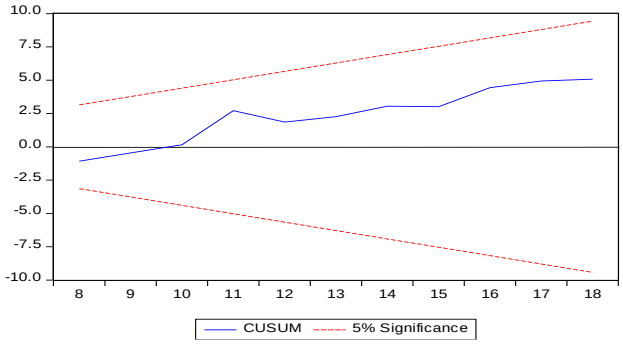

Figure 1. CUSUM Chart

The results show that the trend line lies within the boundaries, thus the model is stable. Thereafter, the bounds test was performed between the two long-run variables to check if they are statistically significant. The null hypothesis under the Wald test is that the two long-run variables are both equal to zero. The results of the regression are shown in Table 6 below:

Table 6. Wald Test Results

Wald Test			
Test Statistic	**Value**	**df**	**Probability**
F-statistic	7.251003	(2, 11)	0.0098
Chi-Square	14.50201	2	0.0007

The p-value of the F-statistic in the Wald test shows statistical significance, however, that is not the determinant of significance when it comes to Wald tests. To determine significance, a Pesaran table was used to determine whether the p-value is significant. The p-value is significant if the calculated F-statistic value is greater than the upper bound value from the Pesaran table and under the 5 percent significance level, the lower and upper bound values from the table are 4.94 and 5.73 respectively. Thus, from the ARDL model regression it was concluded that the model is significant and there is a long-run relationship between bank regulation and bank solvency risk which was represented by the z-score since the calculated F-statistic value of 7.25 is greater than the upper bound value from the Pesaran table. The nineteen new banking regulations that were implemented in South Africa are shown in Table 7.

Table 7. Bank Related Regulations Implemented in South Africa from 2000 to 2017

Year	Regulation
2017	Financial Sector Regulation Act 9 of 2017
2016	King IV
2015	Bank Amendment Act
2013	Protection of Personal Information Act
2012	Financial Markets Act
2010	Basel III
2009	Taxation Laws Amendment Act, King III
2008	Consumer Protection Act
2007	Bank Amendment Act, Corporative Bank Act
2005	National Credit Act
2004	Basel II
2003	Bank Amendment Act
2002	King II, Financial Advisory and Intermediary Services Act
2001	Financial Intelligence Centre Act
2000	Bank Amendment Act

6. Conclusion

This study aimed to determine the relationship between banking regulation and solvency levels of five major banks in SA. The main objective was to determine if the implementation of new bank regulations was assisting bank solvency or not. By using z-scores to determine the levels of solvency in the top five banks the results showed that four of the five banks have had stable z-scores over the period from 2000 until 2017. The only exception was Capitec bank which had low z-score measures which could indicate that it has been on the edge of bankruptcy since the turn of the century. There is no study from the empirical literature that supports nor contests this finding therefore this could relatively be a new finding in this field of study. This finding can also be a potential area of a study looking into how a Capitec bank has been existing with relatively low levels of solvency.

Logit Regression showed that the z-score for South African banks cannot be used to predict whether new regulation will be implemented in the future. This result that showed that there was no relationship between bank solvency and new regulation implemented in South African banks was in support of some of the studies in the literature which also found no relationship between bank risk and bank regulation. A relative conclusion can be drawn that the implementation of banking regulation does not affect bank risk using solvency levels as a proxy. This could mean that they may be other factors such as economic variables and the micro- and macroeconomic environment that can influence the solvency levels of banks.

However, using an ARDL model, results showed that there is a long-run relationship between the z-score for the top five South African banks and new regulation being implemented. This result was in support of the result by De Haan and Klomp (2015) who also used z-scores as a risk proxy against bank regulation and found a positive relationship between the two variables. The study also found that there have been nineteen new regulations, including amendments of the bank act, that have been introduced to South African banks since 2000 until 2017. Based on the varying results from the different methodologies implemented in this study, it can be recommended that more regulation needs to be implemented that specifically looks into increasing the solvency levels of South African banks**.**

References

ABSA. (2019). *Barclays Africa Group Relaunches as Absa Group with a Fresh New Look*. https://www.absa.co.za.

Admati, A. & Hellwig, M. (2014). *The Bankers' New Clothes: What's Wrong with Banking and What to Do about It-Updated Edition*. New Jersey: Princeton University Press.

Altman, E. I. (1968). Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. *Journal of Finance*, 23, 4, pp. 589–609.

Altman, E. I.; Iwanicz-Drozdowska, M.; Laitinen, E. K. & Suvas, A. (2017). Financial distress prediction in an international context: A review and empirical analysis of Altman's Z-score model. *Journal of International Financial Management & Accounting*, 28, 2, pp. 131-171.

Angkinand, A. P. (2009). Banking regulation and the output cost of banking crises. *Journal of International Financial Markets, Institutions and Money*, 19, 2, pp. 240-257.

Appiah, K. O. (2011). Predicting Corporate Failure and Global Financial Crisis: Theory and Implications. *Journal of Modern Accounting and Auditing*, 7, 1, pp. 38-47.

BankSeta. (2017). *Banking Sector Skills Plan 2017/18*. https://www.bankseta.org.za.

Bany-Ariffin, A. N.; Matemilola, B.T. & Muhtar, F.E. (2015). The impact of monetary policy on bank lending rate in South Africa. *Borsa Istanbul Review*, 15, 1, pp. 53-59.

Bara, A. & Le Roux, P. (2017). South Africa's Financial Spillover Effects on Growth and Financial Development in the Southern African Development Community. *International Journal of Economics and Financial Issues*, 7, 5, pp. 400-412.

Barth, J. R.; Caprio, G. & Levine, R. (2004). Bank regulation and supervision: what works best? *Journal of Financial Intermediation*, 13, 2, pp. 205-248

Barth, J. R.; Caprio, G. & Levine, R. 2006. *Rethinking Bank Regulation: Till Angels Govern. Cambridge*. Cambridge: Cambridge University Press.

Barth, J. R.; Caprio, G. & Levine, R. (2008). Bank regulations are changing: for better or worse? *Comparative Economic Studies*, 50, pp. 537-563

Barth, J. R.; Lin, C.; Ma, Y.; Seade, J. & Song, F. M. (2013). Do bank regulation, supervision and monitoring enhance or impede bank efficiency? *Journal of Banking & Finance*, 37, 8, pp. 2879-2892.

Beaver, W. H. (1966). Financial ratios as predictors of failure, empirical research in accounting. *Supplement to Journal of Accounting Research*, pp. 71-111.

Beck, T.; Levine, R. & Levkov, A. (2010). Big bad banks? The winners and losers from bank deregulation in the United States. *The Journal of Finance*, 65, 5, pp. 1637-1667.

Becker, E. (2016). *Knowledge Capture in Financial Regulation: Data-, Information-and Knowledge-asymmetries in the US Financial Crisis*. New York: Springer.

Bessis, J. (2015). *Risk Management in Banking*. Hoboken, NJ: John Wiley & Sons.

Bhatt, R. K. (2011). Recent global recession and Indian economy: an analysis. International *Journal of Trade, Economics and Finance*, 2, 3, pp. 212-217.

Cai, C. X.; Keasey, K.; Vallascas, F. & Zhang, Q. (2015). Are Market-Based Measures of Global Systemic Importance of Financial Institutions Useful to Regulators and Supervisors. *Journal of Money, Credit and Banking*, 47, 7, pp. 1404-1442.

Canuto, O. & Ghosh, S. (Eds.). (2013). *Dealing with the challenges of macro financial linkages in emerging markets*. The World Bank.

Capitec Bank (2019). *About us.* https://www.capitecbank.co.za/about-us.

Chava, S.; Oettl, A.; Subramanian, A. & Subramanian, K. V. (2013). Banking deregulation and innovation. *Journal of Financial Economics*, 109, 3, pp. 759-774.

Chiaramonte, L.; Croci, E. & Poli, F. (2015). Should we trust the Z-score? Evidence from the European Banking Industry. *Global Finance Journal*, 25, 99, pp. 111 – 131.

Chipatiso, T. & Kawadza, H. (2018). Business rescue as a mechanism for addressing bank failures: possible lessons from the American approach. *Journal of Corporate and Commercial Law and Practice*, 4, 2, pp. 37-50.

Chironga, M.; Cunha, L. & De Grandis, H. (2018). Roaring to life: Growth and innovation in African retail banking. McKinsey & Company. https://www.mckinsey.com/za.

Chortareas, G. E.; Girardone, C. & Ventouri, A. (2012). Bank supervision, regulation, and efficiency: Evidence from the European Union. *Journal of Financial Stability*, 8, 4, pp. 292-302.

Chitamba, A. (2018). Customers perceptions on competitiveness of ABSA Bank in South Africa. Durban- Durban University of Technology *(PhD- dissertation).*

Claessens, S. & Kodres, M. L. E. (2014). The regulatory responses to the global financial crisis: Some uncomfortable questions (No. 14-46). International Monetary Fund.

Costello, A. M., Granja, J. & Weber, J. (2019). Do Strict Regulators Increase the Transparency of Banks. *Journal of Accounting Research*, 57, 3, pp. 603-637.

Dawid, H. & van der Hoog, S. (2017). Bubbles, crashes, and the financial cycle: The impact of banking regulation on deep recessions. *Macroeconomic Dynamics*, pp. 1205-1246.

de Haan, J.; de Vries, F. & Kellermann, A. J. (2013). *Financial supervision in the 21st century*. Berlin: Springer.

de Haan, J. &. Klomp, J. (2014). Bank regulation, the quality of institutions, and banking risk in emerging and developing countries: an empirical analysis. *Emerging Markets Finance and Trade*, 50, 6, pp. 19-40.

de Haan, J. & Klomp, J. (2015). Bank regulation and financial fragility in developing countries: Does bank structure matter? *Review of Development Finance*, 5, 2, pp. 82-90.

de Nicolo, G. (2000). Size, charter value and risk in banking: an international perspective. *International Finance Discussion Papers* No. 689, Washington, DC: Board of Governors of the Federal Reserve System. http://www.federalreserve.gov.

Delis, M. D.; Molyneux, P. & Pasiouras, F. (2011). Regulations and productivity growth in banking: Evidence from transition economies. *Journal of Money, Credit and Banking*, 43, 4, pp. 735-764.

Dermirguc-Kunt, A., Detragiache, E. & Tressel, T. (2008). Banking on the Principles: Compliance with Basel Core Principles and Bank Soundness. *Journal of Financial Intermediation*, 17, pp. 511-542.

Demirgüc¸-Kunt, A. & Detragiache, E., (2011). Basel core principles and bank soundness: does compliance matter? *Journal of Financial Stability*, 7, pp. 179–190.

DeYoung, R. (2010). Banking in the United States. *The Oxford handbook of banking*, pp. 1-47.

du Jardin, P.; Veganzones, D. & Séverin, E. (2017). Forecasting corporate bankruptcy using accrual-based models. *Computational Economics*, pp. 1-37.

Ernst & Young (2018). *Global Bank Outlook*. https://www.ey.com/za.

European Investment Bank. (2018). *Banking in Africa: Delivering on Financial Inclusion, Supporting Financial Stability*. https://www.eib.org.

Foggitt, G.M.; Heymans, A.; Van Vuuren, G.W. & Pretorius, A. (2017). Measuring the systemic risk in the South African banking sector. *South African Journal of Economic and Management Sciences.*, 20, 1, pp. 1-9.

Fu, X. M.; Lin, Y. M. & Molyneux, P. (2014). Bank competition and financial stability in Asia Pacific. *Journal of Banking & Finance*, 38, pp. 64-77.

Gepp, A. & Kumar, K. (2015). Predicting financial distress: A comparison of survival analysis and decision tree techniques. *Procedia Computer Science*, 54, pp. 396-404.

Jiang, C. & Yao, S. (2017). *Chinese Banking Reform: From the Pre-WTO Period to the Financial Crisis and Beyond*. New York: Springer.

Ifeacho, C. & Ngalawa, H. (2014). Performance of the South African banking sector since 1994. *Journal of Applied Business Research*, 30, 4, pp. 1183-1196.

Ikhide, S. & Maredza, A. (2013). Measuring the impact of the global financial crisis on efficiency and productivity of the banking system in South Africa. *Mediterranean Journal of Social Sciences*, 4, 6, pp. 553-568.

IMF. (2014). Country Report: South Africa. *IMF Financial Sector Assessment Program*. https://www.imf.org/external/pubs/ft/scr/2014/cr14340.pdf.

IMF. (2014b). *South Africa Financial System Stability Assessment*. https://www.imf.org.

Iyer, R.; Puri, M. & Ryan, N. (2016). A tale of two runs: Depositor responses to bank solvency risk. *The Journal of Finance*, 71, 6, pp. 2687-2726.

Jacobs, J. & Van Vuuren, G. (2014). Is regulatory capital a legitimate, comparable and objective global standard? Evidence from 51 institutions across 17 countries. *South African Journal of Economic and Management Sciences*, 17, 3, pp. 266-283.

Jayasekera, R. (2018). Prediction of company failure: Past, present and promising directions for the future. *International Review of Financial Analysis*, 55, pp. 196-208.

Johnstone, D.; Jones, S. & Wilson, R. (2017). Predicting Corporate Bankruptcy: An Evaluation of Alternative Statistical Frameworks. *Journal of Business & Accounting*, 44, 1, pp. 3-34.

Kamarudin, F. & Sufian, F. (2016). The impact of globalization on the performance of Banks in South Africa. *Review of International Business and Strategy*, 26, 4, pp. 517-542.

Kim, T. & Mangla, V. (2019). Capital Regulation with Two Banking Sectors: Cyclicality and Implementation. *Journal of Money, Credit and Banking*, 51, pp. 485-537.

Kumbirai, M., & Webb, R. (2010). A financial ratio analysis of commercial bank performance in South Africa. *African Review of Economics and Finance*, 2, 1, pp. 30-53.

Laeven, L. & Levine, R. (2009). *Bank governance, regulation and risk taking. Journal of Financial Economics*. 93, pp. 259–275.

Lepetit, L. & Strobel, F. (2013). Bank insolvency risk and time-varying Z-score measures. *Journal of International Financial Markets, Institutions and Money*, 25, pp. 73-87.

Levine, R., Levkov, A. & Rubinstein, Y. (2014). Bank deregulation and racial inequality in America. *Critical Finance Review*, 3, 1, pp. 1-48.

Li, X.; Malone, C. B. & Tripe, D. W. (2017). *Measuring bank risk: An exploration of z-score*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2823946.

López-Espinosa, G.; Moreno, A.; Rubia, A. & Valderrama, L. (2012). Short-term wholesale funding and systemic risk: A global CoVaR approach. *Journal of Banking & Finance*, 36, 12, pp. 3150-3162.

Mare, D. S.; Moreira, F. & Rossi, R. (2017). Nonstationary Z-score measures. *European Journal of Operational Research*, 260, 1, pp. 348-358.

Mishra, A. K. & Singh, B. P. (2016). Re-estimation and comparisons of alternative accounting based bankruptcy prediction models for Indian companies. *Financial Innovation*, 2, 1, pp. 1-28.

Mlambo, K. & Ncube, M. (2011). Competition and Efficiency in the Banking Sector in South Africa. *African Development Review*, 23, 1, pp. 4-15.

Mohamed, S. (2015). The South African Financial System. *FESSUD: Studies in Financial Systems* No 15.

Moyo, B. (2018). An analysis of competition, efficiency and soundness in the South African banking sector. *South African Journal of Economic and Management Sciences*, 21, 1, pp. 1-14.

National Treasury. (2011). *A safer financial sector to serve South Africa better*. http://www.treasury.gov.za.

National Treasury. (2018). 2017/18 National Treasury Annual Report. http://www.treasury.gov.za.

Novis, S. (2010). An Analysis of the Performance of the Barclays/ABSA Cross-Border Acquisition. Cape Town: UCT *(Dissertation - PhD)*.

Pasiouras, F.; Tanna, S. & Zopounidis, C. (2009). The impact of banking regulations on banks' cost and profit efficiency: Cross-country evidence. *International Review of Financial Analysis*, 18, 5, pp. 294-302.

PwC. (2018). *Resilient despite headwinds: South Africa – Major bank analysis*. www.pwc.co.za/banking-analysis.

PwC. (2019). *Regulated industries*. https://www.pwc.de/en/branchenregulierung.html Date 07.02.2019.

Simatele, M. (2015). Market Structure and Competition in the South African banking sector. *Procedia Economics and Finance*, 30, pp. 825-835.

Smit, A. M. & Swanepoel, E. (2016). The impact of executive remuneration on risk-taking in the banking industry. *Investment Management and Financial Innovations*, 13, 3, pp. 110-117.

South African Reserve Bank. (2017). *Group Annual Financial Statements* 2016/17. https://www.resbank.co.za.

South African Reserve Bank (SARB). (2018). *Financial Stability Review 2018*. https://www.resbank.co.za.

South African Reserve Bank. (2018b). *Financial Stability Review 2018 2nd Edition*. https://www.resbank.co.za.

South African Reserve Bank. (2018c). *Group Annual Financial Statements 2017/18*. https://www.resbank.co.za.

Sperandei, S. (2014). Understanding logistic regression analysis. *Biochemia medica*, 24, pp. 12-18.

Tchana, F. T. (2008). *Regulation and banking stability: A survey of empirical studies*. https://ssrn.com/abstract=1150823.

The Banking Association South Africa (2019). *Financial service charter code*. https://www.banking.org.za.

Tinoco, M. H. & Wilson, N. (2013). Financial distress and bankruptcy prediction among listed companies using accounting, market and macroeconomic variables. *International Review of Financial Analysis*, 30, pp. 394-419.

Treasury (2017). *Budget Review*. http://www.treasury.gov.za.

Wilf, M. (2016). Credibility and Distributional effects of International Banking regulations: evidence from us Bank stock returns. *International Organization*, 70, 4, pp. 763-796.

World Economic Forum (2018). *Global Competitiveness Index 4.02018 edition*. Retrieved from http://reports.weforum.org.

Zeidan, M. J. (2012). The effects of violating banking regulations on the financial performance of the US banking industry. *Journal of Financial Regulation and Compliance*, 20, 1, pp. 56-71.