Risk and Regulation for the Soundest Banking Systems in the World

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Abstract: Objectives The objectives of this paper were to analyse the different risk measures to determine the best measure of bank risk to use in the quantile regression between risk and regulation; determine the best proxies for bank regulation from the World Bank survey on banking regulation and evaluate the nature of the relationship between bank risk and bank regulation variables this study built on the work done in 2012 by Klomp and De Haan and added a new focus study to their methodological approach A factor analysis was used to explain variability amongst the variables in the risk indicators of the different countries. After that, a principal component analysis was performed with the regulation data of the sample. Finally, a multilevel quantile regression function was used to determine the relationship between strict regulation and risks for the identified banks in different countries. The results indicated that bank regulation and supervision mainly affect high-risk banks which are in the 0.75 and 0.95 quantiles. This finding was also similar to what de Haan and Klomp discovered in their results. The study highlighted the lack of literature for African studies in the bank risk and regulation topic post the 2008 global financial crisis. The paper indicated that more bank risk that focuses on capital regulatory requirements need to be implemented to assist in the reduction of possible banks risk.

Keywords: bank risk indicators; sound financial systems; global financial crisis

JEL Classification: C5; K2; G2

1. Introduction

Each year the World Economic Forum (WEF) publishes a global competitiveness report which assesses the competitiveness landscape of 140 economies (World Economic Forum, 2019). The assessment evaluates and compares how countries perform in various sectors of their economies compared to their peers. One of the sectors evaluated in the report is the banking sector. In this sector, the soundness of

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the different banking systems in the specific economies is compared and ranked. However, irrespective of such scrutiny on the global banking environment, the 2008 global financial crisis occurred because of unsound bank practices (Shiller, 2012:1). Since the occurrence of the 2008 global financial crisis, an emphasis has been placed on the importance of sound banking regulation and supervision (de Haan & Klomp, 2012, p. 3197).

Subsequently, the 2008 global financial crisis brought forth several consequences in the global market including, a liquidity crisis; slowdown in the global economy, and a downturn for countries in Eastern Europe (Pintea *et al.*, 2015, p. 4). As a result, it was labelled as the most disruptive and complex crisis since the great depression of 1929 (Celik Girgin *et al.*, 2017). Global aggregate losses in 2008 amounted to an estimate of US $50 trillion which equalled to one year with economic output (Drezner & McNamara, 2013). As a rescue measure, the United States (US) led by the Bush administration offered financial bailouts of US $ 700 billion into the US financial system (Bhatt, 2011, p. 212). To aid in mitigating another crisis with such losses from occurring in the future new banking regulations such as the Basel III and Basel IV accords were implemented (Sironi, 2018).

Therefore, because of the above literature that identifies the importance of the banking sector in the overall economy, the risk faced by banks need to be effectively identified and managed. Moreover, there is a need for more literature that identifies whether protective measures of banks are efficient and able to mitigate future bank risk. Thus, this study will aim to determine the relationship between bank risk and bank- regulation, and supervision for the top 25 soundest financial systems in the world ranked by the World Economic Forum. Additionally, it the study will also aim to determine which type of regulatory and supervision measures are more effective in combating certain types of bank risks compared to others. Research in this focus area can assist bank regulatory policymakers in their policy formulations, it can also add to the body of knowledge that exists on the topic.

The rest of the study is organised as follows: section two will provide a literature review on the use of Capital adequacy, Asset Quality, Management Ability, Earning Quality, Liquidity, and Sensitivity analysis (CAMELS) indicators in different financial sectors. Then proceed to provide a section of the data description and methodology in section three, while section four details the results and discussion thereof. Thereafter section five will conclude the study and also provide recommendations.

2. Literature Review

2.1. Previous Studies

Various studies that relate to banking and regulation exist, more so, after the occurrence of the crisis in 2008 with some examples being studies by Fratzscher *et al*, (2015) and Schwarcz (2015). The study by Fratzscher *et al.* (2015) analysed how implementing tighter banking regulations can increase bank stability and how it also affects credit provision. The results of the study showed that the tightening of bank regulatory requirements affects credit growth and bank stability irrespective of the institutional quality. Schwarcz (2015) analysed how bank regulation can be implemented to in a way that also addresses market failure caused by bank asset securitisation in the finance sector. The conclusion was that a regulatory framework that is transparent, simple, and standardised can assist in addressing market-failure caused by bank asset securitisation. More extensive studies on banking regulation and supervision follow.

Mayers and Stremmel (2012) examined bank distress with a sample of US banks that were insured by the FDIC from 1992 to 2012. They compared two models used in bank failure prediction, namely the logistic (logit) technique and discrete survival time analysis, which incorporated CAMELS indicators to conclude on the stability of contributing banks' characteristics. The results showed that the logit model can separate sound banks from failing banks with an accuracy of 80 percent and the survival time model can do it with an accuracy of 98 percent. However, evidence was found that there is a slight difference in the influence of the characteristics of the two methods. Kupiec *et al.* (2017) used a novel strategy to quantify the impact of the average bank supervisory CAMELS rating on the loan growth of a bank. The sample consisted of quarterly data from US banks from the period of 1994 to 2011. They discovered that poor a CAMELS rating adversely impacts the growth of bank loans.

In another study, Fredrick (2013, p. 22) determined if there was a relationship between the financial performance of commercial banks in Kenya and credit risk management proxied by CAMELS indicators. The study used multiple regression analysis on secondary data obtained from banking sector surveys done by the Central Bank of Kenya. The results of the study indicated that CAMELS indicators and financial performance have a strong impact on each other. It also concluded that the CAMELS indicators can be used as a proxy for credit risk management. Since the indicators predict bank failure they should contain important information that relates to credit risk (Hasan *et al.*, 2016, p. 277). Using Malaysian banks as a sample Hashim and Muhmad (2015, p. 109) investigated the bank performance of both domestic and foreign banks in the country using CAMELS indicators. The

study used regression analysis and concluded that CAMELS indicators have an impact on the performance of Malaysian banks.

In another eastern hemisphere bank study, Kumar and Sayani (2015) evaluated the soundness of Islamic banks from 2008 to 2014 using CAMELS indicators along with the z-score model. The results indicated that the chosen banks had sufficient capital during the period but showed a decrease in the asset quality and earnings ability but it was not severe enough to lead them to bankruptcy. Altan *et al.* (2014) appraised the financial performance of 15 state-owned and private Turkish banks using 23 CAMELS indicators from 2005 to 2012. The results showed that each of CAMELS aspect had a different bank that had more was more efficient in that area that the other banks. Roman & Şargu, (2013) used the CAMELS indicators on 15 commercial banks in Romania to comparatively analyse their financial soundness. The data used was obtained from the Bureau Van Dijk Bankscope database along with the financial statements of the banks. Amongst other conclusions, they noted that their largest bank in the sample ranked best in one of the indicators which were management ability but did not produce high ranking results for the other factors.

Sayed and Sayed (2013) employed the CAMELS indicators on the top four private banks in India namely; Axis Bank; HDFC Bank, ICICI Bank, and Kotak Mahindra Bank; at the time to evaluate the performance and quality. The banks were chosen based on data from the Economic Times (ET) Intelligence group database for three years; 2008-09, 2009-10, and 2010-11. After comparing all the CAMELS weights for the chosen banks Kotak Mahindra Bank was chosen as the best amongst the four according to its overall score. Another study, Bastan *et al.* (2016) used the CAMELS indicators along with a qualitative system dynamics approach to determine the performance of Iranian banks. The conclusion was that Capital Adequacy, Asset Quality, and Management ability were the most important factors that Iranian banks need to develop to have soundbanks.

Aydoğan *et al*. (2014) compared the performance of conventional Turkish banks against Islamic banks using logistic regression for a period of 2001-2009. In the study, CAMELS indicators were used to evaluate the banks' managerial and financial performance. The conclusion was that Islamic banks in Turkey perform better than domestic Turkish banks expect the sensitivity to the market aspect. De Haan & Klomp (2014) used data from 371 banks that were from nonindustrial countries from the period of 2002 to 2008, to examine the effect of bank regulation and supervision on bank risk. They discovered that strict regulation such as capital regulations and supervisory control reduces risk. Additionally, they concluded that the level of development also affects the impact of regulation and supervision in a bank.

Through various forms and methods, the studies in this literature evaluated the interaction between bank risk with bank- regulation, and supervision. The literature

also indicated various methods that can be used in the study of bank risk, bank regulation, and bank supervision such as multiple regression analysis, logistic (logit) technique, and discrete survival time analysis. The conclusion for most of the studies was that a positive relationship exists between bank risk and bank-regulation and supervision regulation and supervision that targets capital requirements assisted in the reduction of risk. The results of the studies in the literature can assist as a benchmark for comparison for the results that will be obtained in this study.

2.2. CAMELS Indicators

In this study, the CAMELS indicator will be used as the proxy for risk level. The indicators take into consideration the scale of the bank, complexity, and risk level to determine whether the operations of a bank are being effectively managed (Chen, 2014:535). In other words, it measures the performance of a bank over a given period. The different components are each assigned a rating from 1 to 6, good and bad respectively (Kanagaretnam *et al.*, 2016, p. 34). After they are all assigned individual ratings they are combined to find an average result called a composite rating. A result of one to two indicates that there is little or no intervention needed whereas a rating of three and above indicates that a certain bank is in need or potential intervention (Mayes & Stremmel, 2012, p. 4). Any rating that is greater than 4 is given to banks that are in dire need of intervention and are facing great safety and soundness issues (Kupiec *et al.*, 2017, p. 29).

It was originally made up of five indicators and the last indicators sensitivity to market was introduced in 1996 as a representative of risk (Roman & Şargu, 2013, p. 704). They take into account different aspects of a bank which include financial statements, funding sources, macroeconomic data, budget, and cash flow (Dang, 2011:16). Gallali and Messai (2015, p. 11) performed a study on 618 European banks from the period 2007-2011 to determine which distress prediction method was the most efficient and CAMELS indicators were found to be superior. Since the indicators provide different financial ratios thus the profitability, liquidity and solvency aspects of it are more useful in the short-run whereby the asset quality aspects are useful in the long run (Duraj & Shkurti, 2016, p. 35). The indicators are useful in assisting bank regulators and other stakeholders in raising any potential threats that can eventually lead to bank failure (Azar & Vaidyanathan, 2015, p. 11). Leading indicators of bank distress are group into three, namely; balance sheet and income statement financial ratios; market prices of financial instruments, and thirdly, less common measure such as deposit rates or indicators characterizing the economic environment in which the banks operate (Arabi, 2013, p. 160). From these groups, CAMELS indicators fall under the first one and have been popular

among studies of distress. Capital adequacy has been the most popular regulatory tool that is being used in prudential regulation (Lall, 2012, p. 610).

3. Methodology

3.1. Research Design

To aid in examining the impact of banking regulation and supervision on bank risk this study will make use of quantitative research design. This research design will make use of the following analytical tools, factor analysis, 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.

3.2. Sample Selection and Data Description

The sample will comprise 133 banks from the top 25 soundest banking systems in the world according to the 2018/19 WEF report. According to the report, the top 25 countries with the soundest banking systems in the world are Finland, Canada, Singapore, Australia, Chile, Hong Kong SAR, Luxembourg, Switzerland, New Zealand, Slovak Republic, Panama, Israel, Czech Republic, Philippines, Dominican Republic, Uruguay, United States of America, Taiwan, Saudi Arabia, Austria, Netherlands, Egypt, Austria, Guatemala, and Brazil. South African (SA) banks will also be included to compensate for the lack of presence of banks in Singapore and the Czech Republic due to data availability issues. South Africa was ranked as number 29 on the soundest banking systems in the world survey.

To derive risk measures from the banks in the sample a measure known as Capital adequacy, Asset quality, Management ability, Earnings ability, Liquidity, and Sensitivity to market also known as CAMELS indicators will be used (Sayed & Sayed, 2013, p. 31). Banks should always be healthy, solid, and stable, thus, the need to periodically evaluated them and correct any potential threats that they can be faced with (Roman & Șargu, 2013, p. 703). One of the most efficient ways to periodically evaluate them is through the use of the CAMELS indicators. These indicators have been in use as an early warning system since they were developed by the Federal Deposit Insurance Cooperation (FDIC) in the US in the late 1970s (Azar & Vaidyanathan, 2015, p. 2). In the US, CAMELS ratings represent both the central and comparable output of banking supervision along with being a major input for some regulatory decisions (Agarwal *et al.*, 2014, p. 896). Such decisions include approval of mergers, licence issuance to regulators, access to government programs, and lending to micro-organisations.

This study includes control variables similarly done by de Haan and Klomp (2012). To properly control for macroeconomic influence nine (9) control variables will be

used in the analysis. Macroeconomic control variables include inflation, economic growth, depreciation of the exchange rate, current account balance, income per capita, exports, imports, government revenue. According to Asongu *et al.* (2018), these control variables are relevant because of the positive relationship that exists between growth in the economy and stability within the financial sector. The second set of control variables tests for a relationship between banking risk and capital outflows. The interest rate will be the sole control variable under this section. This variable is significant because one of the regulatory measures discussed in this study is capital regulatory measures and the addition of this variable will assist in capturing how the capital flow is affected.

3.3. Model Specification

Quantile regression

This study uses quantile regression to determine if there is a relationship between bank risk and regulation. It is used to describe the distribution of the dependent variable and assess both the lower and higher extremes of the dependent variable. In the quantile regression model, the relationship between the independent variables labelled as x and the conditional quantiles of the dependent variable labelled as y. This means that it estimates different quantile functions which provides a more comprehensive description of the heterogeneous relation between bank regulation and supervision and bank soundness. This characteristic of the model makes it more suitable for this study as compared to other techniques such as the ordinary least squares (OLS) which only focus on the mean. The quantile regression function estimates the median of the conditional distribution. The τth quantile of the conditional distribution is estimated by minimizing:

$$\phi_\tau = (Y - X\beta) \tag{1}$$

with respect to β, where $\phi_\tau(u) = \phi(\tau - \mathrm{I}(\mathrm{u} < 0))$ where I is an indicator function and u equals $Y - X\beta$. This function can be interpreted as the inclination of bank riskiness (Y), which is dependent on observed variables (X) and a random error term (u). The conditional quantile function can be formally expressed as:

$$Q_{yi} = (\tau|x_i) = X_i'\beta(\tau) \tag{2}$$

The baseline quantile regression formula is given by:

$$Q_{\tau ijt}(BR_{kijt}) = \alpha_{\tau ijt} + \theta_\tau BR_{kijt-1} + \gamma_\tau RI_{jt-1} + \eta_t + \varepsilon_{i,t} + \varepsilon_{j,t} \tag{3}$$

Where BR_{kijt} is the risk indicator of type k for bank i in country j at time t. The parameter η_t captures time fixed effects. The final two terms are error terms measured on bank-level i and country-level j, respectively. The regression is

estimated for τ-quantiles, where τ is the 25th, 50th, 75th, and 95th quantile. The models for the identified risk from the factor analysis performed earlier will be estimated separately.

In explaining the relationship between risk and regulation for the soundest banking systems in the world, several variables are employed to achieve that objective. These variables are summarised in Table 1.

Table 1. Predictor Variables for CAMELS Indicators

CAMELS	**Predictor Variables**
Capital Adequacy	Equity/Total Assets (E/A)
	Leverage effect
	Solvency ratio
Asset Quality	Total loans / total assets (TL/TA)
	Asset growth rate (AGR)
	Loan loss / total loans (LL/TL)
	The growth rate of loans (GROL)
Profitability	Return on Assets (ROA)
	Return on Equity (ROE)
Liquidity	Loans / deposits (L/D)
	Net stable Funding Ratio
Quality Management	Interest Expense / deposits (IE/D)
	Operating expense/deposits (OE/D)
Sensitivity Risk	Bank assets/total assets of the banking system

Source: Adapted from Maria-Daciana and Nicolae (2014:136)

3.4. Procedure

The study will use 24 variables from CAMELS indicators which will represent banking risk. Factor analysis will be used to extract and group variables that will represent specific risks from within the CAMELS indicators. More specifically, dynamic factor analysis will be used to combine the different indicators using the period from 2011 to 2018 from the banks in the top 25 countries with the soundest banking systems. The indicators are divided according to their classes in the CAMELS list and are listed in Table 1.

To determine the specific variables to choose from the factor analysis the eigenvalues which measure the variance that is accounted for by a specific variable will be assessed. A low eigenvalue, a value less than one, means that a specific factor did not contribute to explaining the variance and a high variance means that the variable had more influence in the variance. Using the Kaiser criterion every factor with an eigenvalue that is lower than one will be removed from the list. These factors are graphically shown on a Cattell scree test which has the eigenvalues on the vertical axis and the factors on the vertical axis. Thereafter,

varimax rotation which is an orthogonal rotation method that matches each item with an individual factor is used to interpret the chosen factors. The Kaiser-Meyer-Orkin test (KMO) is used to determine whether the results of the factor analysis are valid. The KMO value ranges from 0 to 1 and values that are above 0.5 are considered useful whilst those less than 0.5 cannot be used (International Business Machines, 2019).

Since the banks are from different countries with different regulations the chosen banks were put in the study based on data availability. Unlike de Haan and Klomp (2012) who included banks with at least 75 percent of the information available this study only included banks with over 80 percent of the information. The information being the variables that are represented in Table 1.

3.5. World Bank Survey on Banking Supervision

Data from the World Bank survey on banking regulation and supervision is used as the proxies for bank regulation and supervision and the responses from the survey acts as the independent variables in this study. It was created in the early 2000s and has been released a total of 3 a times after the initial release namely in 2003, 2007, and 2012 and the fifth edition is set to be released in September 2019 (World Bank, 2019). For this study, the 2012 version is being used as the independent variable. The survey has questions that are categorised into 14 different categories namely that relate to the way that banking systems in different economies are regulated and supervised. Questions from the survey relate to the following categories, (1) entry/licensing, (2) ownership, (3) capital, (4) activities, (5) external auditing, (6) internal management or governance, (7) liquidity and diversification, (8) depositor protection, (9) provisioning, (10) disclosure and information, (11) dealing with problem institutions and exit from the industry, (12) supervisory powers, (13) banking sector characteristics and (14) consumer protection.

From the survey, the different questions are sorted based on their ability to be computed into a factor analysis. That is to say that questions that can be coded to be run into statistical software. Examples of questions that cannot be run into statistical software include questions that ask about who the regulatory body in a country is. Much alike to the dependent variable factors, factor analysis is used to extract the components from the survey response which will be able to represent the independent variables. The results of the factor analysis will then determine the variables that will be used to run the quantile regression as independent variables.

4. Results and Interpretation

This study uses CAMELS indicators to measure the relationship between risk and regulation for the soundest banking systems in the world. De Haan & Klomp

(2014) used data from 371 banks located in nonindustrial countries from the period of 2002 to 2008, to examine the effect of bank regulation and supervision on bank risk. They discovered that strict regulation such as capital regulations and supervisory control reduces risk. Additionally, they concluded that the level of development also affects the impact of regulation and supervision in a bank. The results of this study will be compared to this finding because from the various studies located in the literature of this study it is more similar to this current study only with exception to the sample.

4.1. Correlation Matrix

Table 2 shows the correlation matrix of the indicators used as proxies for bank risk that is to say CAMELS indicators. Based on the results of the factor analysis there are four dimensions or factors that can be used to represent banking risk and they make up 81.77 percent of the variance explained by the variables. The scree plot from the factor analysis shown in Figure 1 also confirms this graphically. The KMO test of sphericity has a figure of 0.520 which is slightly above the minimum threshold shows the results are valid and can be trusted. Thus, according to both the Kaiser rule and the scree plot, banking risk can be represented as a four-dimensional construct.

Table 2. Correlation Matrix of CAMELS Indicators Variables

	E/A	TL/TA	AGR	LL/TL	GROL	ROA	ROE	L/D	IE/D	OE/D
E/A	1.000									.
TL/TA	-.065	1.000								
AGR	-.021	.013	1.000							
LL/TL	.096	.147	-.002	1.000						
GROL	.033	-.022	.978	-.019	1.000					
ROA	.761	-.059	.007	.172	.040	1.000				
ROE	.166	.036	.067	.156	.056	.666	1.000			
L/D	-.010	.031	-.035	-.034	-.026	-.016	-.004	1.000		
IE/D	-.002	.023	-.036	-.020	-.027	-.011	-.007	.997	1.000	
OE/D	.016	.013	-.023	.050	-.008	.044	.068	.916	.909	1.000

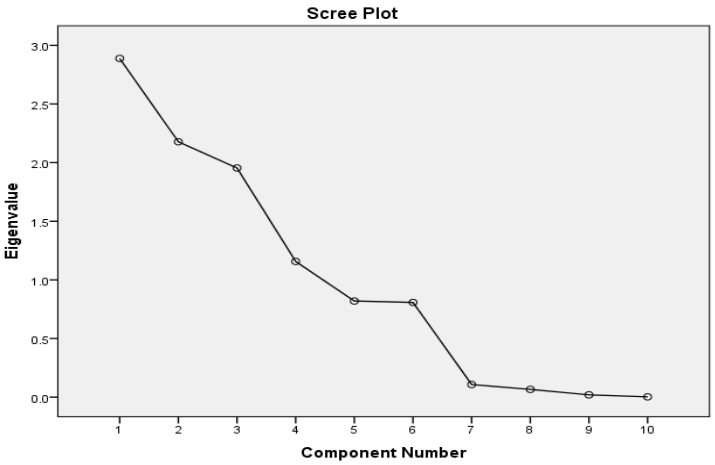

Figure 1. Scree plot for CAMELS Indicators

The first factor has variables on liquidity and management that have high values and this study labels this factor as liquidity and management risk. The second factor has variables related to capital adequacy and earnings risk score high thus label it as capital and earnings risk. Unlike de Haan and Klomp (2012) this study has third and fourth factors that have variables in asset quality that score high and therefore will be combined and labelled as asset risk. Therefore, this study is represented by three distinct risks that form part of dependent variables. The results of the rotated component matrix from the factor analysis and risk classification are shown in Table 3.

Table 3. Factor Analysis Results for CAMELS Indicators

Variables	Risk Type		
	Liquidity & Management	**Capital & Earnings**	**Asset Quality**
L/D	.991		
IE/D	.989		
OE/D	.959		
E/A		.800	
ROA		.978	
ROE		.687	
TL/TA			.781
AGR			.995
LL/TL			.691
GROL			.992
Kaiser-Meyer-Olkin test	0.520		
Significance level	0.000		

*Blank spaces indicate no relevant relationship

The questions from the world bank survey on bank regulation and supervision were categorised into seven groups namely, (1) capital regulations; (2) regulations on private monitoring; (3) regulations on activities restrictions; (4) supervisory control; (5) deposit insurer's power; (6) liquidity regulations, and (7) market entry regulations. After a principal component factor analysis was run on the survey questions 10 factors resulted. However, some of the factors interlinked and ultimately resulted in 5 factors. The classification of the factors is, (1) Capital adequacy regulation; (2) Activities restrictions; (3) Transparency supervision (4) Market entry; and (5) Private sector monitoring. The survey questions; variance; mean and classification of factor questions are shown in Appendix A.

After the dependent and independent variables along with the control were established multiple quantiles regressions for the three different measures of risk are run. The results of the three regressions with the control variables alone are shown in Table 4. The main quantile regressions which include the variables for bank risk and regulation are shown in Table 5. Both tables show the probability value along with the coefficient value of every statistically significant variable in the different regressions. Statistical significance was taken was considered from the 0.01; 0.05 and 0.10 significant levels.

Table 4. Quantile Regression with Control Variables

Quantile	**Liquidity and Management risk**				**Capital and Earnings risk**				**Asset quality**			
	.25	.5	.75	.95	.25	.50	.75	.95	.25	.50	.75	.95
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Current account balance	.275	.525	.479	.102	.163	.664	.262	.070 **.04**	.497	.947	.132	.000 **.04**
Economic growth	.869	.936	.543	.219	.475	.734	.424	.001 **-2.2**	.380	.847	.443	.000 **.13**
Exchange rate	.326	.624	.399	.929	.751	.874	.148	.219	.185	.969	.051 **-.00**	.000 **-.01**
Exports	.009 **5.39**	.193	.149	.369	.436	.579	.188	.443	.003 **2.7**	.971	.000 **-5.3**	.000 **-2.9**
Imports	.001 **-4.2**	.136	.056 **-4.3**	.308	.598	.302	.205	.802	.000 **-2.0**	.988	.000 **5.6**	.000 **2.52**
Income per capita	.614	.772	.229	.004 **.00**	.529	.466	.614	.005 **-.00**	.880	.919	.849	.000 **9.69**
Inflation	.423	.785	.960	.470	.710	.803	.170	.012 **-1.0**	.973	.930	.517	.503
Interest rate	.426	.061 **-.00**	.912	.944	.369	.003 **.21**	.015 **.013**	.186	.570	.884	.981	.956
Revenue	.328	.604	.390	.933	.742	.833	.157	.276	.199	.967	.044 **2.3**	.000 **1.43**

*Bold denotes the coefficient value of statistically significant variables

From the initial regression shown in Table 4, all the control variables are significant in at least one of high-risk banks, represented by the 0.75 and .095 quantiles, for the three different risk types of this study. Control variables such as exports and imports also show the significance for low-risk banks, represented by 0.25 and the 0.50 quantiles, but only for asset quality risk and liquidity and management risk. The magnitude and effect of these statistical significant variables vary on each quantile even for the same independent control variable. For example, exports present a negative relationship between asset quality risk and high-risk banks, upper quantile banks, but a positive relationship between asset quality risk and low-risk banks. The statistical significance of the control variables is also in line with the study by de Haan and Klomp (2012) who showed statistical significance control variables for most high-risk banks.

Thereafter, variables representing bank regulation and supervision were included in the quantile regression and the results are shown in Table 5. The objective of the study was to determine the relationship between bank risk and bank- regulation and determine which type of regulatory and supervision measures are more effective in combating certain types of bank risks compared to others. Against these objectives, the results of the study will be interpreted. The first regulation and supervision variable is capital adequacy regulation and it showed statistical significance for high-risk banks of all three risk types captured in the study. The results show that there is a negative relationship between capital adequacy regulation and two risks namely; liquidity and market risk, and capital and earnings risk. This means that an increase in the regulatory measures relating to capital adequacy significantly decreases the occurrence of liquidity and management risk along with capital and earnings risk for high-risk banks represented by the 0.75 and 0.95 quantiles. However, an increase in measures relating to capital adequacy risk also increases the occurrence of asset quality risk in high-risk banks.

The second regulation and supervision type relates to private sector monitoring and is statistically significant on asset quality risk and capital and earnings risk. The results show that an increase in private sector monitoring also increases capital and earnings risk for high-risk banks in the 0.75 quantile but reduces asset quality risk for high-risk banks in the 0.95 quantile. The third regulation type relates to the restriction of certain activities performed by banks and showed significance on all three risk types. An increase in regulation and supervision relating to bank activity restriction reduces liquidity and management risk for high-risk banks in the 0.75 quantile and reduces capital earnings risk for high-risk banks in the 0.75 and 0.895 quantile. Increasing bank activity regulation and supervision does however also increase asset quality risk for high-risk banks in the 0.95 quantile.

Regulation and supervision relating to transparency only have a positive effect on liquidity and management risk on high-risk banks in the 0.75 quantile. Lastly, there

is no relationship between regulation and supervision relating to market entry and any of the three risk types. Meaning that bank regulations and supervision that are in place for market entry do not influence the risks that can potentially be faced by banks. Which can suggest that the entry of new banks in the banking system is not related to the increase in bank risk.

Table 5. Quantile Regression between Bank Risk and Bank Regulation and Supervision

Quantile	**Liquidity and Management risk**				**Capital and Earnings risk**				**Asset quality**			
	.25	.5	.75	.95	.25	.50	.75	.95	.25	.50	.75	.95
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Capital adequacy regulation	.572	.595	.097 **-.32**	.085 **-11**	.259	.044 **-5.3**	.084 **-7.4**	.259	.332	.213	.801	.073 **.049**
Private sector monitoring	.835	.909	.157	.215	.505	.272	.015 **0.44**	.629	.617	.706	.901	.001 **-.05**
Activity restriction	.635	.692	.013 **-.18**	.113	.289	.756	.090 **-1.6**	.076 **-13**	.693	.429	.869	.001 **.29**
Market entry	.371	.120	.541	.925	.692	.495	.677	.851	.401	.754	.983	.799
Transparency supervision	.474	.255	.010 **0.96**	.101	.261	.203	.869	.318	.638	.449	.881	.110

*Bold denotes the coefficient value of a statistically significant variable

5. Conclusion

This study aimed to determine the relationship between different bank risk and banking regulation and supervision for banks in the top 25 soundest banking systems in the world according to the World Economic Forum 2018/19 survey. It derived the methodology from a study performed by de Haan and Klomp (2012). Data for this study was collected from 133 banks from the 25 sample countries using a period of 2011 to 2018.

The independent variables were chosen from a 2011 survey compiled by the World Bank on bank regulation and supervision. Factor analysis was used to extract different components from the study that will capture different types of banking

regulation and supervision. From the factor analysis, 5 different aspects of banking regulation and supervision were captured; namely; capital adequacy regulation; private sector monitoring; regulations on activity restriction; market entry regulation; and transparency supervision. These different regulation variables were then regressed with the different risk types identified from the study.

The different risk types for this study came from CAMELS indicators which are variables used to determine the soundness of banks in different countries. Factor analysis was also used on the CAMELS indicators to determine the different risk types to be used as the dependent variables of the study. From the factor analysis, 3 different risk types were identified and they are liquidity and market risk; capital adequacy risk; and asset quality risk. To measure if regulation and risk had an effect on bank risk a quantile regression was used and the 0.25; 0.50; 0.75 and 0.95 quantiles were used as the subjects of choice.

Thus, this study aimed to determine the relationship between bank risk and bank-regulation and supervision for the top 25 soundest financial systems in the world ranked by the World Economic Forum. Additionally, it the study will also aim to determine which type of regulatory and supervision measures are more effective in combating certain types of bank risks compared to others. Based on the set objectives the study found that there is a relationship between the different types of bank risk and bank regulation and supervision. However, there was no relationship between regulations relating to market entry and any of the risks identified by the study. Furthermore, the results indicated that bank regulation and supervision mainly affect high-risk banks which are in the 0.75 and 0.95 quantiles. This finding was also similar to what de Haan and Klomp (2012) discovered in their results. A major finding of this study was that bank regulation and supervision helps to combat risk for banks that are highly faced with risk but has no effect on low-risk banks.

Therefore, as a recommendation to policymakers, more bank risk that focuses on capital regulatory requirements need to be implemented to assist in the reduction of possible banks risk. Future studies can focus on how bank risk in Africa is affected by various regulatory and supervision measures implemented post the 2008 global financial crisis. The reason for this is the limited literature that focuses on regulation in the African banking sector.

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