



The Impact of Basel III Capital Regulation on Credit Risk: A Hybrid Model¹

Nadim Alfouhaili

Corresponding Author: Department of Business, University Paris 1 Pantheon-Sorbonne, Paris, France. ORCID ID: [//orcid.org/0000-0003-0542-4462](https://orcid.org/0000-0003-0542-4462)

Frédéric Gautier

Department of Business, University Paris 1 Pantheon-Sorbonne, Paris, France.

Iyad Zaarour

Department of Business, Lebanese University, Beirut, Lebanon.

Abstract

This research examined the impact of Basel III capital regulation (BCR) on credit risk (CR) using a sample of 25 commercial banks in Lebanon over the period 2012–2017. BCR is measured using the capital adequacy ratio (CAR) and the common equity tier one ratio (CET1 ratio), CR is measured using net provision for credit losses /total assets. To analyze the data, we constructed a hybrid model based on 3 statistical approaches. First, we modelled the dual impact of BCR and CR using probabilistic inference in the framework of Bayesian Belief Network formalism (BBN). Second, to highlight more about the correlation between BCR and CR, we used Spearman correlation test as a nonparametric approach. Third to study the simultaneous effect of CAR and CET1 ratio on CR we applied multivariate regression analysis. By analyzing the probabilistic inference for the first approach we concluded that there is an effect of BCR on CR especially for the high level of CET1 ratio, but when we investigated more if this effect is significant using the Spearman correlation test and the multivariate regression analysis, we concluded that there is no effect statistically significant of Basel III capital regulation (BCR) on credit risk (CR). The findings are interesting. In fact, from the regulatory perspective Basel III capital regulation must reduce credit risk. Yet, the results of this article contradict regulators. This allows for further exploration and studies of the coorelation between Basel III and credit risk in MENA banks.

Keywords: Basel III capital regulation (BCR); credit risk (CR); Bayesian belief network (BBN); capital adequacy ratio (CAR); common equity tier 1 ratio (CET1 ratio)

JEL Classifications: G21; G32

¹ This article is an extension of authors' paper submitted to LAU

Introduction

There are conflicting predictions concerning the impact of capital regulations on banking risk. Past findings like Klomp and De Haan (2012) discovered that “banking regulation and supervision has an effect on the risks of high-risk banks. However, most measures for bank regulation and supervision do not have a significant effect on low-risk banks” (Klomp & De Haan, 2012, p. 3197). Different researches examined the trade-off relationship between profitability and risk. “While regulators seem to believe that higher capital requirements will have a positive impact on the banking sector, Awdeh et al. (2011) found that higher capital requirements are associated with increase in risk” (as cited in Lee & Hsieh, 2013, p. 710). In contrary Fonseca and González (2010) “found that stringent capital requirements reduce banking risk” (as cited in Klomp and De Haan, 2012, p. 3201).

Recent findings like Tao et al. (2019) revealed the effect of the capital adequacy requirements on bank risk. They used a sample of U.S. banks and insurance companies from 2003 to 2010, and they found that banks with a lower marginal risk-based capital (RBC) at the beginning of the year increased the amount of the risk taken in the portfolio of the financial institutions. On the other hand Bitar et al. (2018) informed that Basel III risk-based capital ratio failed to lower the bank risk using a sample of 1992 banks from 39 OECD countries between 1999 and 2013.

In this article we try to fill the gap by studying the impact of Basel III capital regulation (BCR) on credit risk (CR) using a sample of 25 commercial banks in Lebanon over the period 2012–2017. We asked our critical question: how can we study the impact of Basel III capital regulation (BCR) on credit risk (CR)?

To answer this question, we considered a timeline for the study from 2012 to 2017, covering the period after the development of Basel III accord. In this timeframe, the central bank of Lebanon has adopted Basel III Capital Regulation ratio according to 2 circulars: -Basic circular No 119 and intermediate Circular No 358. Then Based on the timeline set by circulars mentioned above we divided our study into 2 clusters of timelines: The First cluster is A (contains the financial data of the sample between 2012-2015). The second cluster is B (includes the financial data of the sample between 2016-2017). By studying the effect of BCR on CR moving from cluster A to cluster B we can answer our research question.

To analyze the data of our research question, we constructed a hybrid model based on 3 statistical approaches. First, we modelled the dual impact of BCR and CR using probabilistic inference in the framework of Bayesian Belief Network formalism (BBN). Second, to highlight more about the correlation between BCR and CR, we used Spearman correlation test as a nonparametric approach. Third to study the simultaneous effect of CAR and CET1 ratio on CR, we applied multivariate regression analysis.

The rest of this article is organized as follows: Section 2 presents the literature review of the study. Section 3 describes the research and methodology. Section 4 reveals the findings. section 5 presents the final conclusion.

Literature Review

In this section, our goal is to introduce how Basel Capital Regulation affects banking risk based on academic researches related to this area. Firstly, we discussed the evolution of regulatory capital based on Basel accord (Basel I, Basel II & Basel III). Secondly, we presented a subset of literature based on 2 hypotheses in order to understand more how capital regulation affects banking risk.

Basel I. It was published by the Basel Committee on Banking Supervision (BCBS) in 1988. The main focus of this accord was the minimum regulatory capital, which is the bank’s capital divided by the risk-weighted assets. Basel I provided an international platform on bank capital regulation, and was a quick answer to the internationalization of the banking sector.

Basel II. It is “introduced after the various financial crises of the 1990s (the Mexican Crisis of 1994, the Asian crisis, and the Brazilian and Argentinean crisis). Basel II did not modify the definition of capital introduced in the previous Accord and did not increase the minimum capital ratio (still at 8%). The critical innovation in

Basel II is related to the computation of risk-weighted assets, which now included credit, market, and operational risk” (Motocu, 2013, para 1).

Basel III. It was published in 2011 resulting of the global financial crisis in 2008. Basel III amplified the quality and the level of capital by “admitting only the highest quality instruments in the core Tier, revising the components of Tier 1 and Tier 2 and eliminating Tier 3 from the regulatory capital within ten years” (Tanda, 2015, para 17). The capital ratio is now a combination of elements, and a percentage of the components of the total capital.

Based on the above, we can see that Basel Capital Regulation has progress from Basel I to Basel III. “In Basel III, banks have to strengthen the quality and level of capital by admitting the highest quality instruments in the core Tier 1” (Tanda, 2015, p. 16).

Questioning the effect of the capital regulation on the bank risks remains an unattainable. In the following a subset of literature has been selected based on its relevance to the following hypotheses - Higher capital adequacy ratios correlate with lower bank risk. - Higher capital adequacy ratios correlate with higher bank risk.

Hypothesis 1: Higher capital adequacy ratios are associated with lower bank risk

Bitar et al. (2016) concluded that the commitment with the Basel capital demands increases bank protection against risk, and enhances efficiency: they chose an average of 168 banks in 17 MENA countries from 1999–2013 period.

Hoque et al. (2015) examined if permissive regulations are accountable for exaggerated risk taking by the banks. To achieve such a purpose, they used the 2008 World Bank research survey that was conducted on bank regulation data. Their results showed that the increase in capital ends up in reducing the bank risk during the financial crisis of 2008. However, a firm authoritative supervision ended up in a great systematic risk in banks during the crisis. Lee and Hsieh (2013) admitted that: the impact of bank capital on risk and profitability using a sample of Asian banks over the period 1994 to 2008. They realized that increasing capital improves profitability and decreases the risk. This evidence indicates that poorly capitalized banks generate less profitability and take more risk. Also, the negative relationship between capital and risk can be explained by the moral hazard hypothesis, while the positive association between capital and profitability can be understood under the structureconduct- performance hypothesis. (as cited in Bougatef & Mgdami, 2016, p. 52).

Furthermore, Klomp and De Haan (2012) examined the effects of capital regulation on banking risk. They referred to data, which exceeded 200 banks around 21 OECD countries from 2002 till 2008. Based on quantile regressions analysis Klomp and De Haan discovered that banking regulation and supervision have an effect on the risks of high-risk banks. However, most measures for bank regulation and supervision do not have a significant effect on low-risk banks” (Klomp & De Haan, 2012, p. 3197).

Hypothesis 2: Higher capital adequacy ratios correlate with higher bank risk

Bougatef and Mgdami (2016) illustrated that prudential regulations did not succeed in lowering banks’ risk-taking stimulus nor in increasing capital. They used 24 banks functioning in the MENA region between 2004 and 2012. “They found also a strong negative relationship between the bank size and risk suggesting that large banks have more experience in managing their risk levels through diversification” (Bougatef & Mgdami, 2016, p. 51).

Tran et al. (2016) studied “the interrelationships among liquidity creation, regulatory capital, and bank profitability of US banks using unbalanced quarterly panel data of all U.S. banks from 1996 to 2013” (p. 98). They used vector autoregressive model (VAR) to analyze the data, their findings show that “the relationship between regulatory capital and bank performance is not linear and depends on the level of capitalization. Regulatory capital is negatively related to bank profitability for higher capitalized banks but positively related to profitability for lower capitalized banks. Therefore, a change in regulatory capital has differential impacts on bank performance” (Tran et al., 2016).

Delis et al. (2012) investigated the impact of capital regulation on bank risk-taking using a large international panel dataset between 1998–2008. They used local estimation technique (LGMM) to analyze the data, their findings suggested “that the impact of capital regulation on bank risk is very heterogeneous across banks and the sources of this heterogeneity can be traced into both bank and industry characteristics” (Delis et al., 2012, p. 57).

Finally, Awdeh et al. (2011) studied “the impact of regulatory capital on bank risk-taking using a panel of Lebanese commercial banks over the period 1996–2008” (p. 2). They proved “that higher capital requirements are associated with an increase in risk, larger banks in Lebanon tend to hold lower capital and have better capability to control risk, mainly through diversification” (Awdeh et al., 2011, p. 2).

Research and Methodology

Before we begin detailing our research and methodology. In Figure 1, we show a summary of our General Research Model.

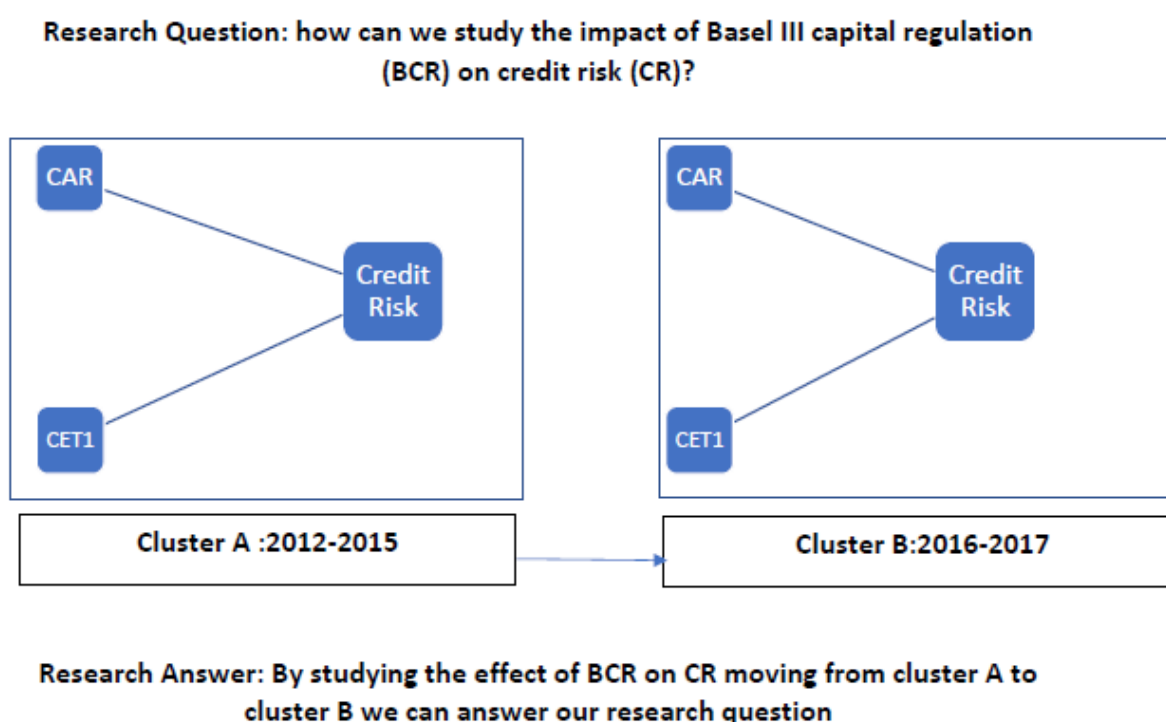


Figure 1: General Research Model

In this model we try to examine the impact of Basel III capital regulation (BCR) on credit risk (CR) using a sample of 25 commercial banks (Appendix A) in Lebanon over the period 2012–2017. We asked our critical question: how can we study the impact of Basel III capital regulation (BCR) on credit risk (CR)?

To answer this question, we considered a timeline for the study from 2012 to 2017, covering the period after the development of Basel III accord. In this timeframe, the central bank of Lebanon has adopted Basel III Capital Regulation ratio according to 2 circulars: -Basic circular No 119² and intermediate Circular No 358³. Then Based on the timeline set by circulars mentioned above we divided our study into 2 clusters of timelines: The First cluster is A (contains the financial data of the sample between 2012-2015). The second cluster is B (includes the financial data of the sample between 2016-2017). By studying the effect of BCR on CR moving from cluster A to cluster B we can answer our research question.

² <http://www.bdl.gov.lb/circulars/index/5/33/0>

³ <http://www.bdl.gov.lb/circulars/intermediary/5/37/0/Intermediate-Circulars.html>

The financial data for banks has been retrieved from company called Bankdata⁴ which is a consulting company established in Lebanon since 1986. BCR is measured using the capital adequacy ratio (CAR) and the common equity tier one ratio (CET1 ratio), CR is measured using net provision for credit losses /total assets.

To analyze the data of our research question, we constructed a hybrid model based on 3 statistical approaches. First, we modelled the dual impact of BCR and CR using probabilistic inference in the framework of Bayesian Belief Network formalism (BBN). Second, to highlight more about the correlation between BCR and CR, we used Spearman correlation test as a nonparametric approach. Third to study the simultaneous effect of CAR and CET1 ratio on CR, we applied multivariate regression analysis.

In Table 1, we show a summary of all variables in the study including definition and formulas

Table 1: Variables description

Variables	Definition	Formulas
1. Capital adequacy ratio (CAR)	Regulatory capital	(Tier 1 +Tier2)/risk weighted assets
2. CET1 ratio	Regulatory capital	CET1 capital/risk-weighted asset
3. Credit risk	Risk measure	Net provision for credit losses /total assets

Findings

The aim of this section is to present the outcome of our hybrid model mentioned earlier. First, in the descriptive statistics section we presented a comparison between clusters A and B based on the Mean, Median and standard deviation of the variables of interest in the study. Second in the empirical model section we analyze our 3 statistical approaches.

The aim of this section is to describe the basic features of the data in the study. First, we present the mean times series plot of the 3 variables of interest. Second, in order to compare the evolution of these variables over the years we constructed a table contain the Mean, Median and standard deviation.

Figure 2 presents the Bar chart of the CAR mean values over the years for the two clusters A and B. It shows clearly that there are no significant changes over the years nor between the clusters.

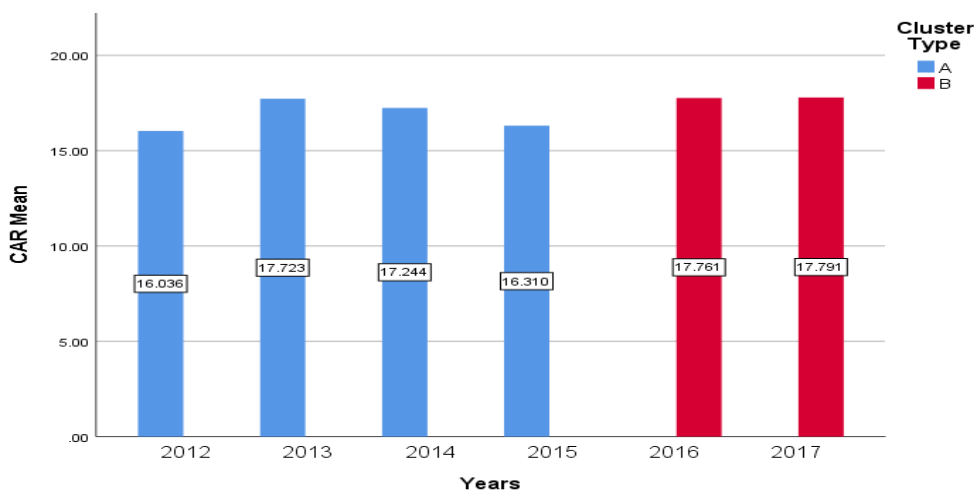


Figure 2: CAR mean values over the years for the two clusters A and B

⁴ <http://www.bankdata.com/AboutUs/Profile>

Figure 3 presents the Bar chart of the CET1 mean values over the years for the two clusters A and B. It shows clearly that there are no significant changes over the years nor between the clusters.

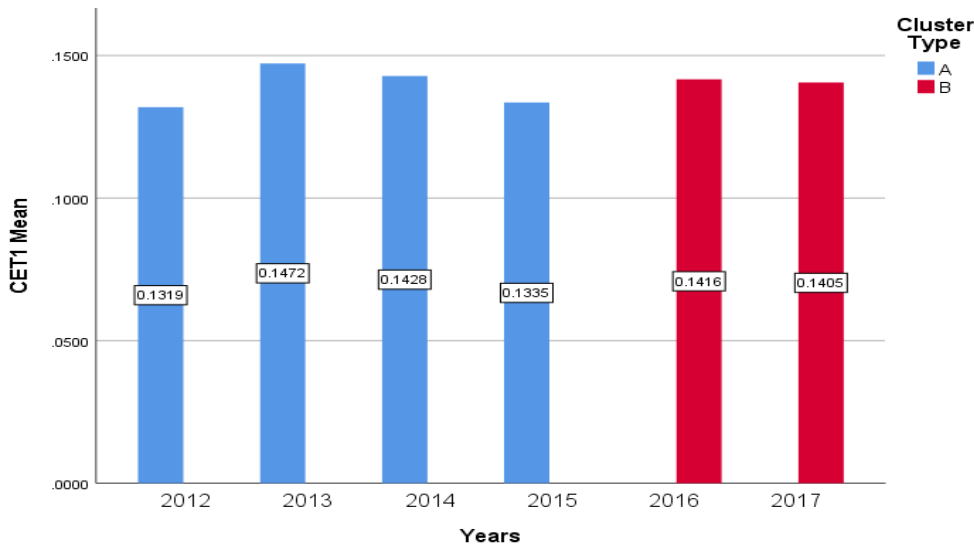


Figure 3: CET1 mean values over the years for the two clusters A and B.

Figure 4 presents the Bar chart of the CR mean values over the years for the two clusters A and B. It shows clearly that there is an increase in CR over the clusters between years 2015 and 2016 due to the application of the new circular No 358 by the central bank of Lebanon concerning Basel III capital regulation but this increase in credit risk return to normal value in 2017.

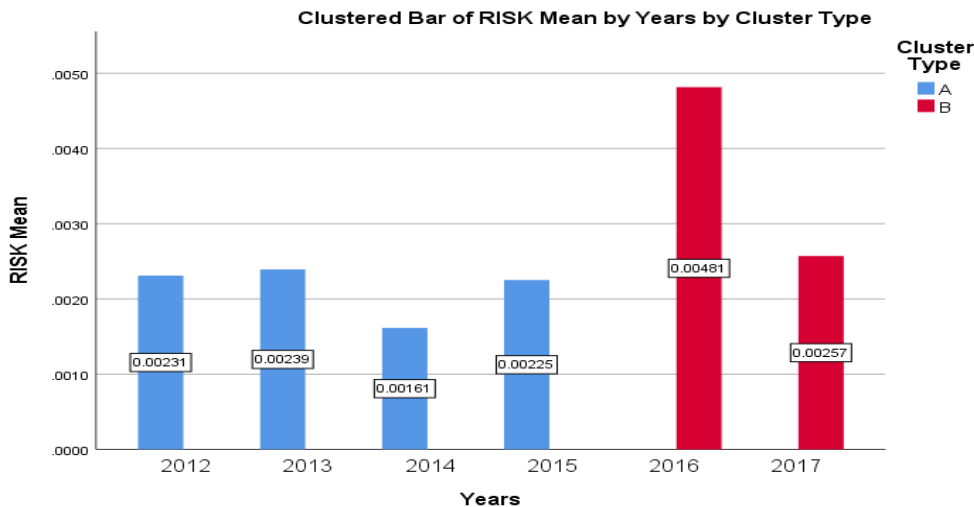


Figure 4: CR mean values over the years for the two clusters A and B

Table 2 presents the descriptive statistics of CAR, CET1, and CR over Clusters. It shows that the mean and median values for cluster B are slightly higher than the values in cluster A (ex: Mean CAR B = 17.77 > Mean CAR A = 16.82). Moreover, the Std. Dev. values for the independent variables CAR and CET1 in cluster B are less than the values in cluster A (ex: Std. Dev. CAR B = 5.02 < Std. Dev. CAR A = 9.95). This means that the CAR and CET1 values across years in cluster B are less deviated and therefore closer to the mean values in comparison with cluster A.

Table 2: Comparisons between CAR, CET1, and CR over Clusters

Variables	Cluster A					Cluster B				
	Mean	Median	Std. Dev.	Min	Max	Mean	Median	Std. Dev.	Min	Max
CAR	16.82	13.80	9.95	8.69	77.66	17.77	16.51	5.02	11.36	36.23
CET1	0.1388	0.1093	0.1083	0.0520	0.7749	0.1410	0.1223	0.0578	0.0877	0.3622
CR	0.0021	0.0010	0.0039	0	0.0259	0.0036	0.0020	0.0049	0.000025	0.0227

In this paragraph, we will present the inferential statistics using BBN for two clusters of timelines: The first cluster (A) contains the financial data of the sample between 2011 and 2015. The second cluster (B) contains the financial data of the sample between 2016 and 2017. The sample size is the same, 25 banks, for the two clusters A and B. In addition, a brief descriptive comparison between the two clusters will be presented.

In our study, we used algorithms done by Spiegelhalter et al. (1993), Neapolitan (1990), and Jensen et al. (1994). In order to use BBN in a proper way that maximizes its efficiency, we have to discretize our variables of interests. The process of “Discretization” is very crucial when using “conditional probability” one of the most exciting features of BBN. Based on the Consultancy with Mr. Shadi Riashi member of The Banking Control Commission (BCCL). Variables are discretized in appendix (B).

Table 3 shows the CAR, CET1 and CR probability values for different levels LOW, MEDIUM and HIGH. $P(CAR=LOW) = 0.01$, $P(CAR= MEDIUM) = 0.17$ and $P(CAR= HIGH) = 0.82$. Thus, the probability of the Capital Adequacy Ratio increases with the increase of the CAR level. The same can be applied to Common Equity Tier 1 Ratio. Meanwhile, the CR probability variable shows almost the same value around 0.33 for the different levels

Table 3: CAR, CET1 and CR probability values for cluster A

Variables	Probability		
	LOW	MEDIUM	HIGH
CAR	0.01	0.17	0.82
CET1	0.02	0.13	0.85
CR	0.36	0.31	0.33

Table 4 presents the effect of the CAR and CET1 independent variables, separately, on the conditional probability of the dependent variable CR. For example, the conditional probability of CR having a LOW level given that the CAR level is LOW is equal to 0.33. $P(CR=LOW|CAR=LOW) = 0.33$. The results show that CAR level LOW does not affect the CR probability. Meanwhile, MEDIUM and HIGH CAR levels affect the CR probability values. Moreover, results in Table 6 show that the CR conditional probability values are also affected by all CET1 levels. For example, the probability of CR having a HIGH level given that the CET1 level is HIGH is equal to 0.28. $P(CR=HIGH|CET1=HIGH) = 0.28$ different than $P(CR=HIGH|CET1=LOW) = 0.25$.

Table 4: Effect of CAR and CET1 separately on CR probability for cluster A

		CR Probability		
		LOW	MEDIUM	HIGH
CAR	LOW	0.33	0.33	0.33
	MEDIUM	0.35	0.45	0.20
	HIGH	0.49	0.22	0.29
CET1	LOW	0.25	0.50	0.25
	MEDIUM	0.13	0.60	0.27
	HIGH	0.52	0.20	0.28

Table 5 presents the effect of the CAR and CET1 independent variables, jointly, on the conditional probability of the dependent variable CR. For example, the conditional probability of CR having a LOW level given that the CAR level is MEDIUM and the CET1 level is LOW is equal to 0.25. $P(\text{CR}=\text{LOW}|\text{CAR}=\text{MEDIUM}, \text{CET1}=\text{LOW})=0.25$. Moreover, Tables 5 and 6 show that the CR probability conditional values are affected more by the CET1 levels in comparison with the CAR levels. For example, $P(\text{CR}=\text{LOW}|\text{CAR}=\text{MEDIUM}, \text{CET1}=\text{HIGH})=0.58$ can be driven by the fact that $P(\text{CR}=\text{LOW}|\text{CAR}=\text{MEDIUM})=0.35$ and $P(\text{RISK}=\text{LOW}|\text{CET1}=\text{HIGH})=0.52$.

Table 5: Effect of CAR and CET1 jointly on CR probability for cluster A

		CR Probability		
CAR	CET1	LOW	MEDIUM	HIGH
LOW	LOW	-	-	-
LOW	MEDIUM	-	-	-
LOW	HIGH	-	-	-
MEDIUM	LOW	0.25	0.50	0.25
MEDIUM	MEDIUM	0.10	0.60	0.30
MEDIUM	HIGH	0.58	0.25	0.17
HIGH	LOW	-	-	-
HIGH	MEDIUM	0.25	0.50	0.25
HIGH	HIGH	0.51	0.20	0.30

Regarding cluster B, Table 6 shows the CAR, CET1 and CR probability values for different levels LOW, MEDIUM and HIGH. $P(\text{CAR}=\text{LOW})=0.02$, $P(\text{CAR}=\text{MEDIUM})=0.30$ and $P(\text{CAR}=\text{HIGH})=0.68$. Thus, the probability of the Capital Adequacy Ratio increases with the increase of the CAR level. The same can be applied to Common Equity Tier 1 Ratio. Meanwhile, the CR probability variable shows almost the same value around 0.33 for the different levels.

Table 6: CAR, CET1 and CR probability values for cluster B

	Variables Probability		
	LOW	MEDIUM	HIGH
CAR	0.02	0.30	0.68
CET1	0.02	0.21	0.77
CR	0.33	0.29	0.37

Table 7 presents the effect of the CAR and CET1 independent variables, separately, on the conditional probability of the dependent variable CR. For example, the conditional probability of CR having a LOW level given that the CAR level is LOW is equal to 0.33. $P(\text{CR}=\text{LOW}|\text{CAR}=\text{LOW})=0.33$. The results show that

CAR level LOW does not affect the CR probability. Meanwhile, MEDIUM and HIGH CAR levels affect the CR probability values. Moreover, results in Table 8 show that the same pattern can be applied to CET1 levels.

Table 7: Effect of CAR and CET1 separately on CR probability for cluster B

		CR Probability		
		LOW	MEDIUM	HIGH
CAR	LOW	0.33	0.33	0.33
	MEDIUM	0.33	0.22	0.44
	HIGH	0.39	0.11	0.50
CET1	LOW	0.33	0.33	0.33
	MEDIUM	0.46	0.23	0.31
	HIGH	0.35	0.12	0.53

Table 8 presents the effect of the CAR and CET1 independent variables, jointly, on the conditional probability of the dependent variable CR. For example, the conditional probability of CR having a LOW level given that the CAR level is MEDIUM and the CET1 level is LOW is equal to 0.33. $P(CR = \text{LOW} | \text{CAR} = \text{MEDIUM}, \text{CET1} = \text{LOW}) = 0.33$. This probability is the same for all CET1 and CAR levels less than MEDIUM.

Table 8: Effect of CAR and CET1 jointly on CR probability for cluster B

		CR Probability		
CAR	CET1	LOW	MEDIUM	HIGH
LOW	LOW	0.33	0.33	0.33
LOW	MEDIUM	0.33	0.33	0.33
LOW	HIGH	0.33	0.33	0.33
MEDIUM	LOW	0.33	0.33	0.33
MEDIUM	MEDIUM	0.44	0.22	0.33
MEDIUM	HIGH	0.25	0.25	0.50
HIGH	LOW	0.33	0.33	0.33
HIGH	MEDIUM	0.43	0.29	0.29
HIGH	HIGH	0.38	0.09	0.53

Table 8 presents a comparison between the two clusters A and B in terms of the conditional probability of the dependent variable CR taking into consideration the effect of the independent variables CAR and CET1 separately. Results show that there is a difference between the conditional probability values between the two clusters.

Table 9: Comparison between the two clusters A and B

		CR Probability, Cluster A			CR Probability, Cluster B		
		LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
CAR	LOW	0.33	0.33	0.33	0.33	0.33	0.33
	MEDIUM	0.35	0.45	0.20	0.33	0.22	0.44
	HIGH	0.49	0.22	0.29	0.39	0.11	0.50
CET1	LOW	0.25	0.50	0.25	0.33	0.33	0.33
	MEDIUM	0.13	0.60	0.27	0.46	0.23	0.31
	HIGH	0.52	0.20	0.28	0.35	0.12	0.53

Table 10 presents a comparison between the two clusters A and B in terms of the conditional probability of the dependent variable CR taking into consideration the effect of the independent variables CAR and CET1 jointly. Results show that there is a difference between the conditional probability values between the two clusters.

Table 10: Comparison between the two clusters A and B (in terms of the CR conditional probability taking into consideration CAR and CET1 jointly)

		CR Probability, Cluster A			CR Probability, Cluster B		
CAR	CET1	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
LOW	LOW	-	-	-	0.33	0.33	0.33
LOW	MEDIUM	-	-	-	0.33	0.33	0.33
LOW	HIGH	-	-	-	0.33	0.33	0.33
MEDIUM	LOW	0.25	0.50	0.25	0.33	0.33	0.33
MEDIUM	MEDIUM	0.10	0.60	0.30	0.44	0.22	0.33
MEDIUM	HIGH	0.58	0.25	0.17	0.25	0.25	0.50
HIGH	LOW	-	-	-	0.33	0.33	0.33
HIGH	MEDIUM	0.25	0.50	0.25	0.43	0.29	0.29
HIGH	HIGH	0.51	0.20	0.30	0.38	0.09	0.53

We conclude that there is an effect of BCR on CR especially for the high level of CET1 ratio between clusters A and B. To investigate more if this effect is significant, we used statistical hypothesis testing: Spearman correlation test.

Let the null hypothesis H0: There is no effect, statistically significant, of common equity tier 1 ratio (CET1 ratio) ratio on credit risk (CR) moving from cluster A to cluster B assuming a significance level of 0.05.

Hence the alternative hypothesis Ha: There is an effect, statistically significant, of common equity tier 1 ratio (CET1 ratio) on credit risk (CR) moving from cluster A to cluster B assuming a significance level of 0.05.

Let $CARDiff = CAR_b - CAR_a$ the difference CAR values between the two clusters. Let $RISKdiff = RISK_b - RISK_a$ the difference RISK values between the two clusters.

Table 11 shows the correlation value with the corresponding significance value Sig. It indicates that the Sig. value is equal to 0.669 which is greater than 0.05. Therefore, we will accept the null hypothesis H0 and we can say that the capital adequacy ratio (CAR) does not affect the credit risk (CR) moving from cluster A to cluster B.

Table 11: Correlation analysis

		CARDiff	RISKdiff
Spearman's rho	CARDiff	Correlation Coefficient	1,000
		Sig. (2-tailed)	,090
		N	,669
			25

Let the null hypothesis H0: There is no effect, statistically significant, of common equity tier 1 ratio (CET1 ratio) ratio on credit risk (CR) moving from cluster A to cluster B assuming a significance level of 0.05.

Hence the alternative hypothesis Ha: There is an effect, statistically significant, of common equity tier 1 ratio (CET1 ratio) on credit risk (CR) moving from cluster A to cluster B assuming a significance level of 0.05.

Let $CET1diff = CET1_b - CET1_a$ the difference CET1 values between the two clusters. Let $RISKdiff = RISK_b - RISK_a$ the difference RISK values between the two clusters.

Table 12 shows the correlation value with the corresponding significance value Sig. It indicates that the Sig. value is equal to 0.734 which is greater than 0.05. Therefore, we will accept the null hypothesis H0 and we can say that the common equity tier 1 ratio (CET1) does not affect the credit risk (CR) moving from cluster A to cluster B.

Table 12: Correlation analysis

			CET1diff	RISKdiff
Spearman's rho	CET1diff	Correlation Coefficient	1,000	,072
		Sig. (2-tailed)	.	,734
		N	25	25

In Spearman correlation test section (4.2.2) we study the effect of CAR on CR and the effect of CET1 ratio on CR independently. The result is that there no effect statistically significant of CAR and CET1 ratio on CR. To investigate more about the simultaneous effect of CAR and CET1 ratio on CR and to predict the shape of the relationship between those components, we used multivariate regression analysis.

Linearity test analysis (Figure 5) is conducted for CR vs CAR and CR vs CET1 regarding Cluster A in order to check the validity of the first assumption for OLS regression.

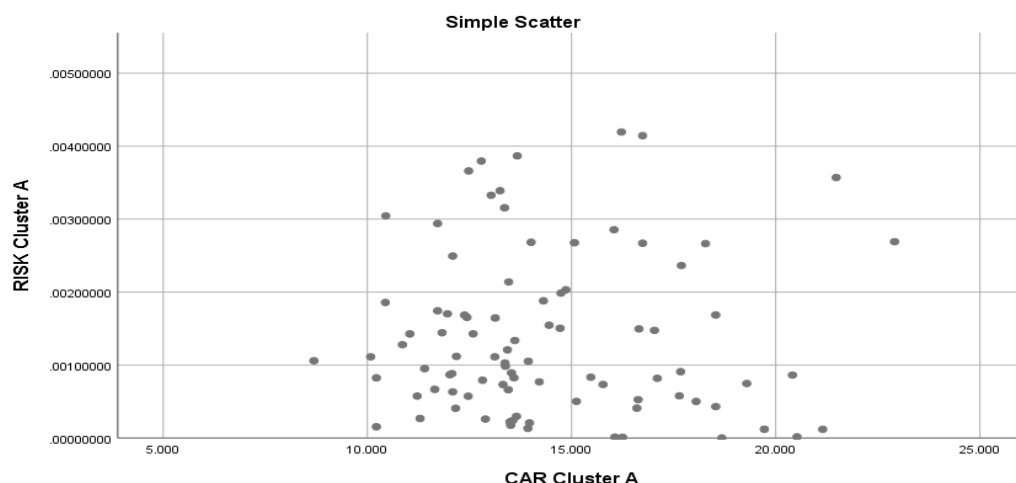


Figure 5a: Checking Linearity Assumption for CR vs CAR in Cluster A

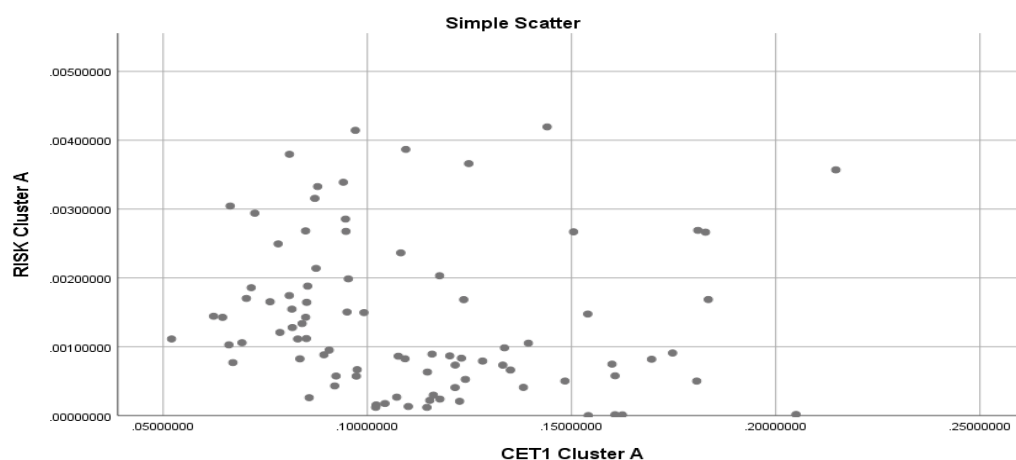


Figure 5b: Checking Linearity Assumption for CR vs CET1 in Cluster A

As we can see in Figure 5, the CR variable is showing a nonlinear distribution around CAR and CET1 variables. Hence, linear regression models cannot be applied to CR. In addition, multiple nonlinear regression models (such as Logarithmic, Inverse, Quadratic, Cubic models) were tested in order to fit the CR variable into CAR and CET1 independent variables without success as shown in Figure 6.

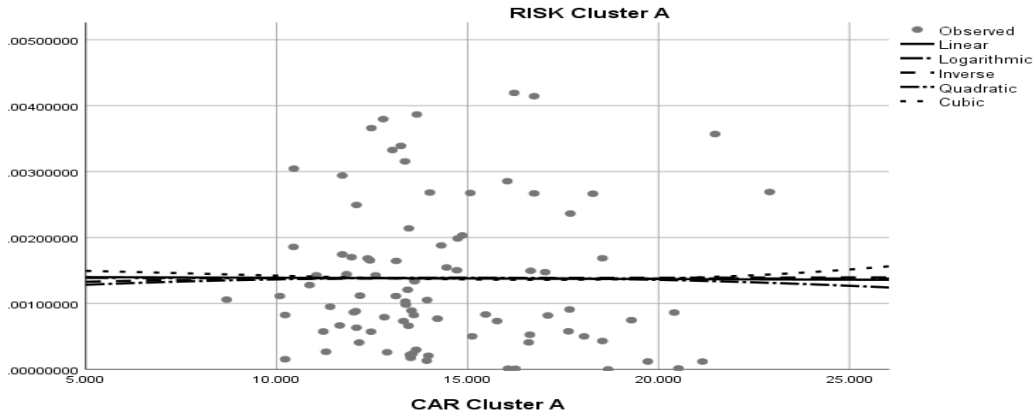


Figure 6a: Testing nonlinear regression models for CR vs CAR in Cluster A

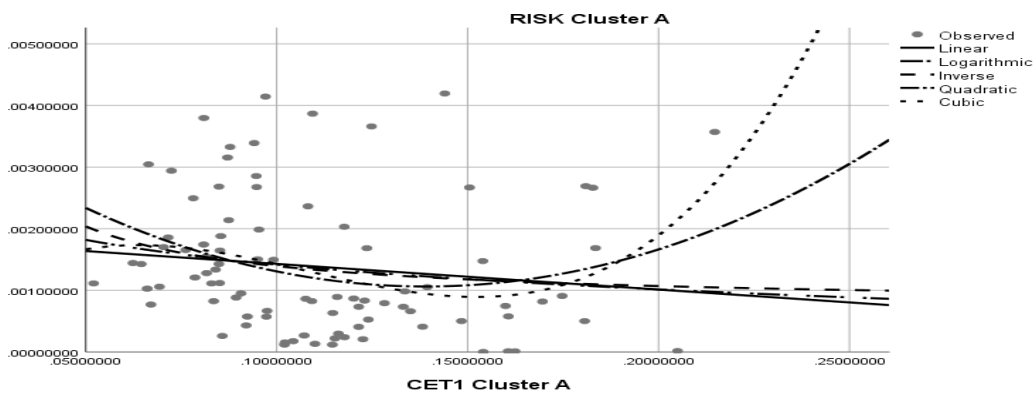


Figure 6b: Testing nonlinear regression models for CR vs CET1 in Cluster A

Linearity test analysis (Figure 7) is conducted for CR vs CAR and CR vs CET1 regarding Cluster B in order to check the validity of the first assumption for OLS regression.

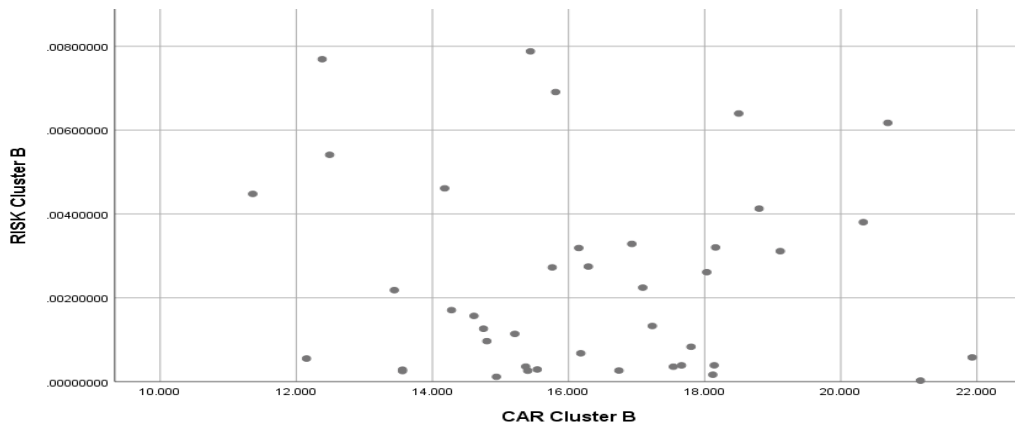


Figure 7a: Checking Linearity Assumption for CR vs CAR in Cluster B

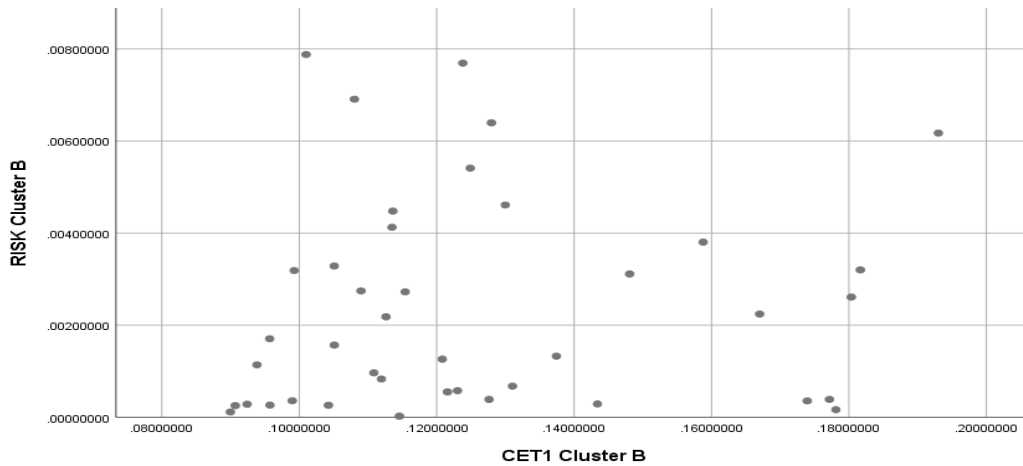


Figure 7b: Checking Linearity Assumption for CR vs CET1 in Cluster B

As we can see in Figure 7, the CR variable is showing a nonlinear distribution around CAR and CET1 variables. Hence, linear regression models cannot be applied to CR. In addition, multiple nonlinear regression models (such as Logarithmic, Inverse, Quadratic, Cubic models) were tested in order to fit the CR variable into CAR and CET1 independent variables without success as shown in Figure 8.

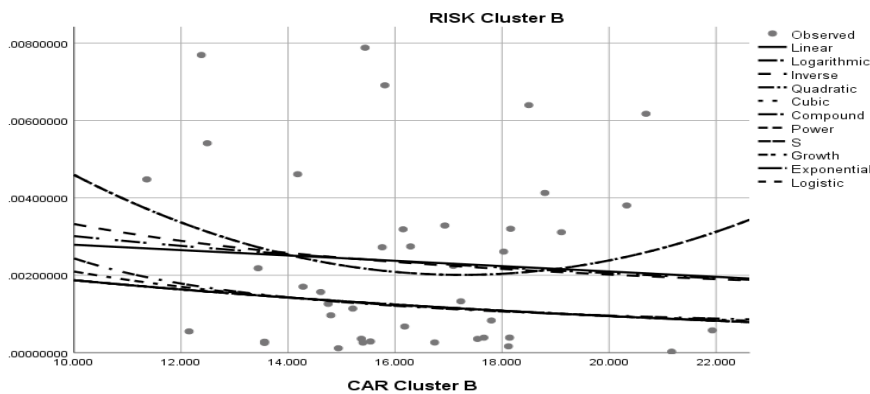


Figure 8a: Testing nonlinear regression models for CR vs CAR in Cluster B

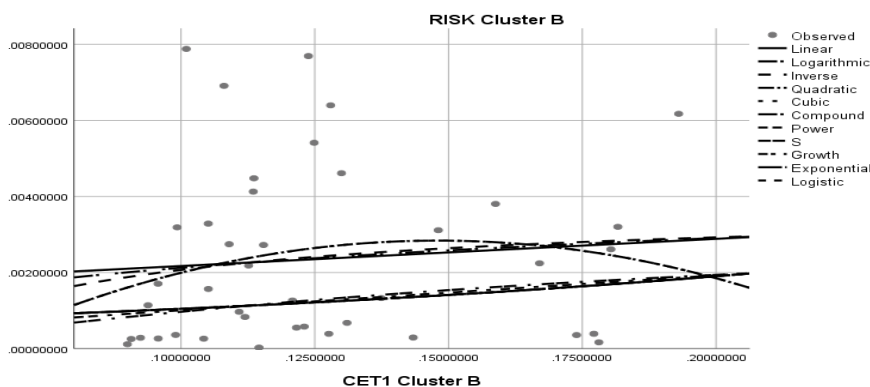


Figure 8b: Testing nonlinear regression models for CR vs CET1 in Cluster B

In conclusion, Figures (5 and 7) showed that there is no linear regression between CR vs CAR and CR vs CET1. Figures (6 and 8) showed that the test for nonlinear regression like (Logarithmic, Inverse, Quadratic, Cubic models.) is negative also. Based on all mentioned above we can finally say that there is no effect statistically significant of Basel III capital regulation (BCR) on credit risk (CR) moving from cluster A to cluster B.

Conclusion

Our findings show that there is no effect statistically significant of Basel III capital regulation (BCR) on credit risk (CR) moving from cluster A to cluster B. This result aligns with Klomp and de Haan (2012) findings' that emphasized the insignificant effect of bank regulation and supervision effect on low-risk banks and with Bitar et al. (2018) findings', which proved that Basel III risk-based capital ratio failed to decrease bank risk Using a sample of 39 OECD countries during the 1999–2013 period.

This study faced several limitations and difficulties. First of all, at the data level; the original sample was 33. Then, we excluded banks for which we cannot find complete financial data. Thus, we ended up with a final sample of 25 banks. Second, in Lebanon there is not an official Financial Data of the state like Data from the Central bank. In order to resolve those difficulties, we have taken database provided by Bankdata which is a consulting company established in Lebanon since 1986. "Bankdata's publishing department has established a solid reputation of being a unique, independent and trustworthy source of information on Lebanese banks" (Analytics. Information. Insight, 2020). Thus, this study might form the basis for future articles when studying the impact of Basel III capital regulation on credit risk and profitability in Lebanese banks.

References

- Analytics. (2020). <http://www.bankdata.com/AboutUs/Profile>
- Awdeh, A., Moussawi, C., & Machrouh, F. (2011). The effect of capital requirements on banking risk. *International Research Journal of Finance and Economics*, 66, 133–146. <https://doi.org/10.1016/j.srfe.2015.11.001>
- Bitar, M., Pukthuanthong, K., & Walker, T. (2018). The effect of capital ratios on the risk, efficiency and profitability of banks: Evidence from OECD countries. *Journal of International Financial Markets, Institutions and Money*, 53, 227–262. <https://doi.org/10.1016/j.intfin.2017.12.002>
- Bitar, M., Saad, W., & Benlemlih, M. (2016). Bank risk and performance in the MENA region: The importance of capital requirements. *Economic Systems*, 40(3), 398–421. <https://doi.org/10.1016/j.ecosys.2015.12.001>
- Bougatef, K., & Mgadmi, N. (2016). The impact of prudential regulation on bank capital and risk-taking: The case of MENA countries. *The Spanish Review of Financial Economics*, 14(2), 51–56. <https://doi.org/10.1016/j.srfe.2015.11.001>
- Delis, M. D., Tran, K. C., & Tsionas, E. G. (2012). Quantifying and explaining parameter heterogeneity in the capital regulation-bank risk nexus. *Journal of Financial Stability*, 8(2), 57–68. <https://doi.org/10.1016/j.jfs.2011.04.002>
- Fonseca, A. R., & González, F. (2010). How bank capital buffers vary across countries: The influence of cost of deposits, market power and bank regulation. *Journal of Banking & Finance*, 34(4), 892–902. <https://doi.org/10.1016/j.jbankfin.2009.09.020>
- Hoque, H., Andriosopoulos, D., Andriosopoulos, K., & Douady, R. (2015). Bank regulation, risk and return: Evidence from the credit and sovereign debt crises. *Journal of Banking & Finance*, 50, 455–474. <https://doi.org/10.1016/j.jbankfin.2014.06.003>
- Jensen, F., Jensen, F. V., & Dittmer, S. L. (1994). From influence diagrams to junction trees. *Uncertainty Proceedings*, 367–373. <https://doi.org/10.1016/B978-1-55860-332-5.50051-1>

- Klomp, J., & De Haan, J. (2012). Banking risk and regulation: Does one size fit all? *Journal of Banking & Finance*, 36(12), 3197–3212. <https://doi.org/10.1016/j.jbankfin.2011.10.006>
- Lee, C. C., & Hsieh, M. F. (2013). The impact of bank capital on profitability and risk in Asian banking. *Journal of International Money and Finance*, 32(1), 251–281. <https://doi.org/10.1016/j.jimonfin.2012.04.013>
- Lee, T. H., & Chih, S. H. (2013). Does financial regulation affect the profit efficiency and risk of banks? Evidence from China's commercial banks. *The North American Journal of Economics & Finance*, 26, 705–724. <https://doi.org/10.1016/j.najef.2013.05.005>
- Motocu, M. (2013). The framework resulting from the Basel III regulations. *Annals of the University of Oradea: Economic Science*, 22 (1), 1103-1112. Retrieved March 13, 2020, from: <https://doaj.org/article/d7f13a0602bb489299b8778947441b13>
- Neapolitan, R. (1990). Probabilistic Reasoning in Expert Systems: Theory and Algorithms. New York: Wiley-Interscience Publication.
- Spiegelhalter, D. J., Dawid, A. P., Lauritzen, S., & Cowell, R. G. (1993). Bayesian analysis in expert system. *Statistical Science*, 8 (3), 219–247. <https://doi.org/10.1214/ss/1177010888>
- Tao, C., Rong, G. J., Kamiya, S., & Pingyi, L. (2019). Marginal cost of risk-based capital and risk-taking. *Journal of Banking and Finance*, 103, 130–145. <https://doi.org/10.1016/j.jbankfin.2019.03.011>
- Tanda, A. (2015). The Effects of Bank Regulation on the Relationship Between Capital and Risk. *Comparative Economic Studies* 57, 31–54. <https://doi.org/10.1057/ces.2014.35>
- Tran, V. T., Lin, C. T., & Nguyen, H. (2016). Liquidity creation, regulatory capital, and bank profitability. *International Review of Financial Analysis*, 48, 98–109. <https://doi.org/10.1016/j.irfa.2016.09.010>

Appendix A: List of banks and their assets

List of banks	Bank's asset size in USD Million (2017)
Bank Audi Sal	43751.839
Bank of Beirut Sal	18366.26
Bank Med Sal	16625.311
Banque Libano-Francais Sal	13620.49
BBAC Sal	6928.563
BLOM Bank Sal	32544.015
Byblos Bank Sal	22661.497
Credit Libanais Sal	11562.123
Credit Bank Sal	3821.017
First National Bank Sal	4895.311
Fransabank Sal	22058.068
IBL Bank Sal	7195.668
Lebanon and Gulf Bank Sal	4697.922
Société Generale de Banque au Liban Sal (SGBL)	21550.215
Banque Misr Liban Sal	1987.929
BSL Bank Sal	1284.369
Emirates Lebanon Bank Sal	1580.12

Fenicia Bank Sal	1720.208
Jammal Trust Bank Sal	1061.567
Lebanese Swiss Bank Sal	2200.821
MEAB Sal	2064.488
National Bank of Kuwait (Lebanon) Sal	287.078
North Africa Commercial Bank Sal	1053.629
Banque de Crédit National Sa	208.211
Syrian Lebanese Commercial Bank Sal	411.087
Total	244137.806

Appendix B: Basel III capital regulation (BCR)

Cluster A:

Variables	From	To	Categories	interval
CAR	0	9.5	Low	<9.5
CAR	9.5	12	Medium	$9.5 \leq X < 12$
CAR	12	...	High	$12 \leq X \dots$
CET1 Ratio	0	5.5	Low	<5.5
CET1 Ratio	5.5	8	Medium	$5.5 \leq X < 8$
CET1 Ratio	8	High	$8 \leq X \dots$

Cluster B:

Variables	From	To	Categories	interval
CAR	0	10.5	Low	<10.5
CAR	10.5	15	Medium	$10.5 \leq X < 15$
CAR	15	High	$15 \leq X \dots$
CET1	0	5.5	Low	<5.5
CET1	5.5	10	Medium	$5.5 \leq X < 10$
CET1	10	...	High	$10 \leq X \dots$

Credit Risk (CR):

Variables	From	To	Categories	interval
CR	0	0.001	Low	$0 \leq X < 0.001$
CR	0.001	0.002	Medium	$0.001 \leq X < 0.002$
CR	0.002	...	High	$0.002 \leq X < \dots$