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Capital Regulation and Risk-taking Behavior: Empirical Evidence for Islamic Banks

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ABSTRACT

This paper investigates whether regulatory pressures have an impact on the relationship between change in capital and bank risk-taking. On the basis of a well-developed theoretical background, capital regulation constitutes the core of prudential regulation within the banking sector. Several researches have investigated this relationship between capital and risk in conventional banks, and this subject has gained in interest since the last financial crisis. This study is one of the few studies that have attempted to provide empirical evidence on this issue for Islamic banks. We use data of Islamic banking sectors over the period 2010–2014. The results reveal that Islamic banks tend to behave differently at each level of capital adequacy. In addition, we provide some evidence that change in capital is positively related to the change in risk for highly capitalized Islamic banks.

Keywords: Islamic Banking Sector, Regulatory Pressure, Total Capital, Risk-Taking
JEL Classifications: G21, G28, G29, G32

1. INTRODUCTION

As our understanding of the determinants of financial stability, three interrelated factors in the banking sector are gaining attention from analysts and policymakers: Regulation, capitalization, and risk-taking. The relationship between these three elements is provided by an article by Shrieves and Dahl (1992), who argues that change in capital is positively related to the change in the level of risk for banks with capital ratios above the minimum regulatory levels. However, few researchers have investigated empirically if and how regulations, such as capital requirements and supervisory authority, interact to influence the risk-taking behavior of Islamic banks (IB) (Smolo and Kabir, 2010). Islamic financial intermediation (Grais and Kulathunga, 2007) has attracted increasing attention from national regulators, policymakers and academics. Efforts for standardization, regulation and supervision of these institutions have intensified in recent years. Several international Islamic institutions are working to develop Shariah-compliant standards and procedures to strengthen the financial sector architecture in various countries, but the most influential are the Organization of Accountants and Auditors of Islamic Financial Institutions (AAOIFI), the Islamic Financial Services Board (IFSB), the International Islamic Financial Market (IIFM), and the International Islamic Ratings Agency (IIRA). Capital regulation attempts to ensure that banks maintain a minimum of capital appropriate to their risk exposure and that their capital decisions respond to changes in their risk position caused by endogenous or exogenous factors (Sundarajan and Errico, 2002). Yet, if not properly conceived, capital requirements can produce adverse consequences via moral hazard and information asymmetry inducing banks to overrisk (Kahane, 1977; Leland and Pyle 1977; Koehn and Santomero, 1980; Kim and Santomero, 1988; Gennotte and Pyle, 1991; Santos, 1999).

Despite the development of IB, international regulators have not taken into consideration the specificities of Islamic banking activities. So, compliance of IB with international standards and guidelines (such as the capital requirements set by the Basel III Accord), while

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respecting the principles of Islamic Shariah, is the most important challenge. And this is not an effortless process, as IB are faced to specific risks (such as displaced commercial risk, reputation risk and Sharia compliance risk). The profit-and-loss sharing (PLS) partnership affects the nature of the risks incurred by IB, as they do not transfer the risks to their customers. The global economic crisis (in Europe, USA, etc.), seems to be related to financial crises caused by financial products using interest rates and which are prohibited by the Sharia. The main characteristics of the Islamic financial system, which are the backing of the transaction with real assets and the principle of profit-and-loss sharing, may lead to more stability in the financial system (Daoud and Kammoun, 2014). An appropriate level of capital ensures that the financial institution has sufficient capital to support its activities and that its net value is sufficient to cover the devaluation of its assets without it becoming insolvent. In this study, we focus on the empirical analysis of the relationship between changes in capital and changes in risk taking in Islamic Banks (IB). We try to find out whether this interaction between capital and risk differs depending on the level of ex-ante regulatory capital of IB.

The rest of the article is structured as follows. Section 2 presents a theoretical discussion to support our choice to study the relationship between regulation, capital change and risk taking. Section 3 examines the data for the study. Section 4 presents the empirical model and discusses the results. Section 5 suggests further investigations and section 6 concludes the paper.

2. LITERATURE REVIEW

Several empirical studies seek to investigate the impact of regulatory constraints on bank risk-taking and capitalization[1], and the relationship between changes in capital and changes in risk levels. These researches are based on the econometric specification proposed by Shrieves and Dahl (1992), Jacques and Nigro (1997); Aggarwal and Jacques (1998); Ediz, Michael and Perraudin (1998), Rime (2001), Aggarwal and Jacques (2001), Van Roy (2008); Saadaoui (2008).

Shrieves and Dahl (1992) analyze the relationship between capital regulation, risk changes and capital changes on a large sample of American banks during the period 1983-1987. For the study period, a requirement on the unweighted risk capital ratio of 7% was imposed on American banks. The sample consists of approximately 1800 independent commercial banks insured with the Federal Deposit Insurance Corporation (FDIC) and affiliated bank holding companies with assets in excess of $100 million as of December 1984. The authors use the ratio of equity to total assets as a measure of book value of capital. Equity includes common stock, non-operating earnings, retained earnings, capital reserves, and foreign currency. The results show that the change in capital is positively related to the change in risk for banks with capital ratios above the minimum regulatory levels, and that for undercapitalized banks the regulation was at least effective during the period covered. The findings suggest that bank's capital evolution over the study period was "risk-based."

Aggarwal and Jacques (1998) conduct an empirical study of 2552 FDIC-insured commercial banks with total assets equal to or greater than $100 million over the periods 1990-1993. The authors use two risk measures: the ratio of risk-weighted assets to total assets and the ratio of non-performing loans to total assets. For undercapitalized and adequately capitalized banks, regulatory pressure has led to an increase in their capital ratio and a reduction in their risk (risk-weighted assets).

Ediz et al. (1998) study the impact of capital regulation on the capitalization of 94 UK banks from the fourth quarter of 1989 to the fourth quarter of 1995. These authors find that capital requirements lead banks to increase their capital ratio. This increase in the capital ratio is done through an increase in capital and not through a substitution between low-weighted and high-weighted assets. These results therefore highlight that capital requirements appear to be an important regulatory instrument, as they enhance the stability of the system without restricting the asset choices of UK banks.

Rime (2001) selects a sample of 154 Swiss banks for a period from 1989 to 1995. The author uses two definitions of capital, the ratio of capital to total risk-weighted assets and the ratio of capital to total assets (used by Shrieves and Dahl (1992)). The first definition was used by Jacques and Nigro (1997), Aggarwal and Jacques (1998) and Ediz et al (1998). Regarding the risk measure, the author refers to the ratio of risk-weighted assets to total assets (RWA). The justification for this measure is that the risk of the portfolio can be determined mainly by the distribution of assets across the different risk categories. An obvious advantage of RWA is that it reflects banks' risk-taking decisions. This approach, however, supposes that the risk weighting correctly reflects the economic risk of the different asset categories. The author utilizes two measures of regulatory pressure (Table 1). The first measure is a probabilistic measure. The regulatory pressure variable REG is equal to unity if the bank's capital ratio is in a set interval around the minimum capital requirement and 0 otherwise. The second approach is based on the Proactive Corrective Action (PCA), implemented in the USA. Two regulatory variables are then constructed. The first variable (PCAU) is equal to unity when the risk-weighted capital ratio is below 8% and 0 if not. The second variable (PCAA) which measures the behavior of adequately capitalized banks takes the value 1 if the capital ratio of the bank is between 8 and 10% and 0 otherwise. The author finds that Swiss banks approaching the minimum regulatory capital requirements tend to increase their capital to RWA ratio. This indicates that regulatory pressure has a positive and significant impact on the risk weighted capital ratio. In addition, regulatory pressure has a positive and significant impact on the capital to total assets ratio, but no significant impact on banks' risk taking. For adequately capitalized banks, regulatory pressure has no effect on the level of capital or on risk. Finally, the author finds a positive relationship between changes in the unweighted capital to total assets ratio and risk taking, however changes in the risk weighted capital ratio did not affect risk taking of Swiss Banks.

1 Theoretical and empirical work has shown that the reaction of banks to shocks varies according to their level of capitalization. In order to study the impact of the level of equity on the lending behavior of banks, three main categories have been identified: highly capitalized, adequately capitalized and undercapitalized (Baglioni, 2005).

Table 1: Definitions of regulatory pressure

Author (s)	Definitions of regulatory pressure
Shrieves and Dahl (1992)	Dummy variable that takes the value of unity if the capital adequacy ratio is below 7% and zero otherwise
Jacques and Nigro (1997)	Two variables: One is equal to the difference between the inverse of the bank's total capital ratio and the inverse of the regulatory minimum for all banks with a total capital ratio below 7.25%, and zero otherwise. The other is equal to the difference between the inverse of the regulatory minimum and the inverse of the bank's total capital ratio for all banks with a total capital ratio greater than or equal to 7.25%, and zero otherwise.
Aggarwal and Jacques (1998)	Two Dummy variables: One takes the value of unity if the bank is sufficiently capitalized by PCA standards and zero otherwise. The other takes the value of unity if the bank is undercapitalized, significantly undercapitalized, or critically undercapitalized by PCA standards and zero otherwise.
Ediz et al. (1998)	Two Dummy variables: One takes the value of unity if the bank has experienced an upward adjustment in its regulatory trigger rate in the previous three quarters and zero otherwise. The other takes the value of unity if the bank's capital ratio is below a bank-specific standard deviation above the bank's trigger and zero otherwise.
Rime (2001)	Two approaches. (1) Binary variable that takes the value of unity if the bank's capital ratio is one standard deviation from the minimum capital requirement and zero otherwise. (2) Two dummy variables, one that takes the value of unity for banks with a capital ratio of less than 8% and zero otherwise and a second that takes the value of unity for banks with a capital ratio between 8% and 10% and zero otherwise.
Stolz (2007)	Three approaches: (1) Binary variable that takes the value of unity if a bank has a normalized equity buffer equal to or less than the median normalized equity buffer over all observations, and zero otherwise. (2) splitting the sample according to the threshold defined in (1) and estimating the two subsamples separately (3) the rolling window approach, which allows for a continuous change in behavior as a function of the size of the equity buffer
Van Roy (2008)	Dummy variable that takes the value of the unit if the total capital ratio is less than 10% or if the Tier 1 capital ratio falls below 6% and 0 otherwise.
Tanda (2015)	Two variables: one measures the difference between the bank's capital ratio and the minimum capital ratio, which is 8%, and a second represents the product of the gap between the minimum requirement of 8% and the level of the capital ratio at the starting point of the period (cap_{t-1}) and indicates the rapidity with which banks adjust their capital.

Van Roy (2008) utilized a simultaneous equation model to examine the behavior of 576 commercial banks in six G-10 countries over the period 1988-1995. He considers a dummy variable to measure regulatory pressure. It takes the value of unity if the total capital ratio is below 10% or the Tier 1 capital ratio falls below 6% and 0 otherwise. The findings show that only in the USA under capitalized banks increase their total capital ratio faster than the highly capitalized banks. This is explained by regulatory pressures.

Calem and Rob (1999) examine the impact of capital regulation on risk-taking using data on American banks between 1984 and 1993, hypothesizing that banks' risk-taking varies with their initial capital level. This relationship can be represented by a U-shaped curve. Undercapitalized banks hold a large share of risky assets in their portfolio and they decrease their risk as their capital increases. Then, at a certain level of capital, the bank increases its risk-taking when the capital increases. Thus, both undercapitalized and highly capitalized banks take more risk than adequately capitalized banks. However, the basis for risk-taking for these two types of banks is not the same. For undercapitalized banks the high risk-taking is due to a moral hazard problem, plus they have minimal losses in case of default. However, highly capitalized banks increase their risk-taking because they hold a very high level of capital to cover their risk.

Camara (2010) focused on a sample of 3411 commercial bank, cooperative and mutual and European savings institutions over a period from 1992 to 2006. The author tried to determine whether the impact of changes in capital on risk taking depended on the level of ex ante regulatory capital. In this study banks are classified into three categories according to their risk-weighted capital ratio (RWR): highly capitalized banks RWA ≥10%, adequately capitalized banks 8% ≤RWA ≤10% and undercapitalized banks RWA ≤8%. The author applied a model based on the econometric techniques of panel data and estimated the risk measures (non-performing loan ratio, the risk-weighted asset ratio, and the 3-year moving average of the standard deviation of the return on assets SD_ROA) in terms of variation. The results obtained show that banks with different levels of ex ante regulatory capital react distinctly in terms of risk taking when they change their capital. While undercapitalized banks decrease their risk-taking, adequately and highly capitalized banks increase it.

Regarding the literature on Islamic banking, the regulatory process in Islamic banking systems is quantitatively and qualitatively distinct from that in conventional banking systems. In addition, providing alternative methods for calculating adequate capital is important (e.g. Abdel Karim, 1996; Ariss and Sarieddine, 2007; Basher et al., 2017). However, certain other researchers maintain that IB could adopt the same international standards and guidelines used by conventional banks (such as the capital requirements set by the Basel III Accord) (e.g. Errico and Farahbaksh, 1998; Hassan and Dicle, 2005).

There are only a few studies that document relationship between bank capital and risk of IB. Ghosh (2014) analyze the simultaneous relationship between capital and risk among 100 GCC banks during the period 1996-2011. The result indicates that under regulatory pressure Islamic banks increase their capital in response to an increase in risk, and not vice versa, more than conventional banks.

Ghosh (2017) examines the factors influencing the capital buffer of Islamic and conventional banks located in the MENA region for 2001-2012. The result shows that when credit risk increase IB tend to increase their capital buffer.

Basher et al. (2017) assess the interaction between risk taking and capital regulations of a sample of 22 IB during the period 2007-2013. They find a positive relationship between total capital and the levels of asset risks.

Lately, Bougatef and Korbi (2018) assess the interactions between changes in capital buffer and changes in credit risk of Islamic and conventional banks from the Middle East and North Africa (MENA) region for 1999–2016. Their results suggest that an increase in the changes in capital buffer has a negative effect on the changes in credit risk for the two types of banks.

3. STUDY DATA

3.1. Bank Capitalization

Referring to Shrieves and Dahl (1992), we use the ratio of capital to total assets. Capital (CAP) includes Tier1 items (equity and reserves) and Tier2 items. We use the annual changes in CAP of bank j defined as: $\Delta CAP_{j,t} = CAP_{j,t} - CAP_{j,t-1}$

This study tries to determine whether the impact of changes in capital on the risk taking of IB is different depending on the level of ex-ante regulatory capital of the bank. Thus, we proceed to the classification of banks into different categories according to the level of regulatory capital adequacy ratio (CAR) of the previous period. The CAR is calculated as the ratio of regulatory capital (Tier1 and Tier2) to risk-weighted assets. Based on the work of Calem and Rob (1999), Aggarwal and Jacques (2001), Rime (2001) and Camara (2010), we will classify Islamic banks into three categories: undercapitalized (UNDER), adequately capitalized (ADC) and highly capitalized (HIGH).

For most Islamic banks, capital requirements greatly exceed the Basel minimum of 8 percent (Rizwan et al., 2012; Bitar and Madiès 2013). In the majority of countries where Islamic banks operate, the central bank represents the regulatory authority that sets the capital requirement for these banks (Table 2).

The countries in which central banks set a minimum CAR level of:

- 8% are: Bahrain, Djibouti, Egypt, Indonesia, Iran, Malaysia, Saudi Arabia, Thailand, Turkey, United Kingdom, Yemen.
- 10% are: South Africa, Bangladesh, Brunei, Pakistan, Sri Lanka.
- 12% are: United Arab Emirates, Iraq, Jordan, Kuwait, Sudan, Qatar.

In line with previous empirical works (e.g., Shrieves and Dahl (1992), Jacques and Nigro (1997), Aggarwal and Jacques (1998), Ediz et al. (1998), Rime (2001), Stolz (2007), Van Roy (2008)) we consider three dummy variables to classify the IB in our study:

- HIGH for highly capitalized banks with a CAR≥12%
- ADC for adequately capitalized banks with a 10%≤CAR<12%
- UNDER for under capitalized banks with a CAR <10%.

3.2. Risk Measures

Two risk measures are used: the ratio of risk-weighted assets to total assets (RWA) and the ratio of non-performing loans to total loans (NPL). The ratio of risk-weighted assets to total assets (RWA) represents the definition of risk according to the Basel Accords (for conventional banks) and according to the IFSB standards (for Islamic banks). The measure of this ratio corresponds to the allocation of bank assets between the major asset categories weighted at 0, 20, 50 and 100%. Some authors have used the RWA variable as a measure of risk: Shrieves

Table 2: Distribution of Islamic banks by country

	Country	Number of selected Banks	Regulatory Authority
1	South Africa	1	Central Bank
2	Saudi Arabia	5	SAMA (Saudi Arabian Monetary Agency)
3	Bahrain	14	Central Bank
4	Bangladesh	6	Central Bank
5	Brunei	1	AMBD (Autority Monetary Brunei Darussalam)
6	Djibouti	1	Central Bank
7	Egypt	2	Central Bank
8	United Arab Emirates	5	Central Bank
9	Britain	2	Central Bank
10	Indonesia	2	Central Bank
11	Iraq	3	Central Bank
12	Iran	1	Central Bank
13	Jordan	2	Central Bank
14	Kuwait	2	Central Bank
15	Malaysia	11	BNM (Bank Negara Malaysia)
16	Pakistan	10	SBP (State Bank of Pakistan)
17	Sudan	3	Central Bank
18	Sri lanka	1	BAC (Board Audit) Comitee
19	Qatar	3	Central Bank
20	Thailand	1	Ministerial Regulation
21	Turkey	4	BDDK (Banking Regulation and Supervision Agency)
22	Yemen	1	Central Bank
Total		81	

and Dahl (1992) then by Jacques and Nigro (1997), Aggarwal and Jacques (2001), Van Roy (2005) and Jokipii and Milne (2010). This ratio allows us to study the impact of changes in capital on banks' portfolio reallocations between different asset categories.

The ratio of non-performing loans to total loans (NPL) is also used as an indicator of loan quality and an ex-post measure of risk following Shrieves and Dahl (1992), Aggarwal and Jacques (2001) and Camara (2010).

We consider changes in the two risk measures *(ΔRWA and ΔNPL)*, since the objective of this study is to examine the adjustments between changes in risk and changes in capital.

3.3. Sample Composition

The data used in this study is obtained from Bankscope and the websites of each financial institution. And we retain only those for which we have information on financial condition, capital regulation, and non-performing loans for the period from 2010 to 2014. Our sample consists of a panel of data of 81 IB established in 22 countries: Bahrain, Iran, Jordan, Kuwait, Qatar, Saudi Arabia, United Arab Emirates, Yemen, Turkey, Brunei, Indonesia, Malaysia, Philippines, Bangladesh, Pakistan, Egypt, Thailand, South Africa, Sri Lanka, United Kingdom (Table 3).

4. THE MODEL AND RESULT

In light of the considerations in the theoretical and empirical literature reviewed above, we specify the empirical model to test our main hypothesis: The impact of changes in capital ($\Delta CAP_{j,t}$) on Islamic banks' risk taking ($\Delta Risk_{j,t}$) is different depending on the bank's ex-ante regulatory capital level (highly capitalized, adequately capitalized, and undercapitalized).

Model:

$$\Delta Risk_{j,t} = \alpha_{0,j} + \alpha_1 UNDER_{j,t-1} + \alpha_2 AD_{j,t-1} + \alpha_3 \Delta CAP_{j,t} + \alpha_4 \Delta CAP_{j,t} * UNDER_{j,t-1} + \alpha_5 \Delta CAP_{j,t} * AD_{j,t-1} + \alpha_6 CONTROL_{j,t} + \varepsilon_{j,t}$$

Interactive variables are introduced by multiplying CAP by each dummy variable. However, to avoid the singularity problem in the matrix of explanatory variables we eliminate the dummy variable HIGH as well as the interactive term related to this dummy variable ($\Delta CAP_{j,t} * HIGH_{j,t-1}$).

Therefore, highly capitalized banks represent the reference to compare the estimated coefficients associated with the capitalization variables. The coefficient α3 is associated with the changes in capital of highly capitalized banks. And the coefficients (α3 + α4) and (α3 + α5) measure the impact of capital changes on risk changes for undercapitalized and adequately capitalized banks, respectively. We test the significance of these two coefficient sums using a Fisher test. For a panel data sample, we first need to detect the nature of the model: fixed effect model or random effect model. The Hausman test can be used to determine the appropriate model (Table 4).

5. RESULT

Table 5, shows results that are consistent with the hypothesis stating that the impact of changes in capital on risk taking depends on the bank's ex ante regulatory capital level.

First, as expected, our results show a positive relationship between changes in capital and changes in risk (for both risk measures ΔRWA and ΔNPL) for highly capitalized banks (α3 is positive and significantly different from zero). This result shows that highly capitalized banks invest in riskier assets when they increase their capital.

Second, we find a positive relationship between changes in capital and changes in risk (measured by ΔRWA) for adequately capitalized banks that are acting like highly capitalized banks. However, the absence of an explicit regulatory requirement in the majority of countries where IB operate could explain the performance of these banks. But if we consider non-performing loans as a measure of risk, we find a negative and significant relationship. This is explained by the fact that adequately capitalized banks have a higher probability of becoming undercapitalized, so they should be more conservative in their business operations.

Third, we find a negative and significantly non-zero sum of the two coefficients α3 and α4 which means that, for undercapitalized banks, changes in capital negatively affect changes in asset risk. Undercapitalized banks thus seem to adopt a prudent policy when they increase their capital in order to conform to regulations. They aim to avoid specific risks (reputational risk, displaced business risk) by rebuilding their capital ratio. (Jacques and Nigro (1997), Rime (2001), Jokipii and Milne (2011), Altunbas et al. (2007)).

Regarding our control variables, we find that size (TA) has a positive effect on risk taking (ΔRWA and ΔNPL) which means

Table 3: Distribution of the sample

Years/Banks	Undercapitalized	Adequately capitalized	Highly capitalized	Total number of IB
2010	8	26	47	81
2011	6	25	50	81
2012	4	30	47	81
2013	4	32	45	81
2014	6	25	50	81
Total	28	138	239	405

There are three categories of IB: Undercapitalized if CAR<10%; adequately capitalized if 10% <= CAR<=12% and highly capitalized if CAR>12%. The total number of undercapitalized, adequately capitalized and highly capitalized IB is greater than the total number of banks in our sample because the same bank can move from one category to another and from one year to another

Table 4: Definitions of variables

Independent variables	Measure	Associated coefficient	Expected sign
Annual changes in the capital ratio of HIGH	$\Delta CAP_{j,t} = CAP_{j,t} - CAP_{j,t-1}$	α_3	+
Annual changes in the capital ratio of UNDER		$(\alpha_3 + \alpha_4)$	+/-
Annual changes in the capital ratio of AD	$(CAP_{j,t} = Equity / TotalAssets)$	$(\alpha_3 + \alpha_5)$	+
TA: Bank size	Natural logarithm of total assets	α_6	+
EFF : Efficiency	Cost to income ratio	α_7	-
GDP : Economics Growth	Growth rate of the Gross Domestic Product	α_8	+/-

Table 5: Changes in capital and risk-taking of Islamic banks

Variables	ΔNPL	ΔRWA
UNDER (α_1)	0.028 (0.36)	−0.065 (−1.02)*
AD (α_2)	−0.005 (−0.61)*	0.083 (2.68)***
Δ*CAP* (α_3)	0.093 (1.62)**	0.575 (5.61)***
Δ*CAP*UNDER* (α_4)	0.054 (0.14)	−0.578 (−0.57)*
Δ*CAP*AD* (α_5)	−0.091 (−1.45)*	0.046 (0.91) **
TA (α_6)	0.008 (1.66) **	0.028 (0.68)*
EFF (α_7)	−0.009 (−0.58)*	0.048 (0.76)*
GDP (α_8)	0.008 (0.43)*	−0.017 (−0.20)
F. test : $\alpha_3+\alpha_4 = 0$	0.148 (0.37)	−0.003 (4.10) **
$\alpha_3+\alpha_5 = 0$	0.002 (15.40) **	0.621 (13.48) **
Observations	405	405
R-squared	0.0913	0.1309

***, **, and * indicate the level of significance at the 1%, 5%, and 10% level. Numbers in parentheses represent t-statistics. F.test is Fisher's test of the significance of the sum of the coefficients and the numbers in parentheses represent the value of Fisher's statistic. Definition of variables: ΔNPL = annual variation in the ratio of non-performing loans to total net loans, ΔRWA = annual variation in the ratio of risk-weighted assets to total assets, UNDER = 1 if the risk-weighted capital ratio CAR < 10% and 0 otherwise, AD = 1 when CAR is between 10% and 12% and 0 otherwise. ΔCAP = annual change in capital over total assets. TA = logarithm of total assets, EFF = total bank costs on income generated, GDP = the growth rate of gross domestic product

that large IB take more risk. This result supports the "too big to fail" hypothesis. And this is may be attributed to best credit quality systems and corporate governance in small IB (Laeven and Levine, 2009). As expected, the ratio of costs to income (EFF) is negatively related to changes in the ratio of non-performing loans (ΔNPL). A reduction in bank costs leads to greater risk taking. In this case for risk-averse leaders as they may decide to incur greater screening and monitoring costs in order to minimize the risk of loan portfolio, this leads to trading modest revenues for higher loan quality. The influence of macroeconomic conditions (GDP) on Islamic banks' risk taking is found to have negative impact on ΔNPL indicating that favorable macroeconomic conditions contribute to reducing the amount of non-performing loans and increases bank soundness. The absence of a significant effect of GDP on Islamic banks' risk taking measured by ΔRWA suggests that the process on banks' portfolio reallocations between different asset categories is based exclusively on bank-specific factors.

6. FURTHER INVESTIGATIONS

6.1. Differentiation between Small and Large Banks

First, the estimates are conducted by dividing the sample in two groups based on the size of the bank. We tried to assess the size effects on the relationship between the change in capital and risk taking of IB. This distinction allows us to analyze the behavior of small banks and large banks separately. We use a value of one billion to discriminate between large and small banks. Table 6 presents the results obtained from this estimation. The results show that for undercapitalized banks, the positive relationship between changes in capital and changes in risk-weighted assets (ΔRWA) is significant only for small banks. The small, and undercapitalized, banks try to take more risk with the expectation of achieving sufficient profitability to increase their capital level. Indeed, an increase in capital may lead to increase default risk for small, and highly capitalized, banks. Thus, the results for large banks (which represent the majority of our sample) are consistent with those found for full sample.

6.2. Differentiation between Positive and Negative Changes in Capital

The previous results have been interpreted in terms of an increase in capital (positive changes). However, some banks, usually those that are highly capitalized, may reduce their capital level (negative changes). Thus, the sign of variation in capital can affect a bank's risk-taking in a different way. For this reason, the estimates of the econometric model are carried out on two subsamples, considering positive and negative changes in capital separately (Table 7).

First, concerning the sub-sample with positive changes, the results show that highly capitalized banks that proceed to increase their capital take more risk (ΔRWA) as a consequence, consistently with the results of full sample. Second, regarding the subsample with negative changes in capital, change in capital and risk are positively and significantly related only for adequately capitalized banks. These banks reduce their risk-taking when they decrease their capital. However, we observe a negative relationship between negative changes in capital and changes in risk for highly capitalized banks (this is different from the result on the full sample). These banks invest in riskier assets when they reduce their capital level (negative changes).

6.3. Analysis with ΔRWA as an Explanatory Variable

As a robustness check, change in risk-weighted assets (ΔRWA) is introduced in specifications for which ΔNPL is the explained variable. This specification was used by Shrieves and Dahl (1992) who showed that increases in risk-weighted assets can result from the selection of highly weighted assets (e.g. loans to private firms) and this may lead to an increase in non-performing loans. The results in Table 8 show a positive but insignificant relationship between change in risk-weighted assets and change in non-performing loans.

Table 6: Change in capital and risk-taking of small and large Islamic banks

Variables	Small IB		Large IB	
	ΔNPL	*ΔRWA*	*ΔNPL*	*ΔRWA*
UNDER (α_1)	0.028 (0.44)**	0.063 (0.33)	0.007 (0.36)*	−0.216 (−0.88)
AD (α_2)	−0.075 (−1.37)*	0.239 (2.04) **	−0.001 (−0.1)	0.145 (1.5)*
Δ*CAP* (α_3)	0.202 (0.85)	1.470 (4.46) ***	0.001 (0.01)	4.035 (11.44)***
Δ*CAP*UNDER* (α_4)	0.958 (0.43)	15.391 (3.31) ***	0.037 (0.12)	−8.575 (−2.59)**
Δ*CAP*AD* (α_5)	−3.290 (−4.21)***	−1.362 (−1.07)	−0.008 (−0.15)	2.574 (5.90)***
TA (α_6)	0.005 (1.19)	−1.362 (−1.07)	−0.002 (−0.31)	−0.311 (−1.37)**
EFF (α_7)	−0.028 (−1.52)*	−0.001 (−0.04)	−0.040 (−0.30)*	−0.078 (−0.51)
GDP (α_8)	−0.019 (−0.130)***	−0.012 (−0.22)	0.001 (1.570)**	−0.004 (−0.05)
F. test : $\alpha_3+\alpha_4=0$	1.160 (0.80)	16.861 (0.92)	0.038 (3.02)*	−4.140 (2.20)*
$\alpha_3+\alpha_5=0$	−3.088 (7.12)***	0.108 (10.46)***	−0.007 (0.37)	6.6097 (10.37)***
Observations	98	98	307	307
R-squared	0.3650	0.3745	0.1070	0.5358

***, **, and * indicate the level of significance at the 1%, 5%, and 10% level. Numbers in parentheses represent t-statistics. F.test is Fisher's test of the significance of the sum of the coefficients and the numbers in parentheses represent the value of Fisher's statistic. Definition of variables: ΔNPL=annual variation in the ratio of non-performing loans to total net loans, ΔRWA=annual variation in the ratio of risk-weighted assets to total assets, UNDER=1 if the risk-weighted capital ratio CAR<10% and 0 otherwise, AD=1 when CAR is between 10% and 12% and 0 otherwise. ΔCAP=annual change in capital over total assets. TA=logarithm of total assets, EFF=total bank costs on income generated, GDP=the growth rate of gross domestic product

Table 7: Negative and Positive Change in Capital and Risk Taking of the Largest Islamic Banks

Variables	Negative change in capital		Positive change of capital	
	ΔNPL	*ΔRWA*	*ΔNPL*	*ΔRWA*
UNDER (α_1)	0.037 (0.580)*	−0.235 (−0.940)	0.015 (0.280)	0.430 (1.910)**
AD (α_2)	0.006 (0.360)	0.474 (5.890)***	−0.070 (−0.240)	0.063 (0.450)
Δ*CAP* (α_3)	0.035 (0.270)	−0.344 (−0.730)*	−0.018 (−0.190)	5.110 (13.570)***
Δ*CAP*UNDER* (α_4)	−0.476 (−0.240)	−1.082 (−0.180)	0.172 (0.170)	−4.661 (−1.280)*
Δ*CAP*AD* (α_5)	0.055 (0.360)	6.964 (16.410)***	−0.289 (−1.210)*	0.093 (0.071)
TA (α_6)	0.130 (1.310)*	−0.138 (−1.040)*	0.01 (0.66)*	−0.138 (−1.040)*
EFF (α_7)	−0.014 (−0.840)*	0.017 (0.180)	−0.065 (−4.10)***	−0.01 (−0.190)
GDP (α_8)	0.0017 (0.76)	−0.001 (−0.250)	−0.033 (−2.38)***	0.011 (0.140)
F. test : $\alpha_3+\alpha_4=0$	−0.441 (0.09)	−1.426 (0.11)	0.154 (0.20)	0.449 (1.2)*
$\alpha_3+\alpha_5=0$	0.090 (0.10)	6.620 (30.50)***	−0.315 (0.02)	5.203 (0.13)
Observations	246	246	159	159
R-squared	0.1760	0.6935	0.2914	0.7874

***, **, and * indicate the level of significance at the 1%, 5%, and 10% level. Numbers in parentheses represent t-statistics. F.test is Fisher's test of the significance of the sum of the coefficients and the numbers in parentheses represent the value of Fisher's statistic. Definition of variables: ΔNPL=annual variation in the ratio of non-performing loans to total net loans, ΔRWA=annual variation in the ratio of risk-weighted assets to total assets, UNDER=1 if the risk-weighted capital ratio CAR<10% and 0 otherwise, AD=1 when CAR is between 10% and 12% and 0 otherwise. ΔCAP=annual change in capital over total assets. TA=logarithm of total assets, EFF=total bank costs on income generated, GDP=the growth rate of gross domestic product

Table 8: Analysis with Δ*R*WA in explanatory variables

Variables	ΔNPL
Δ*RWA*	0.002 (0.14)
UNDER (α_1)	0.033 (1.05)*
AD (α_2)	−0.001 (−0.07)
Δ*CAP* (α_3)	0.013 (0.170)
Δ*CAP*UNDER* (α_4)	0.007 (0.01)
Δ*CAP*AD* (α_5)	−0.076 (−0.58)
TA (α_6)	0.008 (1.03)*
EFF (α_7)	−0.048 (−4.190)***
GDP (α_8)	0.0001 (0.06)
F. test : $\alpha_3+\alpha_4=0$	0.02 (0.10)
$\alpha_3+\alpha_5=0$	−0.063 (0.314)
Observations	404
R−squared	0.068

***, **, and * indicate the level of significance at the 1%, 5%, and 10% level. Numbers in parentheses represent t-statistics. F.test is Fisher's test of the significance of the sum of the coefficients and the numbers in parentheses represent the value of Fisher's statistic. Definition of variables: ΔNPL=annual variation in the ratio of non-performing loans to total net loans, ΔRWA=annual variation in the ratio of risk-weighted assets to total assets, UNDER=1 if the risk-weighted capital ratio CAR<10% and 0 otherwise, AD=1 when CAR is between 10% and 12% and 0 otherwise. ΔCAP=annual change in capital over total assets. TA=logarithm of total assets, EFF=total bank costs on income generated, GDP=the growth rate of gross domestic product

7. CONCLUSION

In this study, we examined the interplay between regulations, changes in capital, and bank risk-taking. Based on well-developed theoretical considerations, we have limited our investigation on regulations to capital requirements. An important result is that the impact of capital changes on risk taking depends on the bank's ex ante regulatory capital level. In terms of supervisory perspective, our insights suggest that the capital adequacy guidelines for Islamic banks should be strengthened to reflect their specific risks exposures. Our research analyzes the behavior of a sample of Islamic banks and examines research topics previously little treated. However, the extension of this sample to all Islamic financial institutions for a longer period of time is greatly appreciated.

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