The Relationship Between Capital Regulation, Risk and the Performance of Banks Operating in the MENA Region

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Abstract: This study is made up of 222 operating banks from MENA countries. We estimate a dynamic model in panel data. The Purpose of this study is to measure the efficiency of the banking industry in the Middle East and North Africa (MENA) region, to see the performance of its banks, and to investigate its effect on capitalization and risk. Moreover, to present new data on the MENA regions relationship between capital, risk and efficiency. In this study the enforcement of capital specification makes an improvement in the capital of banks, but this observational study as theoretical work, leads to conflicting results about the effect of these requirements on risk- taking. Also investigate that the risk-taking behavior of banks did indeed depend on the level of capital initially held.

Keywords: Bank regulation, Capital, Risk, Efficiency, Performance of banks.

INTRODUCTION

Banking sector is a sector and segment of the economy committed to holding other people's financial assets and spending those financial assets as a leveraged way of producing more assets. The field also covers the regulation of banking activities by government authorities, insurance, mortgages, investor services, and credit cards. There are many similarities between the banking sectors in the MENA region, but they are also very different from one another. There are also massive differences between countries within the region in terms of population, and financial growth. In each bank there is an option of facing risk, and bank risks may be market risk, operational risk, liquidity risk, and credit risk. But banks should have a plan and ways to skip and face any kind of risk it may faces. Investigation on whether bank capital impacts bank risk and efficiency positively or negatively.

Banks have additional regulations because they vary from all businesses of all sorts. Moreover, banks have characteristics which force to be regulated some of these characteristics: financial fragility, contingency, systemic risk and social cost.

Restrictions on banking activities stem from the fact that banks allowed to engage in broad range of activities might get involved in complex or risky activities and investments that are difficult to monitor, and accordingly this would raise conflict of interest issues and moral hazard problems (Boyd J. H, 1998). Accordingly, higher regulatory restrictions are effective at reducing banking risk. Additionally, Fotios, P., et al (2009) found that banks permitted to offer a limited set of services usually end up gaining expertise and specialization in those specific market segments that is then translated into higher profits. However, James, B. et. al. (2004) argued that higher restrictions on banking activities are associated with higher probability of banking crisis and lower probability of banking sector development and stability, and Fotios, P., et al (2009) found that lower regulatory restrictions allow banks to exploit economies of scale and scope and increase cost efficiency but not necessarily increasing profit efficiency especially if the banks were not able to successfully manage its diverse set of financial activities.

In the determination of bank capital and risk levels, capital regulation functions as an external power. Changes in the regulatory structure will affect the decisions of banks. Regulation tends to effectively influence capital and risk decisions, although studies can differ according to factors such as time period, region, and the form of capital examined.

In this study, we will examine by more than one method the impact of capital regulation on risk and performance of the banks. We also seek to study the relationship between risk, efficiency and capital of commercial banks operating in the MENA region. Hence, there are many questions that should be answered: What is the relation between capital, risk and efficiency? How does performance takes place in MENA banking sector? What effect the risk of banks? How and why did these banks regulate? In which way capital regulation influence risk- taking in banks?

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1. LITERATURE REVIEW

Bank efficiency plays an important role in the relationship between capital and banking risk. It impacts capital and risk and it is shown as one of the driving factors. On the other hand, capital regulation and risk- taking informed by it has an effect on efficiency. There are many studies and reports shows the effect of capital, and operating efficiencies on bank risk.

It is expected that capital and risk are positively related. In addition, the degree of bank's efficiency often affects capital and risk. Regulators are likely to encourage more leverage to be used by and effective bank with better management than by an ineffective bank.

1.1. Impact of Regulatory Pressure on Bank Capitalization and Risk Taking

A whole section of the empirical literature seeks to assess the effect of the implementation of capital requirements on risk taking and bank capitalization. These studies are based on the econometric specification developed by Shrieves and Dahl (1992).

In their study, Shrieves and Dahl (1992) showed a positive relationship between changes in risk-weighted assets and changes in capital. They inferred that regulatory pressure contributes to increasing capital and reducing risk-weighted assets of undercapitalized banks.

The results of Jacques and Nigro (1997), based on a methodology similar to that of Shrieves and Dahl (1992), suggested that risk-based capital requirements have led banks to increase their capital ratios and reduce their portfolio risk.

Aggarwal and Jacques (1998) and Aggarwal and Jacques (2001), in line with the work of Shrieves and Dahl (1992) and Jacques and Nigro (1997), highlighted a negative relationship between variations in risk and variations in capital. However, when the measure of risk is the ratio of risk-weighted assets, the relationship between changes in risk and changes in capital is positive. Thus, the relationship between changes in risk and changes in capital is ambiguous. Jokipii and Milne (2010) showed that the short-term adjustments between capital and risk depend on the amount of excess capital held by the bank. The relationship between capital and risk adjustments is negative for banks that hold excess capital close to the regulatory minimum. These banks either increase their excess capital by reducing their risk or adopt a so-called resurrection betting strategy by taking excessive risk in order to increase their excess capital. Conversely, the relationship between capital and risk adjustments is positive for well-capitalized banks.

Empirical work on the link between risk taking and capitalization in the presence of capital regulation for European banks is not numerous. Rime (2001) studied the effect of capital requirements on the behavior of Swiss banks. He does not find a significant relationship between changes in the risk-weighted capital ratio and risk-taking, while a positive relationship between changes in the ratio of unweighted capital to total assets and taking risk is highlighted.

Bichsel and Blum (2004) found that banks increase their risk taking when increasing capital. However, the capital increase has no significant impact on the probability of bank default. The increase in capital is exactly offset by the increase in risk so that it does not affect the probability of bank default. Lee and Hsieh (2013) discovers that when increasing capital it progresses profitability and make the risk decreases. They conclude that the moral hazard hypothesis may describe the negative interaction between capital and risk, whereas the positive correlation between capital and profitability can be understood under the hypothesis of structure-conduct-performance. Ediz, Michael and Perraudin (1998) find that capital requirements lead banks to increase their capital ratio. These authors therefore demonstrated that capital requirements strengthen the stability of the system without constraining the asset choices of UK banks.

A study was conducted by Bougatef and Mgadmi on 24 operating banks in MENA region. The results showed that prudential regulations fail to reduce the incentives for risk-taking by banks and to raise capital. They also find that bank profitability is positively related to the degree of capitalization, indicating that the underdevelopment of MENA countries' financial markets causes banks to focus more on internal resources to build their capital buffers. Also a clear negative relationship between the size of bank and risk.

1.2. Relationship between Capital, Risk and Banking Efficiency

Some of the empirical literature on the link between capital and risk incorporates efficiency into the analysis. Hugues and Moon (1995) and Hugues and Mester (1998) and more recently Fiordelisi et al. (2010) argued that capital and risk tend to be influenced by the level of banking efficiency. Thus, Berger and DeYoung (1997) jointly studied these three variables by measuring risk, capital and efficiency respectively by the ratio of non-performing loans, the ratio of equity to total assets and cost efficiency. They showed that an increase in non-performing loans generally leads to a reduction in banking efficiency. Likewise, a decrease in efficiency leads to an increase in non-performing loans. Finally, for banks with low capital ratios, an increase in non-performing loans is usually preceded by a decrease in capital ratios.

Altunbas et al. (2007) find a positive relationship between capital and risk for commercial banks and savings banks while the reverse relationship is found for cooperative banks. They also found a negative relationship between capital and risk for the most efficient banks.

The empirical studies presented above generally show that the implementation of capital requirements allows an increase in the capital of banks. But this empirical work leads to mixed conclusions regarding the impact of these requirements on risk taking, like the theoretical work.

Mongid et al. (2012) investigate the relationship between risk, capital and inefficiency.

Assessment results given by the three-stage least squares (3SLS) strategy uncover a inverse relation between risk and capital proposing that capitalized banks will in general decrease their risk exposure. On the other hand, the risk ends up having a negative yet no significant effect on capital. The impact of capital-based regulation on Bank is of considerable interest given its importance on financial stability. As men-

tioned previously, the results of theoretical and empirical emphasize on this subject remain diversified. Capital regulations may encounter indirect incentive effects such as reducing the effort made by banks in terms of project selection and supervision. It can also encourage banks to select the riskiest assets to offset the loss of profitability resulting from reduced leverage. Thus, it can, through certain conditions, leads to an increased risk of failure. Conversely, other conditions may lead banks to reduce their risk-taking by following certain capital requirements.

We noted that there isn't specific consensus in the literature on the impact of capital requirements on banks' risk taking. This question is essential in terms of public policy, especially in a context where the regulator seeks to reform the regulation of capital following the crisis which affected the banking sector.

Lemonakis, C., Voulgaris, F., Vassakis, K., & Christakis, S. (2015) showed that there is a positive relationship between capitalization and efficiency and profitability, but capitalization is related to size negatively. While this study finds that there is a negative relationship between risk and efficiency. They also used EGLS econometric model to investigate the impact on capital and Z-score of examining banks. It results a strong positive relationship between capital, efficiency, and stability.

A study by M. Bitar, W. Saad, and M. Benlemlih find that banks with higher capital levels have higher reserves for loan defaults, are more efficient, and are more competitive. For too-big-to-fail banks and banks in countries with good governance, the effect of capital requirements on bank performance and profitability is more significant. Moreover, Basel capital requirements regulation increases bank risk management and improves performance and profitability.

Oteroa, Razia, Cunillc, and Mulet-Fortezaconducted a study resulted a positive relation between economic performance and cost efficiency, while there is a negative influence from market share on former. It also shows that market structure plays an important role for cost efficiency in the banks in MENA. The results also revealed that there is no efficiency difference between conventional and Islamic banks. Finally, as well as adding to the solvency of banks, capital requirements have shown a positive impact on efficiency by supporting laws and regulations such as Basel III.

The study of Colesnic and his colleagues showed that small banks have less negative impact on their technical efficiency and risk management. However, large banks are found to be more flexible during the financial crisis. Therefore, the results further revealed a negative relationship between bank size and technical efficiency (Colesnic et al., 2020). Sarmiento and Galan (2017) shown that size and foreign ownership are vital determinants of efficiency and key characteristics in examining the way changes in risk exposure influence bank efficiency. The results revealed that large and foreign banks have more benefits with high exposure to credit and market risk. As for small and domestic banks, high capitalization levels have a positive relationship with higher efficiency in both costs and profits.

2. METHODOLOGY

This study applies descriptive statistics for both the sample of commercial banks studied; a descriptive statistics study is used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. In addition to generalized method of moments (GMM), a statistical method that combines observed economic data with the information in population moment conditions to produce estimates of the unknown parameters of this economic model. Moreover a fisher test is made on significance of the sum of the coefficient. Granger Causality test is used. It is a predictive hypothesis test for assessing whether one time series is useful for predicting another. The Hausman test is also performed to detect the edogenous variables in regression model.

2.1. Hypothesis Tested

As theoretically shown by Calem and Rob (1999), we first seek to determine whether the impact of variations in banks' risk-taking depending on their level of ex ante regulatory capital. Previous work generally measured the impact of regulatory pressure on bank capitalization and risk-taking following increased capital requirements. To answer this first question, we will analyze the impact of changes in capital on risk taking for heavily capitalized, adequately capitalized and under capitalized banks. Among the under-capitalized banks, we will then distinguish between moderately under-capitalized banks and severely under-capitalized banks. This last distinction makes it possible to verify whether severely under-capitalized banks are betting for the resurrection (gambling for resurrection) by taking more risk following a capital increase, hoping for sufficient profitability. Heavily capitalized banks can also be encouraged to invest in risky assets if they have sufficient capital stock. Conversely, moderately under-capitalized banks may choose to reduce their risk after carrying out a capital increase in order to meet capital requirements.

Hypothesis 1 (H1): Changes in capital lead to different risk-taking behaviors depending on the level of ex-ante regulatory capital of the bank (highly capitalized, adequately capitalized, undercapitalized, moderately undercapitalized or severely undercapitalized).

Hypothesis 2 (H2): Bank efficiency affects the level of risk taken by banks and the bank capital ratio.

Some of the empirical literature on the link between capital and risk incorporates efficiency into the analysis. Hugues and Moon (1995), Hugues and Mester (1998) and Fiordelisi et al. (2010) argue that capital and risk tend to be influenced by the level of banking efficiency. Thus, Berger and DeYoung (1997) jointly study these three variables (risk, capital and efficiency) and show that an increase in non-performing loans generally leads to a reduction in banking efficiency. Likewise, a decrease in efficiency leads to an increase in non-performing loans. Finally, for banks with low capital ratios, an increase in non-performing loans is usually preceded by a decrease in capital ratios.

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2.2. Model variables

2.2.1. Measures of Banking Risk

Several measures of bank asset risks and default risks are used. First, we considered the ratio of risk-weighted assets for total assets (RWA) which is the definition of risk according to the Basel agreements. This measure was used first by Shrieves and Dahl (1992) then by Jacques and Nigro (1997), Aggarwal and Jacques (2001), Heid et al. (2004), Van Roy (2005) and Jokipii and Milne (2010). RWA has been shown to be positively related to risk (Avery and Berger, 1991). This ratio corresponds to the allocation of bank assets between the major asset classes weighted at 0, 20, 50 and 100%. Such a risk measure makes it possible to assess the impact of variations in capital on the reallocations of the banks' portfolio between the different categories of assets.

The share of non-performing loans of total loans is also used as an indicator of loan quality. This measurement was also used by Meeker and Gray (1987), Nejezchleb and Morgan (1990), Shrieves and Dahl (1992) and Aggarwal and Jacques (2001). Unlike the ratio of risk-weighted assets, the ratio of performing loans to loan size (NPLON) is an ex post measure of risk. It has been shown to be a good indicator of future performance problems (Berger et al., 1991). The NPL is used as a complementary measure of risk because it may contain information about changes in risk which *RWA* does not include.

Since the objective of this work is to assess the implications in terms of risk taking of variations in bank capital, we used the variations of the two risk measures (ΔRWA and ΔNPLON).

To test the strength of the results, a 3-year moving average of standard deviation of return on assets (STD_ROA) is also used as a measure of the risk of the asset. Finally, we will determine whether changes in capital affect the risk of default, we will use the logarithm of a measure of default risk $LOG\_Z = Ln\left((100 + M\_ROE / STD\_ROE)\right)$ calculated from the 3-year moving averages of return on equity (M_ROE) and standard deviation of return on equity (STD_ROE).

2.2.2. Bank Capitalization

Like Shrieves and Dahl (1992), we will use the ratio of capital to total assets. The capital (CAP) is composed of elements of Tier1 (equity and reserves) and elements of Tier2 (subordinated debt and hybrid capital. We use the annual variations of CAP defined as ΔCAPIT = CAP (t) -CAP (t-1).

One of the objectives of this work is to determine whether the impact of changes in capital on banks' risk taking depends on the level of ex ante regulatory capital of the bank. To be successfully done, banks are classified into different categories based on the level of the risk-weighted regulatory capital ratio (RAR) of the previous period. The TCR is calculated as the ratio between regulatory capital (Tier1 and Tier2 within authorized limits) and risk-weighted assets. Just like Aggarwal and Jacques (2001) and Rime (2001), banks with a capital ratio of less than 8% the previous year are classified as undercapitalized (UNDCAP). Banks with a capital ratio between 8 and 10% are considered adequately capitalized (ADCAP). Above 10%, banks are qualified as highly capitalized (HIGH). The thresholds used to classify banks are those defined under the early coercive action (PCA) implemented in the United States in 1991.

We will focus more on under-capitalized banks by distinguishing two sub-samples of under-capitalized banks. Certain banks which have risk-weighted capital ratios below 8% (TCR <8) may however meet the requirement on the risk-weighted Tier1 ratio (TIER1 = 4); these banks are classified as moderately undercapitalized (UNDMODCAP). Other banks, on the other hand, may be both undercapitalized in terms of TCR and TIER1 (TCR <8 and TIER1 <4); these banks are considered severely undercapitalized (UNDSTROCAP). These two sub-categories of under-capitalized banks may have different risk-taking behaviors when they vary their capital to meet capital requirements. Severely undercapitalized banks need to increase equity while moderately undercapitalized banks may also increase subordinated debt and hybrid capital.

We calculate five dummy variables corresponding to the three categories (strongly capitalized, adequately capitalized and undercapitalized) and to the two subcategories of undercapitalized banks: (a) D_HICAP for heavily capitalized banks with a TCR = 10; (b) D_ADCAP for adequately capitalized banks with an 8 = TCR <10; (c) D_UNDER for under-capitalized banks with a TCR <8; (d) D_UNDMODCAP for under-capitalized banks with a TCR <8 but a ratio of TIER1 = 4; (e) D_UNDSTROCAP for under-capitalized banks with a TCR <8 and a ratio of TIER1 <4. Over the entire period, the same bank can be classified in different capitalization categories since our classification is made at the beginning of each period.

A set of control variables is introduced into the econometric specifications. We considered a dynamic model by integrating the lagged value (RISK) of one year of the risk variables since one might expect some time dependence. We took into consideration the size of the bank as measured by the logarithm of total assets (SIZE). The efficiency of banks is taken into consideration while studying the relationship between changes in capital and changes in risk. For this reason, we will consider the ratio of bank costs to generated income (EFF). Capital and risk can be influenced by the level of efficiency of the bank (Hugues and Moon, 1995; Hugues and Mester, 1998). Indeed, the regulator can authorize an efficient and well-managed bank to have a stronger debt leverage. Referring to the moral hazard theory, a less efficient bank may tend to take more risk to compensate for its losses in terms of profitability (Altunbas et al., 2007).

Changes in the macroeconomic environment are taken into account through the growth rate of the gross domestic product (GDP) of each country. This variable captures the differences in macroeconomic conditions in the different countries in our sample. If favorable macroeconomic conditions help reduce non-performing loans, banks can take more risk by choosing riskier assets. This is why the impact of the GDP variable on variations in risk is ambiguous.

2.3. Econometric Model

The econometric specification used to test the relationship between risk, capital and bank performance is classified as follow:

$$\Delta Risk_{i,t} = \alpha_1 D\_UNDCAP_{i,t-1} + \alpha_2 D\_AD_{i,t-1} + \alpha_3 \Delta DCAP_{i,t-1} + \alpha_4 \Delta CAP_{i,t} * D\_UNDCAP_{i,t-1} + \alpha_5 D\_AD_{i,t-1} + \alpha_6 CONTROL_{i,t} + \varepsilon_{i,t}$$

Endogeneity issues are suspected in the specifications used. Two tests are carried out to demonstrate the existence of these problems. We first performed a Granger causality test to check whether the past values of changes in capital can precisely explain the risk taking and vice versa. We also considered for this the delays of the three previous years of changes in capital (respectively risk) to explain the current values of risk (respectively changes in capital). It is found that it is the previous indicated values of changes in capital that properly explained the changes in risk-weighted assets (ΔRWA).

We also can indicate, on the one hand, changes in the capital (ΔCAPIT) and changes in non-performing loans (ΔNPLON), as well changes in capital (ΔCAPIT) and the standard deviation of profitability assets (STD_ROA), are mutually explained. A Hausman test is then performed. To perform the Hausman test, we will estimate each of the variables suspected of being endogenous on the set of exogenous variables. For each of these variables, we will determine the calculated value as well as the residuals. Then, we will proceed to estimate the variations in risk on the two components of the variables suspected of being endogenous as well as the exogenous variables. A Fisher test is carried out on the joint significance of the residuals. We have rejected the null hypothesis that the coefficients associated with the residuals are zero for changes in capital (ΔCAPIT), changes in equity (ΔEQ) and efficiency (EFF) for our main measure of risk, namely changes in risk-weighted assets (ΔRWA). These three variables are therefore endogenous.

We also used the method of generalized least moments (GMM) to solve this problem. The approach used here differs from that of most previous work which addresses the problem of endogeneity between capital and risk using simultaneous equations. In this work, we focus on the impact of variations in capital under certain conditions (level of ex ante regulatory capital and type of capital) on risk taking, and not on the relationship between variations in risk and variations in risk capital as in most previous studies. Ayuso et al. (2004), Stolz and Wedow (2005), Jokipii and Milne (2008), Jokipii and Milne (2010) and Fonseca and Gonzàlez (2010) also used the GMM estimator while studying the determinants of excess capital (capital buffer) GMM estimation makes it possible to solve the endogeneity problem by replacing the endogenous variables with instruments such as the lagged values of these variables. Estimated by the GMM are more efficient than those by the least squares (2SLS) in the presence of inter-individual heteroskedasticity, as is the case in this study. We use the estimator of Arrelano and Bover (1995) by taking the lagged values in level of capital CAP t-1 and equity EQ t-1 as instruments of the variables ΔCAPIT t and ΔEQ t respectively. We also used the lagged variable ΔEFF t-1 as the instrument of the variable EFF t and the lagged two-year variable (RISK t-2) as the instrument of RISK t-1.

2.4. Description of Data and Descriptive Statistics

The sample is made up of banks from 17 MENA countries over the period 2011-2019. The data is taken from the Bank Scope Fitch IBCA database which provides annual accounting data for this period for 222 banks operating in the MENA region. The macroeconomic data are taken from the World Bank database. Consolidated data from commercial banks are mainly considered, but when these are not available, unconsolidated data is used. Several criteria were used to build the database. We only use banks that provide information for at least 5 consecutive years. Indeed, we estimate a dynamic model in panel data in which the explained variable and certain explanatory variables are calculated as a first difference (annual variations). Moreover, due to the endogeneity problem, the lagged values of the endogenous variables are used as instruments. It is therefore essential to have a sufficient number of consecutive observations on these variables.

3. EMPIRICAL RESULTS

3.1. Results of Estimates on the Relationship Between Changes in Capital and Changes in Risk

The results of the estimates are shown in table for the three measures of asset risk and the measure of default risk.

The equations are estimated by the generalized method of moments (GMM) according to the method of Arrelano and Bover (1995). The instruments are applied to the variables ΔCAPIT, ΔEQ, EFF and RISK t-1. Since we have exclude the dummy variable D_HICAP as well as the associated interactive variable. Thus, heavily capitalized banks become the benchmark from which we compare the estimated coefficients associated with the other capitalization categories. For specifications (1a-c), the coefficient α_3 measures the impact of changes in capital on changes in risk for heavily capitalized banks. The coefficients associated with changes in bank capital undercapitalized and adequately capitalized respectively ($\alpha_3 + \alpha_4$), ($\alpha_4 + \alpha_5$), α_4 and α_5 representing the coefficients associated with the appropriate interaction terms. Remember that when α_3 and that the coefficient assigned to the interactive term of a category is not significant, then this category does not behave differently from the reference category (highly capitalized banks). We will test the significance of these coefficient sums. The same reasoning applies when considering the specifications successively integrating moderately and severely under-capitalized banks is significant and the coefficient assigned to the interactive term of a category is not significant, then this category does not behave differently from the reference category (heavily capitalized banks). We test the significance of these coefficient sums.

The results highlighted in Tables are consistent with hypothesis H1 according to which the impact of capital adjustments on risk taking depends on the level of ex ante regulatory capital of the bank. For heavily capitalized banks, we found a positive relationship between changes in capital and changes

in asset risk and loan risk (ΔRWA, STD_ROA and ΔNPLON) as expected (positive and significant). This result, shows that heavily capitalized banks invest in riskier assets when they increase their capital. This behavior leads to an increase in the risk of default (LOG_Z), which shows that the negative effect of the increase in risk on the risk of default more than offsets the positive effect of the capital increase. The results also indicates that adequately capitalized banks do not behave any differently from heavily capitalized banks when considering risk-weighted assets and non-performing loans as a measure of risk. However, an increase in capital is associated with an increase in the standard deviation of return on assets for heavily capitalized banks but not for adequately capitalized banks (significant for STD_ROA but not significantly different from zero). Adequately capitalized banks, which have a higher probability of becoming undercapitalized, should behave more cautiously. But the absence in the majority of countries in the MENA region of an explicit regulatory threshold for these banks could explain this behavior.

For undercapitalized banks (equation 1.a), we can show a negative relationship between changes in capital and changes in asset risk (α_4 negative and significant and negative and (α_3+ α_4) significantly different from zero for ΔRWA). Undercapitalized banks thus seem to adopt a cautious behavior when they carry out a capital increase, in order to comply with regulations. They seek to avoid regulator and/ or market sanctions by rebuilding their capital ratio. However, when we consider the two subcategories of undercapitalized banks, we notice that the reduction in risk following a capital increase is only observed for moderately undercapitalized banks, i.e. those that are undercapitalized only relative to the risk-weighted regulatory capital ratio, TCR (equation 1.b).

In contrast, severely undercapitalized banks seem to adopt a less cautious behavior than undercapitalized banks solely in terms of TCR. Indeed, the coefficient associated with the interactive variable of severely under-capitalized banks α_4 is not significantly different from 0 (equations 1.c for ΔRWA and ΔNPLON). Therefore, there is no deviation from the relationship between variations in capital and variations in the risk of highly capitalized banks which constitute the benchmark. The capital increase leads to an increase in the risk of default of these severely under-capitalized banks (LOG_Z). In line with Calem and Rob's (1999), a conclusion can be made that severely undercapitalized banks tend to bet for the resurrection. They can reallocate their portfolio towards very risky assets with high expected profitability. These banks, which have low averages of TCR and TIER1 respectively 2.48% and 1.59%, may also be confronted with the persistence of negative results due to investments in poor quality projects. These banks seem to be less cautious than undercapitalized banks only in terms of TCR which they are close to the regulatory minimum (the average of their TCR being 7.1%). However, the results for undercapitalized banks both in terms of TCR and TIER1 should be taken with caution as the number of such banks in the sample studied is relatively low.

Regarding the control variables, we generally highlighted a negative impact of dummy variables measuring regulatory pressure on variations in risk-weighted assets as in the empirical studies dedicated to this problem (Shrieves and Dahl, 1992; Aggarwal and Jacques, 2001).

The ratio of banking costs to income (EFF) is positively related to changes in the ratio of non-performing loans (ΔNPLON) and to the standard deviation of return on assets (STD_ROA). An increase in banking costs is associated with greater risk-taking and therefore a higher risk of default (LOG_Z).

Bank size (SIZE) is positively related to risk-taking (ΔNPLON and STD_ROA), which shows that large banks take more risk overall, resulting in a higher risk of default (LOG_Z).

As expected, good macroeconomic conditions (GDP) are helping to reduce the amount of non-performing loans on the bank's balance sheet. In addition, the growth rate of gross domestic product has a positive and significant effect on changes in the ratio of risk-weighted assets to total assets. This result suggests that banks tend to select assets with the highest risk weights such as corporate loans when macroeconomic conditions are favorable.

Table **1**. Empirical Results.

Table 1. Empirical Results.

		Δ*RWA*			**Δ*NPLON***	
	1a	**1b**	**1c**	**1a**	**1b**	**1c**
D_UndCAP α_1	-4,859 (-3,96)***			0,582 (0,379)		
D_UNDMODCAP α_1		-4,075 (-2,78)***			-0,028 (-0,07)	
D_UNDSTROCAP α_1			-12,249 (-2,89)***			0.019 (0.02)
D_AD α_2	-3,217 (-4,80)***	-3,238 (-4,23)***	-2,709 (-3,69)***	-0,127 (-0.34)	-0,091 (-0.36)	-0,050 (-0.29)
Δ*CAP* α_3	1,193	1,075	1,018	0.467	0.365	0.403

	(3.75) ***	(2.86) ***	(3.28) ***	(3.97) ***	(4.09) ***	(4.27) ***
Δ*CAP* * D_Under α_4	-2,573 (-3.85)***			-0,431 (-3.09)***		
Δ*CAP* * D_UNDMODCAP α_4		-2,881 (-3.75) ***			-0,427 (2.97) ***	
Δ*CAP* * D_UNDSTROCAP α_4			-0,047 (-2.79)***			-0,458 (1.08)
Δ*CAP* * D_AD α_5	-0,128 (-0.28)	-0,049 (-0.18)	0,124 (0.26)	-0,327 (-2,19)**	-0,206 (-1.45)	-0,217 (1.37)
RWA_{t-1}	-0,079 (-1.98) **	-0,107 (-1.99) **	-0,125 (2.45) ***			
NPL_{t-1}				-0,176 (-3.78)***	-0,185 (-3.89) ***	-0,129 (3.65) ***
EFF	-0,046 (-1,39)	-0,038 (-1,09)	-0,029 (-0,86)	0.128 (4,98)***	0,113 (4,87)***	0,087 (5,09)**
SIZE	-0,746 (-1,28)	-0,738 (-1,19)	-0,128 (-1,96) **	0.162 (3,78)***	0,109 (2,37)**	0,187 (2,19)**
GDP	0,173 (2,15)**	0,237 (2,20)**	0,311 (2,19)**	-0,265 (-2.97)***	-0,178 (-2.32) **	-0,204 (1,99)**
F – Test: $\alpha_3 + \alpha_4$	-1.374 (-4.86)***	-1.486 (-5.08) ***	0.962 (0.76)	0,077 (1,05)	0,064 (1,30)	0,052 (1,18)
F – Test: $\alpha_1 + \alpha_1 = 0$	1.367 (4.15)** *	0.924 (3.90)** *	0.834 (3.98)** *	-0.072 (-1.57)	-0.085 (-1.54)	-0.062 (-1.07)
J - Statistic	76,208	85,319	90,716	78.358	87.469	91.466
Observations	1554	1554	1554	1554	1554	1554

The coefficients are estimated using the GMM method. (***), (**), (*) indicate the significance of the coefficients respectively at the threshold of 1%, 5% and 10%; the numbers in parentheses represent the t statistics.

F. test is the Fisher test on the significance of the sum of the coefficients, the figures in brackets representing the value of the Fisher statistic.

ΔRWA = Annual changes in the ratio of risk-weighted assets to total assets; ΔNPLON = Annual changes in the ratio of non-performing loans to the amount of net loans; D_UNDER=1 when the risk-weighted capital ratio (TCR) <8% the previous year, 0 otherwise; D_UNDMODCAP=1 when the TCR <8 but the ratio of TIER1 (TIER1)=4; D_UNDSTROCAP = 1 when the TCR <8% and the TIER1 <4 the previous year, 0 otherwise; D_AD = 1 when the TCR is between 8% and 10% the previous year, 0 otherwise; ΔCAPIT = Annual changes in capital over total assets; RWAt-RAW t-1 = Values delayed by one year of the ratio of risk-weighted assets to total assets; NPLON t-1 = Values delayed by one year of the ratio of non-performing loans to the amount of net loans; EFF = Total costs on income generated before provisions and taxes; SIZE = Logarithm of total assets; GDP = Growth rate of gross domestic product.

3.2. Robustness Test

A number of estimates are now made to check the solidity of the results obtained, first by modifying the specifications adopted. We then proceeded to a change of threshold to distinguish adequately capitalized banks from highly capitalized banks. Finally, the estimates are made over two sub-periods. Due to the low number of observations regarding undercapitalized banks in specifications 2a-c, some robustness tests are performed only on specifications 1a-c. Tables of estimates are presented at the end of this section.

3.2.1. One-year Lag in the Reaction of Banks to a Change in Capital

The reaction of banks in terms of risk-taking can take place the year following the change in capital. Banks react differently in terms of risk taking to capital changes. A bank can raise more capital or keep profits in order to boost its capital. By reducing hazardous assets (such dangerous loans) or re-

organizing its present assets, a bank can lower its risk-weighted assets. The banks frequently recapitalize during expansions when profits are plentiful from retained earnings. Higher capital leads to higher capital buffers, thereby reducing the probability of insolvency, is, however, too simple. The reason is that banks might increase their asset risk in response to higher capital requirements, thereby possibly overcompensating the positive effect of the higher capital buffer. To prevent banks from excessive risk-taking, regulators soon tried to link the required capital to the risk of the loan portfolio. A strict regulatory environment forces banks to increase their capital ratio and reduce their risks. At a macroeconomic level, it is therefore preferable that the banking sector, which is considered a key sector, is regulated in such a way that any incentive to take excessive risks, is controlled by the authorities by imposing levels of risk. Holding a capital level above the minimum makes it possible to attract potential shareholders, attract deposits and thus facilitate the refinancing of the bank. This is why the estimates are made by delaying the changes in capital by one year (Tables **2**). The results are generally not significant except for the significant relationship between changes in capital delayed by one year and changes in non-performing loans (ΔNPLON). This result makes sense because non-performing loans are an ex-post measure of risk. Therefore, these results show that the reactions of banks in terms of risk-taking following a change in capital take place in the same year for changes in risk-weighted assets (ΔRWA), the standard deviation of return on assets (STD_ROA) and the risk of failure (LOG_Z) as considered in our specifications 1a-c and 2a-c.

F. test is the Fisher test on the significance of the sum of the coefficients, the figures in brackets representing the value of the Fisher statistic.

ΔRWA = Annual changes in the ratio of risk-weighted assets to total assets; ΔNPLON = Annual changes in the ratio of non-performing loans to the amount of net loans; D_UNDER = 1 when the risk-weighted capital ratio (TCR) <8% the previous year, 0 otherwise; D_UNDMODCAP= 1 when the TCR <8 but the ratio of TIER1 (TIER1) = 4; D_UNDSTROCAP = 1 when the TCR <8% and the TIER1 <4 the previous year, 0 otherwise; D_AD = 1 when the TCR is between 8% and 10% the previous year, 0 otherwise; ΔCAPIT = Annual changes in capital over total assets; RWAt-RAW t-1 = Values elayed by one year of the ratio of risk-weighted assets to total assets; NPLON t-1 = Values delayed by one year of the ratio of non-performing loans to the amount of net loans; EFF = Total costs on income generated before provisions and taxes; SIZE = Logarithm of total assets; GDP = Growth rate of gross domestic product.

Table **2**. Empirical results.

3.2.2. Estimates without Interactive Variables

The role of banks in terms of capitalization and risk-taking should differ according to their level of capitalization. Previous studies were not able to distinguish the impact of changes in capital on risk taking for different categories of banks (undercapitalized, adequately capitalized and heavily capitalized).These regulatory initiatives attempted to limit bank risk-taking, stop bank collapses, and maintain the viability of the deposit insurance fund. A bank with enough capital may afford to take greater risk since it is less likely to fail. It is in a position to recover from a significant capital erosion brought on by loan losses. Maximum risk-taking is often replaced with a far more conservative strategy, where the bank takes on very little risk, while capital grows to a more moderately undercapitalized level. As a bank's capital increases it first takes less risk, then more risk. A deposit insurance premium surcharge on undercapitalized banks induces them to take more risk. An increased capital requirement, whether flat or risk-based, tends to induce more risk-taking by ex-ante well-capitalized banks that comply with the new standard. These studies measured the effect of regulatory pressure on banks' risk-taking through dummy variables constructed according to the bank's level of capitalization. The results of the estimates shown in tables (3) are consistent with those of previous studies. As in previous studies, we found a positive link between changes in capital and changes in risk. Also, regulatory pressure (measured through dummy variables of under-capitalized and adequately capitalized banks) helps reduce variations in risk-weighted assets.

Table 2. Empirical Results.

		Δ*RWA*			**Δ*NPLON***	
	1a	**1b**	**1c**	**1a**	**1b**	**1c**
D_Under $_{t-1}$ α_1	-0,809 (-0,96)			0,983*** (2,793)		
D_UNDMODCAP $_{t-1}$ α_1		-0,573 (0,72)			0,283 (0,57)	
D_UNDSTROCAP $_{t-1}$ α_1			2,249 (1.34)			0.149 (0.29)
D_AD $_{t-1}$ α_2	-0,017 (-0,02)	-0,038 (-0,08)	-0,029 (-0,06)	-0,07 (-0.59)	-0,031 (-0.26)	-0,080 (-0.49)

$\Delta CAP_{t-1}\ \alpha_3$	0,003 (0.05)	-0,035 (-0.036)	-0,005 (0.07)	0.067 (2.95) ***	0.165 (3.79) ***	0.107 (3.87) ***
ΔCAP * D_Under $_{t-1}\ \alpha_4$	0,573 (-0.85)			-0,031 (-0.09)		
ΔCAP *D_UNDMODCAP $_{t-1}\ \alpha_4$		0,781 (1.45)			0,057 (0.97)	
ΔCAP * D_UNDSTROCAP $_{t-1}\ \alpha_4$			0,147 (0.192)			-0,652 (-1.58)
ΔCAP * D_AD $_{t-1}\ \alpha_5$	0,428 (0.35)	0,342 (0.26)	0,324 (0.46)	-0,427 (-0,19)	-0,281 (-1.15)	-0,316 (1.27)
RWA_{t-1}	-0,579 (-4.98)***	-0,504 (-3.87) ***	-0,528 (4.95) ***			
NLP_{t-1}				-0,682 (13.78)***	-0,785 (-10.89)***	-0,623 (12.65)***
EFF	-0,016 (-1,29)	-0,029 (-1,05)	-0,039 (-0,76)	-0.002 (-0,92)	-0,003 (-0,82)	0,047 (-0.26)**
SIZE	-2,406 (5,29)***	-1,738 (-4,18) ***	-3,128 (4,86)***	0.561 (4,78)***	0,507 (3,67)** *	0,587 (3,79)** *
GDP	0,253 (2,19)**	0,339 (2,30)**	0,327 (3,09)**	0,063 (0.97)	0,073 (2.42) **	0,004 (0,93)**
$F-Test$: $\alpha_3 + \alpha_4 = 0$	0.024 (0.06)	0.004 (0.007)	0.002 (0.006)	0,017 (0,015)	0,068 (0,11)	0,024 (0,03)
$F-Test$: $\alpha_3 + \alpha_5 = 0$	0.472 (0.55)	0.724 (1.08)	0.134 (0.02)	-0.092 (-0.157)	0.059 (0.04)	-0.762 (-2.72)
J - Statistic	46,228	45,307	40,823	58.312	57.417	57.402
Observations	1554	1554	1554	1554	1554	1554

The coefficients are estimated using the GMM method. (***), (**), (*) indicate the significance of the coefficients respectively at the threshold of 1%, 5% and 10%; the numbers in parentheses represent the t statistics.

Table 3. Empirical Results.

		Δ*RWA*			**Δ*NPLON***	
	1a	**1b**	**1c**	**1a**	**1b**	**1c**
D_UNDCAP $_{t-1}\ \alpha_1$	-6,823 (-4,96)***			-0,382 (-0,82)		
D_UNDMODCAP $_{t-1}\ \alpha_1$		-6,547 (3,72) ***			-0,581 (-1,35)	
D_UNDSTROCAP $_{t-1}\ \alpha_1$			-5,249 (-3.74)***			-0.247 (-0.39)
D_ADCAP α_2	-3,014 (-3,62)***	-3,039 (-4,78) ***	-2,327 (-3,86)***	-0,215 (-1.09)	-0,139 (-0.76)	-0,122 (-0.54)

Δ *CAP* α_3	1,023 (3.75) ***	-1,041 (-3.66) ***	-0,175 (4.08) ***	0.467 (3.95) ***	0.365 (4.19) ***	0.377 (3.93) ***
RWA_{t-1}	-0,072 (-1.72)*	-0,117 (-1.75) *	-0,128 (4.35) ***			
$PLON_{t-1}$				-0,282 (5.18)***	-0,272 (-6.29)***	-0,237 (5.62)***
EFF	-0,016 (-1,29)	-0,029 (-1,05)	-0,039 (-0,76)	0.102 (3,94)***	0,103 (3,98) ***	0,097 (3.86)***
SIZE	-0,406 (-0,89)	-0,747 (-1,18)	-1,128 (1,68)*	0.761 (3,79)***	0,627 (3,77)** *	0,647 (3,82)***
GDP	0,273 (2,18)**	0,319 (2,32)**	0,307 (2,19)**	-3,027 (-3.95)***	-2,073 (3.82) ***	-1,024 (3,87)** *
J - Statistic	76,832	85,143	87,861	88.392	97.675	87.492
Observations	1554	1554	1554	1554	1554	1554

CONCLUSION

The objective of this research was to assess the relationship between capital regulation, risk taking and the performance of banks operating in the MENA region over the period 2011-2019. First, it consisted in taking into account the level of ex-ante capital of each bank given that risk-taking behavior can be different depending on whether banks are initially sufficiently capitalized or not. It was also essential to distinguish between the different components of regulatory capital (equity, subordinated debt and hybrid capital) because the holders of these financial instruments have different requirements in terms of the bank's risk taking. Finally, we successively considered the risk-weighted and unweight capital ratios.One of the originalities of our work therefore consisted in differentiating banks according to their initial level of capital. The second contribution of this first empirical work was to separately consider the impact of the different elements admitted in regulatory capital on banks' risk taking. Risk-taking behavior can therefore depend on these different components that can be used by banking institutions to increase their capital. Indeed, owners of equity generally prefer relatively riskier investments. Creditors holding subordinated debt have strong incentives to monitor banks' risk-taking and discipline their behavior. In the event of bankruptcy, these creditors are not protected by deposit insurance. However, in the event of severe banking difficulties, creditors holding subordinated debt securities may be in favor of a very risky strategy which, if successful, would allow them not to lose their investments. Hybrid capital is the third type of capital considered in this study and exhibits both capital and debt characteristics. Holders of these securities may have different risk-taking requirements from the bank.

The results first revealed that the risk-taking behavior of banks did indeed depend on the level of capital initially held. Heavily capitalized banks take more risk when increasing capital. Moderately undercapitalized banks reduce their risk taking following a capital increase. As for the severely undercapitalized banks, they seem to be betting for the resurrection by adopting risky behavior. We then show that the risk-taking behavior of banks depends, in addition to the level of ex ante regulatory capital, on the capital component (equity, subordinated debt and hybrid capital) used by the bank. Heavily capitalized and adequately capitalized banks choose to take more risk when they increase equity or subordinated debt. Moderately under-capitalized banks adopt a prudent behavior by reducing their risk-taking when increasing equity capital, whereas an increase in second-tier capital items (subordinated debt and hybrid capital) does not lead to a decrease in risk. Finally, banks facing severe difficulties (severely under-capitalized) seem to behave at risk regardless of the component of capital used.

These results allow two main lessons to be drawn. First, the establishment in Europe of several explicit thresholds to classify banks according to their capital ratios would make it possible to rigorously establish the conditions for a graduated intervention by the supervisor in the event of banking difficulties and would minimize the very risky behavior of banks in financial distress. Second, the results support a tighter definition of regulatory capital by strengthening equity and reducing the importance of hybrid debt and capital instruments.

However, the studies carried out in this research have used the banking systems of MENA countries as a framework. Analyzes carried out on the banking systems of other developed countries, emerging and developing countries could make it possible to give an international dimension to the results highlighted. This paper also focused on the microeconomic aspects of prudential regulation and did not focus on the macro-prudential aspects which, moreover, remain very important. Macro prudential regulation aimed primarily at avoiding sharp fluctuations in bank credit growth should help reduce procyclicality between the banking sector and the real economy. Also, transactions between institutions on

complex products led to an amplification of the crisis, which shows the importance to be given to systemic risk. Institutions whose failure poses a systemic risk should receive special regulatory treatment. Macro-prudential regulation is therefore an essential complement to micro-prudential regulation.

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Received: Dec 15, 2022 Revised: Dec 21, 2022 Accepted: Dec 30, 2022