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Abstract

Using a two simultaneous equations model, we analysed the impact of capital requirements on bank risk-taking at Lebanese banks. Using a panel data set of 41 commercial banks between 1996 and 2008, we found that higher capital requirements are associated with increase in risk. We also found a positive correlation between bank profitability and increase in capital, which suggests that Lebanese banks rely on retained earnings to meet capital requirements. The competitive pressures seem to have no impact on bank capitalisation or bank risk-taking. Our findings showed that larger banks tend to hold lower capital and have better capability to control risk, mainly through diversification. Finally, we observed that funding decisions are correlated with risk-taking.

Keywords: Bank capital; Capital regulation; Banking risks.

1. Introduction

Banks are highly levered firms, and the nature of their leverage is unique in the sense that a substantial portion of bank debt is "demandable" (i.e., the bank deposits) and is also part of the economy's payments system. Besides, banks are the most important financial intermediaries, which results from their role as providers of payments, loans and deposits, and as producers of information.

Consequently, bank regulators monitor and constrain bank risk-taking, place limits on banks' investment activities and production plans, and even have the power to remove bank managers and revoke bank charters. The regulatory process aims to guard the interest of depositors, who are not explicitly protected by the standard covenants of debt contracts. Similarly, this regulatory process protects the deposit insurer and insures the safety and continuity of the payments system. That is why banking is the most regulated industry and bank capital standards are one of the most important aspects of this regulation. In 1980s, international efforts to harmonise capital standards emerged, and the international meeting of bank capital regulation started with the 1988

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Basel Accord on capital standards. This Accord has spread the use of Risk-based Capital ratios to ensure the soundness of banks and to trigger (when necessary) regulators' intervention.

Capital regulation was provoked by the concern that banks may hold capital less than what is socially optimal relative to their risk. In this case, regulators can enforce remedial covenants, such as restricting asset growth and certain activities or enforcing the raise of additional capital, which constrain the actions of banks. Because regulatory enforcements impose substantial costs on banks, they provide a vital incentive for banks to limit risk-taking.[1]

This study will examine whether the regulatory tools such as capital adequacy requirements impact bank risk-taking with focus on the Lebanese banking sector, and we expect that the implementation of capital adequacy requirement reduces the probability of insolvency.

The decline of the supervisory control in the Lebanese banking system during the 1980s resulted in a large number of undercapitalised, inefficient, and unstable banks. In 1990, 1991 and 1992 the average equity-to-asset ratio was 1.41%, 1.85% and 2.12% successively. On the other hand, the loan loss provisions-to-gross loan ratios for the same years were about 33%, 27% and 24% successively.

To establish a sound banking system, the central bank of Lebanon decided to take remedies throughout the early 1990s, such as restructuring and reforming the banking system and pushing banks to recapitalise through the implementation of capital adequacy standards. A law passed in November 1991 gave banks that had suffered losses of more than one quarter of their capital, one year to recapitalise otherwise they would be delisted from the list of approved banks. Besides, this law has given the Higher Banking Committee the authority to liquidate insecure banks and allowed the National Institute for Deposit Guarantee to guarantee the deposits of those banks. Another decision has been encouraging the consolidations among banks by the law 192, dated January 1992. The law aimed to facilitate bank M&As through incentives for merged banks. The consolidations among Lebanese banks have decreased the number of commercial banks from 72 in 1992 to 53 in 2010. Consequently, the average size of banks increased from $106 million in 1992 to $2.43 billion in 2010, and the average capital from $2.26 million to $174 million.

In 1993, all banks operating in Lebanon became subject to the capital adequacy standards as implemented by Basel Accord in 1988, and were required to hold a minimum of 8% risk-adjusted capital. In September 1999, these requirements were increased to become 12% by the end of 2001. Additionally, banks have been urged to implement loan follow up and recovery programs and to build provisions according to an efficient classification of risks with the implementation of sound internal controls.

The Lebanese banking sector witnessed deep transformations during the last two decades, and banks that lacked efficiency and were undercapitalised in the early 1990s, possess today a solid capitalisation base and are relatively very efficient.

Nevertheless, the reforms taken by the bank regulatory and supervisory authorities in Lebanon remain insufficient, specifically in terms of credit risks. For instance, the average loan loss provisions-to-gross loans was about 18% in 2000, 24% in 2005, 16% in 2008, and in the doubtful loan-to-total loans ratio in 2009 was 5.6% and 3.9% in 2010, despite the fact that the average equity-to-asset ratio at the end of 2010 was 7.15% and the risk-weighted capital ratio was 13.3%. This persistence of credit risk affects definitely the performance of Lebanese banks and their behaviour regarding the supply of credit.

The regulatory authorities in Lebanon have focused on capital adequacy to guarantee the stability of banking and financial system. Therefore, this study aims to examine the effect of capital requirements on bank risk-taking. It will also try to detect how banks improve their capital ratio when they approach the regulatory minimum, and if increases in capital requirements push banks to decrease (or increase) the riskiness of their assets.

[1] Higher capital requirements may represent entry barriers for newcomers, which would restrict competition and allow existing banks to accumulate power, resulting in a more prudent and less-risky behaviour.

The paper proceeds as follows: in section 2 we present the literature on bank capital and risk. We explain the empirical methodology in section 3. The employed data is illustrated and analysed in section 4. Finally, the empirical results of the paper are presented in section 5.

2. Capital regulation and banking risks

The early studies of Akerlof (1970), Leland and Pile (1977), Diamond (1984), and Diamond and Dybvig (1983), stated that the existence of market imperfections (e.g. transaction costs, information asymmetry, etc...), has led to the emergence of banks as financial intermediaries. The fact that banks finance "illiquid assets" with "liquid resources" makes them particularly vulnerable to the loss of confidence by depositors. This confidence is an unpredictable phenomenon and is managed in an endogenous manner by banks.

The loss of confidence can be a concern for the whole banking system, and if the management of payments system is socially necessary, the intervention of a public agency should be accepted, who, by guaranteeing the deposits, assures the stability of the banking system. But, as soon as there is a form of insurance, certain agents may start to adopt adverse behaviour: they take risks more than they would without insurance and would adopt a risky financial structure, which could lead them to failure.

The analyses of bank failure risk often underline the negative effects of an adverse regulation. Kahane (1977) and Kohen and Santomero (1980) draw attention on the fact that a capital regulation in the form of a simple minimum equity-to-asset ratio could encourage banks to reshuffle their portfolio in favour of more profitable, but also more risky assets. Thus, enforcing such a restricting regulation may be translated into an increase of bank failure risk!

Kim and Santomero (1988) adopted a mean-variance analysis framework[2] to study the effects of capital regulation on the behaviour of banks, in terms of risk and return. They show that a uniform capital regulation is ineffective tool to control bank insolvency risk. The main reason is that it ignores the individual preferences of banks and allows them to overcome the restrictions through the financial leverage or the riskiness of assets. The authors suggested eliminating this adverse effect by imposing a capital ratio based on weighting every asset of the portfolio according to its risk. These weights must be defined in a way that makes it impossible for a bank to increase the profitability of its capital by reshuffling its portfolio, since a more profitable asset (and therefore riskier) will have to be financed with more capital.

Nevertheless, the framework adopted by Kohen and Santomero (1980) and Kim and Santomero (1988) had two shortcomings. Firstly, they treated bank capital like any other share, where banks are assumed to buy and sell their own shares at a price independent of their investment strategies. Secondly, the limited liability of bank stockholders was not considered. Rochet (1992) adopted Kim and Santomero (1988) model, taking into consideration these two shortcomings. He firstly found that imposing a minimum fixed capital ratio does not necessarily result in a reduction in bank failure, and he suggested calculating the risk weights according to the systematic risk of each asset (i.e. beta). He also showed that a prudent regulation becomes effective if it combines in a supplementary way, the enforcement of a capital ratio weighted in function of each asset systematic risk, with an additional minimum amount of capital, below which the bank would not be allowed to operate. A last shortcoming of Kim and Santomero model is that it ignores the value of the implicit option associated with deposit insurance. Keeley and Furlong (1990) showed that this disregard makes the conclusions of Kim and Santomero obsolete, and they suggested adopting a framework in which banks maximise the value of the option associated with deposit insurance. The authors stated that since the marginal value of the option associated with deposit insurance diminishes when debt decreases, an increase in capital requirements reduces the incentive to capture risk.

The fundamental criticism addressed to this part of the literature is its use of the standard theory of options valuation, which is hardly compatible with banking industry. The options theory applied by

[2] The Markowitz two-variable model.

Merton (1977) to deposit insurance is based on the absence of market friction, whereas the existence of banks depends on the presence of such frictions, particularly the information asymmetry (Dewatripont and Tirole, 1994).

Besanko and Kanatas (1996) integrated the information asymmetry into their model by emphasising on the agency problem between bank managers and the external parties such as investors and deposit insurer. Their model assumes that the deposit insurance permits the bank to finance at the risk-free rate and stockholders could benefit from an additional surplus associated with the presence of deposit insurance. The authors show that the regulation of bank capital does not contribute in promoting banking stability and in reducing banking risk.[3] Matutes and Vives (2000), Hellmann et al. (2000) and Repullo (2004) state that capital requirements alone may not be enough and additional regulations could be useful to reduce risk within a competitive environment. For instance, asset restrictions could complement deposit insurance and capital requirements to limit risk-taking when competition is intense.

Blum (1999) analysed the link between bank capital regulation and risk capture in a dynamic framework. The author identifies a sequential effect, which causes an increase in banking risk following the introduction of capital requirement, and the enforcement of a capital level in the future pushes banks to lose important profits in the present. Therefore, if a bank believes it is forbidden to raise additional capital on the capital markets or it is unable of doing so, the only alternative to increase capital in the future is to increase the risk of assets (whose rate of return is higher) today.

The consideration of the bank franchise affects also the effectiveness of bank capital regulation. According to Stiglitz (2001), the increase of capital requirements could be translated into a decrease in the franchise value of the bank. In fact, the capital required to meet the "costly" regulation, results in a decrease in the franchise value and the incentive to capture risk by the bank. Keeleys (1988) studied the relation between risk capture and franchise value of the bank and found that the threat of losing this value disciplines the behaviour of banks. For instance, following the deregulation of banking activities during the 1980s in the United States, the monopoly power of banks diminished as well as their franchise value, which reduced the disciplinary effect of this factor. Claessens and Laeven (2004) observed that lower restrictions on activity lead to more competition, which could have a negative effect on profits and the charter value of banks, encouraging greater risk-taking. Konishi and Yasuda (2004) also found that the implementation of the capital adequacy requirement at the Japanese banks reduced risk-taking as desired by regulatory authorities, nevertheless the decline of franchise values increases risk-taking behaviour of those banks. In a similar context, Agoraki et al. (2011) argue that capital requirements and supervisory power have a direct impact on credit risk, but the stabilising effects of capital regulations diminish when the banks have sufficient market power to increase their credit risk.

Other studies have analysed the link between bank capital regulation and banking risk. The majority of those studies focus on two approaches: the internal models approach and the pre-commitment approach. These two approaches suggest that there is no alternative to grant the risk control responsibility to the bank management and its auditors. The "full models approach" proposes the use of internal models for the regulatory allocation of capital regarding all types of bank risks. Under this approach, the loss density functions estimated for all banking activities using risk quantitative models, determine the regulatory capital. Regarding the coverage of credit risk, capital requirements depend on the estimates produced by VaR models applied to credit risk. The second approach, the pre-commitment, proposed by Kupiec and O'Briens (1997) authorises the bank to disclose its appropriate level of capital (the amount of pre-committed capital). Under this approach, the bank is required to shape *ex post* the level of risk that implies the amount of pre-committed capital, at the risk of being penalised. The penalties imposed by the supervisory authorities can take the form of a monetary penalty, a disciplinary capital charge or other future restrictions on the bank's activities.

[3] They argued that forcing banks to new issuance of equity cause a dilution in management ownership and reduce their incentive to increase the recovery of loans, and therefore to reduce risk.

Rochet (1999) states that the internal models approach and the pre-commitment approach reflect the necessity to take into consideration the decentralised information of individual banks. This means that the paradigm of adverse selection becomes relevant to analyse bank regulation. This vision of the regulatory mechanisms lies on the incentive of disclosure to overcome the problem of information asymmetry. Thus, the internal models approach can be interpreted as a direct mechanism of disclosure in which the bank with certain type of risk must hold a capital level in line with this risk. On the other hand, the pre-commitment approach appears as an indirect mechanism in which the bank, knowing its risk, chooses the capital appropriate to this risk.

Daripa and Varotto (2008) claimed that these two approaches integrate the characteristics of an *ex post* form of banking regulation in contrast to the prudential scheme of Basel Accord, which imposes *ex ante* constraints on risk-taking and forces an exogenous link between risk and capital. The *ex post* regulation authorises the banks to choose their capital and the level of their portfolio risk rather than to impose an *ex ante* constraint on them. According to this approach, the regulatory intervention occurs only if bank's losses are not in accordance with its capital. The authors also state that an *ex ante* regime "wastes the expertise" of banks regarding the assessment of risks and consequently, causes an arbitrage between two types of losses: those related to the safety (insufficiency of capital relative to social optimum) and those resulted from overprotection (excess capital relative to social optimum), both as a function of regulatory losses. The *ex post* regime incorporates completely the bankers private information, but it is more sensitive to problems related to the ignorance of bank managers preferences than the *ex ante* regime. Consequently, the comparison of these two approaches depends on the relative importance of the sources of regulatory uncertainty. If the information of supervisory authorities on risk aversion of bank managers is more (less) definite than their information about risk of the bank portfolio, then an *ex post* regime (*ex ante*) produces weaker regulatory losses. The sensitivity of these two regimes to the different dimensions of information suggests that the combination of these two systems improves the welfare.

3. Methodology

3.1 Model Specification

To evaluate the relationship between capitalisation and banking risk, we use a simultaneous equations model derived from Shrieves and Dahl (1992). In this model, the authors evaluate how banks respond to the requirements imposed by regulators. The model contains two equations whose dependent variables are the capitalisation of the bank and its risk. These two variables are interdependent and vary simultaneously. A change in the capitalisation ratio leads to an adjustment of risk-taking, and similarly, a change in the level of risk provokes the bank to adjust its capitalisation level. An important aspect of Shrieves and Dahl (1992) model is that the changes in capital and risk have two components, one is discretionary (endogenous) and the other is a random shock. The equations are as follows:

$$\Delta CAR_{i,t} = \Delta^d CAR_{i,t} + u_{i,t} \quad (1)$$

$$\Delta RISK_{i,t} = \Delta^d RISK_{i,t} + v_{i,t} \quad (2)$$

where $\Delta CAR_{i,t}$ and $\Delta RISK_{i,t}$ are respectively the observed changes in capital and risk of bank *i* at time *t*, $\Delta^d CAR_{i,t}$ and $\Delta^d RISK_{i,t}$ represent the discretionary adjustments of capital and risk of bank *i* at time *t*. $u_{i,t}$ and $v_{i,t}$ are the random errors.

The optimal levels of capitalisation CAR^* and risk-taking $RISK^*$ that the management of the bank wish to maintain, are assumed to depend linearly on a set of exogenous variables that form the decision process in the bank. It is assumed that the bank aims to achieve – in the long run – these

optimal levels by taking a discretionary adjustment of capital and risk. It is also assumed that the bank cannot instantly achieve the targeted levels of capitalisation and risk-taking but it does this partially. This requires the introduction of two coefficients α and β that represent the parameters associated with the partial adjustment of capital and risk. [4] In this context, the discretionary adjustment of capital and risk are proportional to the difference between the optimal levels the bank wants to achieve in period *t*, and the levels observed in period *t*-1:

$$\Delta^d CAR_{i,t} = \alpha\left(CAR^*_{i,t} - CAR_{i,t-1}\right) + u_{i,t} \quad (3)$$

$$\Delta^d RISK_{i,t} = \beta\left(RISK^*_{i,t} - RISK_{i,t-1}\right) + u_{i,t} \quad (4)$$

where $CAR^*_{i,t}$, $RISK^*_{i,t}$ represent the optimal levels of capital and risk of bank *i* in period *t*. Substituting equations (3) and (4) in (1) and (2), the changes of capital and risk can be written as:

$$\Delta CAR_{i,t} = \alpha\left(CAR^*_{i,t} - CAR_{i,t-1}\right) + u_{i,t} \quad (5)$$

$$\Delta RISK_{i,t} = \beta\left(RISK^*_{i,t} - RISK_{i,t-1}\right) + u_{i,t} \quad (6)$$

The observed changes in capital and risk depend eventually on the optimal levels targeted by a bank, the levels recorded in the previous year, and a set of exogenous factors.

3.2 Definition of capital and risk

The assessment of banking risk is traditionally executed by analysing various key financial ratios (e.g. the ratio of nonperforming loans to total loans, the ratio of provisions for nonperforming loans to total assets, etc...). These variables have been criticised by the empirical literature because they give an *ex-post* estimate of risk, which may be affected by unexpected contingencies or extraordinary events, and are also independent of the bank's attitude towards risk. In addition, the ratios method is not based on any theoretical basis, and even in its most elaborated form, the ratios method does not take into account the impact of diversification on risk. In other words, the ratios method does not take into account the correlation of returns of different assets in the portfolio (Santomero, 1983).[5]

Therefore, we will use the Z-score measure to assess the credit risk and to overcome the shortcomings of the ratios method. This comprehensive measure takes into account both risks related to banking business and the degree of coverage of these risks by the capital (Goyeau and Tarazi, 1992).

The Z-score indicator can be estimated using the probability of default extracted from Roy (1952), Scott (1981), and developed by Goyeau and Tarazi (1992). The probability of default is the probability that losses exceed the equity, or when the net worth becomes negative (Roy, 1952; Blair and Heggestad, 1978; Boyd and Graham, 1986). This may be written as:

Probability of default = $\Pr ob\left(\pi < -E\right)$

It is possible to calculate different indicators of banking risks depending whether we divide the two terms of the inequality by the equity or by the total assets. In the first case, dividing by the equity results in an indicator of risk, Z, in terms of return on equity:

[4] The coefficients α and β are assumed less than the unit, since if α (or β) > 1, then a bank not only reaches its optimal capitalisation ratio, but it also surpasses it.

[5] Santomero (1983) shows that greater interest rate risk-taking allows reducing credit risk.

$$\text{Prob}\left(\frac{\tilde{\pi}}{E} < -\frac{E}{E}\right) = \text{Prob}\left(\frac{\tilde{\pi}}{E} < -1\right) = \text{Prob}\left[\frac{\left(\tilde{ROE} - \mu_{ROE}\right)}{\sigma_{ROE}} < -Z\right] \quad (7)$$

Where $\tilde{ROE}$ is the return on equity, μ_{ROE}, σ_{ROE} are the mean and standard deviation of ROE and $Z = (1 + \mu_{ROE})/\sigma_{ROE}$.

The indicator Z can be considered as an indicator of bank fragility. A higher value of Z corresponds to a lower default risk.

In the second case, dividing by the value of assets results in an indicator in terms of return on assets. It provides an indicator Z', which allows separating explicitly the risk effect from the risk coverage of the bank capital. The probability of default can be written as:

$$\text{Prob}\left(\frac{\tilde{\pi}}{A} < -\frac{E}{A}\right) = \text{Prob}\left(\tilde{ROA} < -\frac{E}{A}\right) \quad (8)$$

where $\tilde{ROA}$ is the return on assets and *A* is the total assets of the bank. If we propose that $\lambda = \frac{E}{A}$, then equation (8) is rewritten as:

$$\text{Prob}\left[\frac{\left(\tilde{ROA} - \mu_{ROA}\right)}{\sigma_{ROA}} < \frac{\left(-\lambda - \mu_{ROA}\right)}{\sigma_{ROA}}\right] = \text{Prob}\left[\frac{\left(\tilde{ROA} - \mu_{ROA}\right)}{\sigma_{ROA}} < -Z'\right] \quad (9)$$

where μ_{ROA} and σ_{ROA} are the mean and standard deviation of ROA and $Z' = \frac{(\lambda + \mu_{ROA})}{\sigma_{ROA}}$ is the indicator of fragility.

The indicator Z' can be decomposed as follows: $Z' = Z'_1 + Z'_2$, where $Z'_1 = \mu_{ROA}/\sigma_{ROA}$ and $Z'_2 = \lambda/\sigma_{ROA}$ The indicator Z'_1 is a measure of risk frequently used in the banking literature. It takes into account both the volatility of returns and the level of returns. The indicator Z'_2 reflects the coverage capacity of bank capital for a given level of risk. This indicator will be used as a proxy for the risk of Lebanese banks.

Regarding capitalisation level, we will use two ratios to proxy for bank capital. The first ratio is defined as the equity-to-total asset ratio (CAR),[6] and the second is the bank equity divided by the risk-weighted assets (CARW).[7]

3.3 Variables Specifications

The targeted levels of capital and risk (CAR^* and $RISK^*$) presented in equations (5) and (6) must be adequately approximated. To do this, we will incorporate the variables that influence either the capital or the risk-taking at the same time.

3.3.1 Bank profitability

Bank profitability is measured by the net income-to-total asset ratio (*ROA*). The theoretical and empirical studies indicate a positive relationship between bank profitability and capital.

[6] This ratio was used by Shrieves and Dahl (1992) and Rime (2001).
[7] This ratio was used by Jacques and Nigro (1997), Ediz et al. (1998), Aggarwal and Jacques (2001), and Rime (2001).

3.3.2 Size

Shrieves and Dahl (1992), Aggrawal and Jaques (2001) and Heid et al. (2003) indicate that the size of a bank influences the level of chosen capital. The larger the size of the bank (*SIZE*), the easier it is to raise the required funds on the capital markets. As a result, large banks choose a target capitalisation level lower than the smaller ones. Additionally, a large bank is expected to diversify its assets better than a small bank, which reduces its credit risk (*RISK*). Therefore we expect a negative relationship between *SIZE* and *RISK*.

3.3.3 Provisions for loan losses

Provisions for loan losses (*LLP*) will be exploited in our estimations. The relationship of this variable with risk-taking depends on the definition of credit risk (Rime, 2001; Heid et al., 2003; Cannata and Quagliariello, 2006). Provisions are used either to cover the losses already recorded and written-off of total loans,[8] or to cover (future) expected losses, leading to a positive relationship between the amount of bad loans and the provisions for loan losses. Given the nature of the indicator of risk-taking adopted by this study, we expect a positive relationship between *LLP* and *RISK*.

3.3.4 Net interest margin

The development of net interest margin reflects the competitive circumstances of banks. Accordingly, the variable *SPREAD* measuring net interest-to-total assets is exploited. A tightening of margins caused by an increase of competition undermines the competitiveness of the bank and reduces its franchise value. In these circumstances, banks may adopt a risky behaviour that results in a reduction in capitalisation and/or a decrease in the quality of granted loans.

3.3.5 Regulatory pressure

Regulatory pressure is among the most important factors that influence capitalisation level and risk-taking of banks. This variable detects whether banks subject to minimum capital standards, feel "threatened" by regulatory constraints, which force them to boost their capital and/or reduce their risk. If at the end of year *t*, a bank *i* reports a solvency ratio (*CAR*) below the regulatory minimum $\left(Min_{REG}\right)$, to which we add the standard deviation of this solvency ratio $\left(\alpha_{CAR}\right)$, then it is likely that during the following year (*t*+1), the bank will be subject to disciplinary actions from its supervisor. More precisely, in year *t* and for bank *i*, the variable *REG1* is defined as follows:

$$\begin{cases} REG1_{it} = 0, & \text{if } CAR_{i,t} > MinREG + \alpha_{CAR} \\ REG1_{it} = \left(Min\left(REG\right) + \sigma_{CAR}\right) - CRA_{i,t} & \text{if } CAR_{i,t} > MinREG + \alpha_{CAR} \end{cases}$$

In fact, this is the most common measure because it incorporates the volatility of bank capital among the determinants of regulatory pressure (Heid et al., 2003; Van Roy, 2005; Cannata and Quagliariello, 2006), and implicitly considers that the increase in equity is costly for a bank. Therefore, the bank prefers to hold a capital in excess of the minimum required, especially if its equity is volatile. The more a bank covers this volatility by excess capital, the less it feels threatened by the penalties of the supervisor.

In sum, we estimate two simultaneous equations which are linked by the two variables *CAR* and *RISK*, with a set of exogenous variables. For bank *i* in year *t*, the structural form of the model is:

[8] This results in a decrease in risk weighting.

$$\Delta CAR_{i,t} = \alpha_0 + \alpha_1 ROA_{i,t} + \alpha_2 SIZE_{i,t} + \alpha_3 SPREAD_{i,t} + \alpha_4 \Delta RISK_{i,t} + \alpha_5 CAR_{i,t-1} + \alpha_6 REG_{i,t-1} + \varepsilon_{i,t} \quad (10)$$

$$\Delta RISK_{i,t} = \beta_0 + \beta_1 LLP_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 SPREAD_{i,t} + \beta_4 \Delta CAR_{i,t} + \beta_5 RISK_{i,t-1} + \beta_6 REG_{i,t-1} + \upsilon_{i,t} \quad (11)$$

The model could be estimated using the two- or three-stage least squares methods. The estimators of the simultaneous equations will take into account that the error terms of the structural equations are correlated with the endogenous variables. The two-stage least squares (2SLS) is a two step process using the ordinary least squares (OLS). The 2SLS method derives the reduced form of a model from its structural form, whereas the three-stage least squares (3SLS) estimates all the model's parameters at once. This method, defined by Zellner and Theil (1962), takes the two steps of the 2SLS method and incorporates a third step, which applies the Generalised Least Squares to estimate the parameters α_i and β_i simultaneously. The advantage of the 3SLS method is that it takes into account a possible correlation among the error terms of the structural form of the model. However, the 3SLS estimator is fragile against a misspecification of the structure of the equations that form the model. Since the 3SLS estimates all parameters simultaneously, an error in the specification of equations would have an effect that may spread throughout the model, leading to non-convergent estimates for all equations. In contrast, the 2SLS estimator does not suffer such a weakness since it treats the equations one at a time.

4. Data

Our empirical analysis is based on a balanced panel data set of 41 commercial banks operating in Lebanon between 1996 and 2008 (i.e. over a period of 13 years). The data set contains commercial banks only to obtain a homogeneous sample. Bank financial data are extracted from the international banking database Bankscope BVD-IBCA, which provides individual time series (i.e. per bank). This database provides annual financial data (balance sheet and income statement) for a sufficiently representative sample of Lebanese banks.

Table 1: Descriptive Statistics (in percentages)

	ROA	**LLP**	**CAR**	**CARW**	**Z-score**	**SPREAD**
Mean	1.20	17.29	8.56	24.77	17.51	3.50
Min	-2.98	0.00	0.18	8.11	-0.46	1.39
Max	4.37	69.71	25.50	69.69	51.60	7.77
SD	0.01	0.16	0.11	0.14	12.30	0.03
CV	1.27	0.77	1.05	0.59	0.70	0.81
Mean	0.74	20.21	10.79	24.24	21.12	3.18
Min	-2.00	2.72	2.87	8.53	1.79	0.57
Max	3.60	81.23	67.28	69.45	107.31	12.90
SD	0.01	0.16	0.11	0.14	19.08	0.03
CV	1.27	0.77	1.05	0.59	0.90	0.81
Mean	1.10	13.44	12.53	28.03	22.91	2.31
Min	-2.52	0.00	-6.77	0.00	-2.62	-0.62
Max	5.39	77.11	67.22	57.89	88.85	5.32
SD	1.18	18.01	12.95	32.27	18.63	1.03
CV	1.08	1.34	1.03	1.15	0.81	0.45
# of banks		41				
# of observations		533				

Table 1 presents the descriptive statistics for the variables for three years (1996, 2001, and 2008) for comparison purposes. We perceive that the capitalisation level represented by CAR has increased over the studied period from 8.56% in 1996, to 10.79% in 2001, and to 12.53% in 2008. CARW also increased from 24.77% in 1996 to 28.03% in 2008. These figures show that Lebanese banks have boosted their capital in line with the instructions of the central bank. On the other hand, LLP increased from 17.29% in 1996 to 20.21% in 2001, but decreased to 13.44% in 2008. Z-scores increased from 17.51% in 1996, to 21.12% in 2001, and to 22.91% in 2008. A final interesting remark is that SPREAD decreased from 3.5% in 1996 to 2.31% in 2008, which reflects the competitive pressures on Lebanese banks, which resulted in lower interest margins.

5. Empirical results

The regression outputs are presented in Table 2 and Table 3. Table 2 presents the estimations using ΔCAR as dependent variable, whereas Table 3 presents the estimations using ΔCARW as dependent variable. Despite the fact that the presented models are overall significant (shown by their F-statistics), the models presented in Table 2 have a much higher explanatory power since they generate higher adjusted R-squared. Looking at the individual variables, we obtain the following conclusions.

The empirical results show that ROA is positively and significantly (at the 1% significance level) correlated to the changes of both CAR and CARW.[9] This suggests that Lebanese banks rely heavily on their retained earnings to raise capital rather than issuing new securities. This could be due to the undeveloped financial market in Lebanon and/or the ownership nature of Lebanese banks, which is family owned to a large instinct. On the other hand, ROA has a positive correlation with RISK in Table 2 (when ΔCAR was used as depended variable), whereas it has a negative correlation with RISK in Table 3 (when ΔCARW was used as depended variable). This contradiction does not allow concluding the effect of profitability on banking risk and whether profitable banks tend to implement riskier behaviour or not.

Regarding SIZE, the estimation results show a strong negative correlation between the size of banks and the change in capitalisation and the change in risk. The relationship between SIZE and the change in capital could be due to many factors: (1) larger banks in Lebanon are more profitable and therefore, can rely on their internal sources of funding, (2) large banks have easier access to (local and/or international) financial markets to raise funds when necessary, (3) smaller banks are "forced" to exceed the minimum capital required by regulator (i.e. having additional buffers) to attract the depositors, and (4) larger banks hold lesser capital based on the too-big-to-fail doctrine. Therefore, large banks tend to hold the minimum "costly" capital, whereas smaller banks tend to surpass this minimum capital as a sign of safety.

With regard to risk-taking, the negative and significant (at the 1% level) relationship between SIZE and RISK shows that larger banks have lower risk than smaller ones. This result, which is consistent with the findings of Godlewski (2005) and Murinde and Yaseen (2004), demonstrates that large banks have better capability to manage their risks through diversification.[10]

The relationship between RISK and LLP is negative, but significant only in one model (in Table 3). This may imply that riskier banks do not maintain higher provisions. In other words, banks with low level of risk allocate more provisions than riskier ones.

[9] This result was obtained, among many others, by Jaques and Aggrawal (1998), Rime (2001) and Hassan and Hussain (2004).

[10] Most empirical studies of risk reduction through diversification done on U.S. and European banks (e.g. Boyd and Graham, 1986; Brewer et al., 1988; Stahan and Demsetz, 1997; Bhargava and Fraser, 1998; Laderman, 1999; De Jonghe and Vennet Baele, 2007) demonstrate that the combination of non-traditional banking activities and traditional activities reduces bank risk.

Leland and Pyle (1977), Karacaw and Campbell (1980), Diamond (1984) and Ramakrishnan and Thakor (1984) show that moral hazard and risk decrease with the size of the financial intermediary, and disappears completely if the bank is well diversified.

The empirical results do not show a strong effect of interest margins on both capital and risk. Thus, the competitive pressures do not impact the behaviour of banks and their attitude towards risk.

Table 2: Estimation Results of Simultaneous Equations with CAR

	ΔCAR	**ΔRISK**
C	0.11*** (3.83)	2.45* (1.75)
ROA	0.12*** (3.18)	-12.02*** (5.85)
SIZE	-0.009** (2.40)	-0.24** (1.98)
LLP		-0.006** (1.98)
SPREAD	0.03 (1.20)	5.03 (1.17)
REG	-0.001 (1.04)	0.25* (1.84)
ΔRISK	0.006*** (4.80)	
CAR(-1)	0.11*** (3.19)	
ΔCAR		3.06** (2.21)
RISK(-1)		0.05*** (3.31)
Adj. R^2	0.92	0.93
F-statistic	140.27	150.82
Prob. (F-stat.)	0.0000	0.0000

***Notes*:**
Standard error in parentheses.
*** Significantly different from zero at the 1% level.
** Significantly different from zero at the 5% level.
* Significantly different from zero at the 10% level.

Regarding the effect of regulation on bank capital, the results show that indeed, the regulatory pressures lead to improve in capitalisation. This effect is positive and significant at the 5% level on CARW. This shows that when capital level approaches the regulatory minimum, banks feel obliged to inject more funds to avoid any supervisory restrictions. On the other hand, the estimates show an unexpected relationship between regulatory pressure and risk, since REG and ΔRISK are positively related. This can be interpreted that, ceteris paribus, banks subject to regulatory pressure tend to increase their risk more than other banks. Accordingly, the regulatory pressure (specifically capital regulation) does not result in a decrease in risk-taking by Lebanese banks.

The results presented in Table 2 and Table 3 show a strong link (significant at the 1% level) between capitalisation level and risk, whether we consider the simple capital ratio or the weighted capital ratio. This result supports the theoretical studies of Khan (1986), Koehn and Santomero (1980) and Kim and Santomero (1988), and the empirical studies of Murinde and Yaseen (2004)

and Hussain and Hassan (2005), and suggests that an increase in capital is followed by a more aggressive behaviour by banks.

Table 3: Estimation Results of Simultaneous Equations with CARW

	ΔCARW	**ΔRISK**
C	0.59***	12.74**
	(6.72)	(2.11)
ROA	0.32***	18.78***
	(3.72)	(6.03)
SIZE	-0.01***	-1.57***
	(3.48)	(-3.16)
LLP		-0.006
		(0.71)
SPREAD	-0.13	7.62
	(1.07)	(1.04)
REG	0.01**	0.49**
	(2.56)	(2.15)
ΔRISK	0.002***	
	(4.66)	
CARW(-1)	0.54***	
	(8.21)	
ΔCARW		1.68***
		(2.84)
RISK(-1)		0.47***
		(6.58)
Adj. R^2	0.35	0.39
F-statistic	5.79	6.50
Prob. (F-stat.)	0.0000	0.0000

***Notes*:**
Standard error in parentheses.
*** Significantly different from zero at the 1% level.
** Significantly different from zero at the 5% level.
* Significantly different from zero at the 10% level.

Finally, we detect a strong and positive association between CAR(-1), CARW(-1) and RISK(-1) with both capitalisation and risk. This may confirm that banks that adjust quickly their capitalisation level to the desired optimal level are those who take consequently higher risk. Thus, to optimise the risk-return combination, banks may increase their risk-taking following an increase in capital requirements. So banks tend generally to arbitrate between the decrease in yields resulted from the compliance with regulatory requirements, and the costs associated with regulatory sanctions if they violate these requirements. Consequently, if the contract between regulator and banks takes into consideration an incentive constraint, then the regulatory capital will be a mechanism encouraging banks to be more prudent. But in certain circumstances, the considerations that lead banks to take excess risk dominate. Thus, the compliance with regulatory requirements may fail if the bank observes a decrease in the expected (future) profits, following an increase in capital and if the cost of loan monitoring is rather high (Kopecky and VanHoose, 1996; Blüm, 1999).

6. Conclusion

Using a model with two simultaneous equations, we analysed the relationship between capital requirements and banking risk. Using a sample of 41 Lebanese commercial banks for the period 1996-2008, our empirical findings showed that in general, higher capital requirements are followed by an increase in risk. Low risk aversion of banks, or the weak incentive of regulatory requirements, may explain this result.

We found also a positive relationship between profitability and the change in capital, which imply that Lebanese banks rely on the internal source of funding to meet capital requirements. On the other hand, we didn't find a significant relationship between profitability and risk. The competitive pressures that squeeze interest margins also seem to have no impact on capitalisation or risk-taking.

Our findings showed that larger banks tend to hold lower capital and have better ability to control risk than their smaller counterparties. Finally, the decisions of funding and risk-taking are interrelated, and our results show a significant correlation between funding levels and risk with their optimal or desired levels.

References

[1] Aggarwal, R., and Jacques K., 2001. "The impact of FDICIA and prompt corrective action on bank.capital and risk: Estimates using simultaneous equations model, *Journal of Banking and Finance*, 25, pp. 1139-1160.

[2] Agoraki, M.E, Delis, M., and Pasiouras, F., 2011. "Regulations, Competition and Bank Risk-taking in Transition Countries, *Journal of Financial Stability*, 5, pp. 38-48.

[3] Akerlof, G.A., 1970. "The Market of Lemons: Quality uncertainty and the market Mechanism, *The Quarterly Journal of Economics*, 84, pp. 488-500.

[4] Besanko, D., and Kanatas, G., 1996. "The Regulation of Bank Capital: Do Capital Standards Promote Bank Safety?", *Journal of Financial Intermediation*, 5, 160-183.

[5] Blair, R. D., and Heggestad, A., 1978. "Bank portfolio regulation and the probability of bank failure", *Journal of Money Credit and Banking*, 10, pp. 88-93.

[6] Blüm J.M., 1999. "Do capital adequacy requirements reduce risks in banking?", *Journal of Banking and Finance*, vol. 23, pp. 755–771.

[7] Boyd, J.H., and Graham, S.L., 1988. "The profitability and risk effects of allowing bank holding companies to merge with other financial firms: a simulation study, *Federal Reserve Bank of Minneapolis, Quarterly Review*, 10, pp. 2-17.

[8] Campbel, T., and kracaw, W., 1980. "Information production, market signalling and the theory of financial intermediation", *Journal of Finance*, 35, pp. 863-882.

[9] Cannata, F., and Quagliariello, M., 2006. "Capital and risk in Italian banks: A simultaneous equation approach", *Journal of Banking Regulation*, 7, pp. 283-297.

[10] Claessens, S., and Laeven, L., 2004. "What Drives Bank Competition? Some International Evidence", *Journal of Money, Credit and Banking*, 36, pp. 563–583.

[11] Daripa, A., and Varotto, S., 2005. "Ex Ante Versus Ex Post Regulation of Bank Capital", *Birkbeck, University of London, School of Economics, Mathematics and Statistics*, BWPEF 0518, pp. 1-51.

[12] Dewatripont, M., and Tirole, J., 1994. "The Prudential Regulation of Banks", *Cambridge, Massachusetts: MIT Press*.

[13] Diamond D. W. 1984. "Financial intermediation and delegated monitoring", *Review of Economic Studies*, 51, p. 393-414.

[14] Ediz T., Michael I., et Perraudin W., 1998. "The impact of capital requirements on U.K. bank behaviour", *Economic Policy Review*, Federal Reserve Bank of New York, pp. 15-22.

[15] Furlong F.T., et Keeley M.C., 1989. "Capital regulation and bank risk–taking: A note" *Journal of Banking and Finance*,13, pp. 883–891.

[16] Godlewski, J.C., 2005. "Bank capital and credit risk taking in emerging market economies", *Journal of Banking Regulation*, 6, pp. 128–145.
[17] Goyeau, D., and Tarazi, A., 1992. "Evaluation du risque de défaillance bancaire en Europe", *Revue Economique*, 102, pp. 250-280.
[18] Heid F., Porath D., et Stolz S., 2003. "Does capital regulation matter for bank behavior? Evidence for German savings banks*"*, *Working Papers*, Kiel Institute for World Economics, n°1192.
[19] Hellmann, T., Murdock, K., and Stiglitz, J., 2000. "Liberalization, Moral Hazard in Banking, and Prudential Regulation: Are Capital Requirements Enough?" *American Economic Review*, 90, pp. 147–165.
[20] Hussain M.E., and Hassan M.K., 2004. "Basel capital requirements and bank credit risk taking in developing countries", *working paper*, *University of New Orleans/Drexel University, LeBow College of Business*, Department of Finance.
[21] Jacques, K., and Nigro, P., 1997. "Risk-based capital, portfolio risk, and bank capital: A simultaneous equations approach", *Journal of Economics and Business*, 49, pp. 533-547.
[22] Kahane, M.C., 1977. "Capital adequacy and the Regulation of Financial Intermediaries", *Journal of Banking and Finance*, 1, pp. 207-218.
[23] Keeley M.C., 1988. "Bank capital regulation in 1980s: effective or ineffective?", *Federal Reserve Bank of San Francisco, Economic Review*, Winter, pp. 1-20.
[24] Kim, D., and Santomero, A.M., 1988. "Risk in banking and capital regulation", *Journal of Finance*, 43, pp. 1219–1233.
[25] Koehn, M., and Santomero, A.M., 1980. "Regulation of bank capital and portfolio risk", *Journal of Finance*, 35, pp. 1235–1244.
[26] Konishi, M., and Yasuda, Y., 2004. "Factors Affecting Risk Taking: Evidence from Japan", *Journal of Banking and Finance*, 28, pp. 215-232.
[27] Kopecky K., and Van Hoose D., 2006. "Capital regulation, heterogeneous monitoring costs, and aggregate loan quality", *Journal of Banking and Finance*, 30, pp. 2235–2255.
[28] Kupiec, P. H., and O'Brien, J.M., 1997. "The Pre-Commitment Approach: Using Incentives to Set Market Risk Capital Requirements", *Federal Reserve Board, Finance and Economics Discussion Series* No. 97-14, March.
[29] Leland, H., and Pyle, D., 1977. "Information Asymmetries, Financial Structure and Financial Intermediaries", *Journal of Finance*, 32, pp. 371-387.
[30] Markowitz, H., 1952. "Portfolio Selection", *Journal of Finance*, 7, pp. 77-91.
[31] Matutes, C., and Vives, X., 2000. "Imperfect Competition, Risk-taking, and Regulation in Banking", *European Economic Review*, 44, pp. 1–34.
[32] Merton R.C., (1977), "An analytic derivation of the cost of deposit insurance and loan guarantees", *Journal of Banking and Finance*, 1, pp. 512–520.
[33] Murinde, V., and Yaseen, H., 2004. "The Impact of Basle Accord Regulations on Bank Capital and Risk Behaviour: 3D Evidence from the Middle East and North Africa (MENA) Region", University of Birmingham.
[34] Ramakrishnan, R., and Thakor, A., 1984. "Information reliability and a theory of financial intermediation", *Review of Economics Studies*, 51, pp. 415-432.
[35] Repullo, R., 2004. "Capital Requirements, Market Power, and Risk-taking in Banking", *Journal of Financial Intermediation*, 13, pp. 156–183.
[36] Rime B., 2001. "Capital requirements and bank behaviour: Empirical evidence of Switzerland", *Journal of Banking and Finance*, 25, pp. 789-805.
[37] Rochet, J.C., 1999. "Solvency regulations and the management of banking risks", *European Economic Review*, 43, pp. 981-990.
[38] Roy, A.D., 1952. "Safety first and the holding of assets", *Econometrica*, 20, pp. 431-449.
[39] Santomero, A.M., 1983. "Fixed versus variable rate loans", *Journal of Finance*, 38, pp. 1363-1380.

[40] Shrieves R.E., and Dahl D., 1992. “The relationship between risk and capital in commercial banks”, *Journal of Banking and Finance*, 16, pp.439-457.
[41] Stiglitz, J., 2001. “Principles of financial regulation: A dynamic portfolio approach”, The World Bank Research Observer, Spring, pp. 1-18.
[42] Van Roy P., 2005. “The impact of the 1988 Basel Accord on banks' capital ratios and credit risk-taking: An international study”, Economics Working Paper, Archive EconWPA.
[43] Zellner A., Theil H., 1962. “Three-Stage Least Squares: Simultaneous Estimation of Simultaneous Equations”, *Econometrica*, 30, pp.54–78.