Capital and Risk from the Perspective of Solvency Regulation of Moroccan Insurance Companies: Dynamic Estimation by Simultaneous Equations with Panel Data

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Abstract: ***This research attempts to answer two questions: Has capital and risk management in Moroccan insurance companies malfunctioned over the past ten years. In addition, Could the new regulatory measures significantly improve the management of capital and risk and especially that of underwriting in non-life? The econometric methodology that we have adapted is a comparison between the two regulations in a logic of panel data based on the partial equilibrium model with simultaneous equations concerning four Moroccan insurance companies over the period 2010-2018 estimated by the generalized moments estimator. The results of the study indicate the importance of capital and risk in the determination of insurance solvency while taking into account the effect of different exogenous variables incorporated in the determination of capital and risk.***

Keywords: Solvency, dynamic panel, regulation, partial adjustment, generalized moment estimator

1. Introduction

This article highlights the causes of the malfunctioning of insurance companies in terms of risk and capital management on the basis of current regulation. In addition, it outlines the superiority of the new regulations in risk and capital management. The period studied corresponds to a very particular time span 2010 to 2018.This period comes after a global financial crisis that occurred in 2008.This research does not focus on the principles and the effects of the new regulation on the policyholders of Moroccan insurance companies. Consequently, the discussion does not differentiate between insurance and reinsurance despite our full awareness of the radical difference between the two, particularly in terms of the accounting and regulatory aspects.

From a contextual point of view, the study concerns a random sample of Moroccan insurance companies. Our conclusions are also available for all other insurance companies in Morocco.

The impact of the nature of regulation is based on the concept of solvency. Indeed, solvency analysis is an activity considered indispensable for every insurance company. An insurance company is considered to be insolvent when it cannot finance its activities or cope with the market hazards apparent in its economic environment. Some companies rely mainly on appropriate formulas to eliminate certain risks specific to the insured.

The insured transfer their risks to the insurance companies, which must, in order to maintain their profitability, take these risks into consideration in a very efficient method. Unfortunately, the quantification of these risks is based on the definitions of the current prudential regulations, which do not take in consideration certain significant (new) risks in the definition of the regulatory capital of insurance companies.

The problem is divided into two main questions. The first question is about the function of insurance companies in solvency management. The second question concerns the evaluation of the introduction of the new solvency regulation in Morocco and the extent to which it could improve the capital and risk management of Moroccan insurance companies.

To answer this question, we have used a fundamental theoretical model. It is a simple dynamic model that is widely used in the econometric literature. It is the partial adjustment model developed by Nerlove (1958).The idea is to assume that the desired level of an economic variable is a function of several exogenous variables through a linear relationship. This model corrects, among other things, the problems raised by traditional staggered lag models.

The econometric techniques used are original (generalized moment estimator) and the statistical tests applied are based on the assumptions of homogeneity and stationarity of the variables used.

In order to take into account the notion of simultaneity between capital and risk of insurance companies, we have relied on a panel data simultaneous equation modeling as used in the work of Shrieves and Dahl, 1992 who were the first to model the relationship between capital and risk in the framework of simultaneous equations at commercial banks.

In the following, we will present the following points: first, it is essential to present the concept of solvency in the international context and in the national context, focusing on the nature of the regulation pursued by insurance companies in some geographical areas. Second, the focus will be on the theoretical framework and its foundations that we have mobilized to trace the relationship between capital, risk and regulation. Next, we will present a framework of the empirical methodology used to trace this relationship. The data, data sources, and research findings will be discussed in a final section.

2. Aspects of solvency regulation at national and international levels

Currently and in a globalized context, insurance companies are confronted with detecting, understanding, measuring and quantifying new types of risks. The development of efficient risk management practices over time explains the evolution of insurance regulation in many countries around the world.

In the early 1990s, the regulatory framework for the insurance industry gradually changed. Indeed, in the past this framework has been based on non-risk-based rules, while the market has practices where risk is the key element. Historically, the United States of America was among the first to adopt risk-based regulatory standards in 1994, followed by Japan in 1996, Switzerland in 2006 and the European Union in 2006.

However, the purpose of the insurance regulator is to ensure that industry participants respect the required solvency standards and practices and to encourage the growth of the industry[1].Solvency is obtained, according to Stiglitz (1972) inside a single model, if the final value of the claims is higher than the total of its commitments. Pearson (2010) considers that one of the most important and an integral part of the growth of the insurance industry is regulatory control. In other words, the existence of rigorous regulation of insurance solvency is necessary in order to deal with any excess of power and/or information asymmetry[2], given the inversion of the information cycle that characterizes this industry.

A solvent capital is one that allows the insurance company to manage its risk. For this purpose, a minimum amount of capital must be provided against the hazards of its business activity or against market anomalies. The literature differentiates between economic capital and regulatory capital. The former is based on advanced risk estimation computations and is used for internal risk management purposes rather than for regulatory purposes. While regulatory capital is based on the calculation of standard formulas based on averages (Fedor, 2007).In what follows, we will be able to give a theoretical overview of the risks associated with insurance companies and the capital employed by these companies.

In particular, the US has established a new regulation that determines the regulatory capital for a specific risk by applying a factor known as risk-based capital (RBC). It refers to an exposure amount obtained from the annual statement. This was probably a significant impact on the risk exposure of a US insurance company (Grace et al. 1998).This standard has two parts, the first part is related to the determination of a minimum capital, and the second part automatically gives the state regulator the right to take certain measures depending on the level of deficiency of the insurance company[3].

The Swiss regulation consisted of the determination of capital requirements following a two-level approach, the first level consisting of the determination of a minimum capital, and the second level consisting of the identification of a target capital based on the market value, which is defined as the difference between the market value of assets and the best estimate of liabilities. This standard also includes a quality assessment focusing on internal processes and risk control.

For Europe, the objective was to harmonize the regulations of insurance companies that operate in the member states of the European Union. In this context, Solvency II has determined two levels of capital requirements. These are the Minimum Capital Requirement, which corresponds to an amount of eligible basic own funds below which policyholders and beneficiaries would be exposed to an unacceptable level of risk if the insurance or reinsurance undertaking were authorised to continue its activity[4], and the Solvency Capital Requirement, which corresponds to the Value-at-Risk of the basic own funds of the insurance or reinsurance company, with a confidence level of 99.5% over a one-year horizon[5]. Under Solvency II, assets and liabilities are evaluated according to economic principles in accordance with the guidelines of IFRS.

From the above, it can be seen that regulation of the insurance industry varies around the world, making it difficult to determine the most effective regulatory system.
Current Moroccan regulations on insurance solvency are ensured by the constitution of a minimum share capital, which provides for an adequate evaluation of commitments. In addition to prudential technical provisions, it also provides for restrictive asset allocation rules to better satisfy the solvency margin.

However, this regulation only takes into account insurance risks and does not take into account other risks in the

[1]Mirah, D. et Masa'deh, R. (2014), An Analysis of the Insurance Industry Regulator in Saudi Arabia and Jordan through the Comparison with Insurance Industry Regulator in the UK, Asian Social Science; Vol. 10, No. 3, p 211.

[2]Eling, M., Schmeiser, H., Schmit, J, (2007), THE SOLVENCY II PROCESS: OVERVIEW AND CRITICAL ANALYSIS, Risk Management and Insurance Review, 2007, Vol. 10, No. 1, 69-85, p 74.

[3] The National Association of Insurance Commissioners (NAIC), report of 2005.

[4] Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 Solvency II, article 129

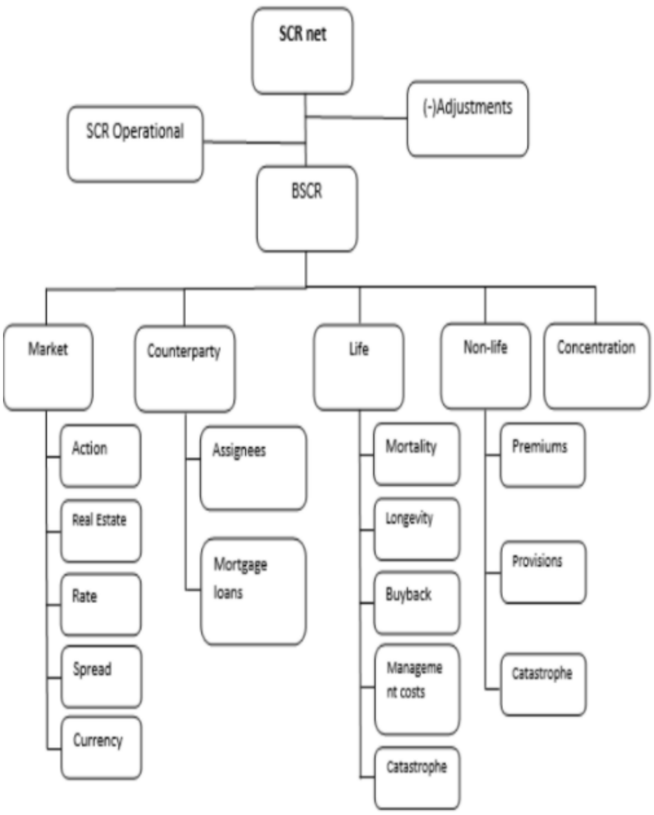
[5] Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 Solvency II, article 101

determination of the solvency margin. The risks involved in the calculation of this solvency margin are:

- Premium risk: the recommended indicators are premiums written at the end of the year and the amount of the unearned premium reserve. These are simple indicators to measure but they contain risks of manipulation. Indeed, a company can reduce its solvency margin requirements by underpricing.
- Risk on technical provisions: the indicator is the technical provisions (PSAP, mathematical provisions, mathematical provisions of unit-linked contracts). An undervaluation of these technical reserves leads to the constitution of an insufficient minimum capital requirement.
- Currency risk: Valid only for reinsurance acceptances. The indicator used is the amount of foreign currency liabilities.
- Counterparty risk: retention rates are limited to minimum levels of 50%, 70% and 80% depending on the branch.

New categories of risk are taken into account in the new insurance regulations, notably market risk, which includes equity, interest rate, spread and currency risk. Counterparty risk which includes assignee counterparty risk, insured counterparty risk and mortgage counterparty risk. Concentration risk and non-life underwriting risk, in particular: premium, reserve and natural catastrophe risks. Life underwriting risk and finally operational risk.

The risks taken into account in the new Moroccan prudential regulations can be summarized in the diagram below:



3. Theoretical framework of the research

Insurance works by mutualizing risk. Having a very large number of insureds, insurance companies can easily use statistical (provisional) analysis to project into the future and be able to know what their actual losses will be for a given class or a specific product. Indeed, theoretically, insureds cannot suffer losses at the same time. This statistical law allows insurance companies to operate and be profitable while paying out the various indemnities that occur in the event of a real loss.

Insurance is a mechanism by which businesses can reduce the negative financial effects of an uncertain event or potential financial loss. It reduces the impact of financial losses on firms, including banks. Blunden and Thirlwell (2010) describe insurance as a financial contract that depends on the occurrence of an unforeseen event and over which the insured has no control. It is a mechanism of risk transfer that facilitates the transfer of the cost of a risk from the insured to the insurer in exchange for the payment of the insurance premium (Marshall, 2001).

Insurance is a financial contract and a means of managing the consequences of a risk perceived as external (Levitas, 2005) and (Adam et al, 2006). The consideration of all risks in a common vision makes risk transfer and the law of large numbers among the main characteristics of insurance. This common vision of risks implies the consideration of a methodology of homogeneous groupings of the different risks to provide better forecasts of future losses. However, risk transfer reduces future losses because it implies the transfer of risks from the insurer to the reinsurer or any other third party willing to assume these risks (Mutenga and Staikouras, 2007).

Insurance operates on the basis of the law of large numbers [6](Bank, 2004). Thus, this law is also important in defining insurance as a social device that aims to reduce overall risk by summing up a number of risk units. This operation can make individual losses collectively predictable (Mehr and Cammack, 1961).

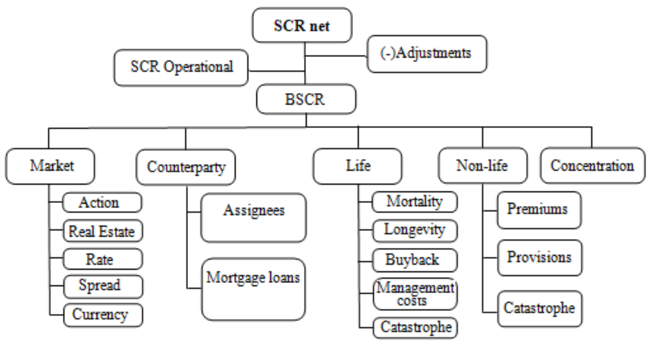
From an economic perspective, this law can be viewed as a form of economy of scale and a monetized instrument to compensate and manage risk exposure at a reduced cost by spreading the cost of contingent risks across many actors (Knight, 1921) and (Jarvis, 2009). It can facilitate the possibility of externalizing risk through insurance by strengthening a financial loss compensation mechanism for insurance companies (Levitas, 2005), (Skipper and Kwon, 2007) and (Stein, 2007). This is possible because insurance companies have a more diversified financial portfolio that helps reduce the effect of unexpected losses. In essence, insurance facilitates the transfer of economic risk to the insurer, while the actual risk lies with the insured (Coyle, 2002) and(Gordon, 2003).

[6] The law of large numbers states that as the number of experiments increases, the average result approaches the true value. It allows to interpret the probability as a frequency of success.

Insurance supports economic activities by generating huge cash flows needed to promote growth and development of the economy (Hancock et al, 2001). It also contributes to economic development through the intermediation of financial services and job creation (Ward and Zurbruegg, 2010) and (Liedtke, 2007). It promotes financial stability, reduces anxiety, facilitates trade, supports government security programs, mobilizes savings, promotes effective and efficient risk management and efficient and effective capital allocation, and encourages risk reduction and loss minimization (Ward and Zurbruegg, 2010).

The theory of collective risk called "ruin theory" has attempted to explain a very important factor of insurance company risk. According to Lundberg (1934), it is primarily concerned with the random volatilities of an insurance company's total assets and risk reserves. He focused on estimating the probability that an insurance company's reserves will be sufficient to pay claims when they are established. He normally assumes that the insurance company has initial capital and the insureds pay a gross risk premium at fixed periods. Since claims are made for random amounts and times, his model assumes that for an insurance company that experiences two inverse cash flows[7], premiums arise at a constant rate from customers and claims arise according to a completely independent Poisson process[8].

The nature of this discrepancy between premiums collected and claims paid in terms of time and value requires that the insurance company necessarily provide for a minimum reserve. The theory concludes that the basic probabilities are constant and that the differences that occur can be interpreted as random fluctuations. Consequently, risk theory appears to be a simple application of probability theory, which starts with a binomial distribution and leads to a Poisson process.



Stakeholder theory was put forward by Freeman (1984) as a management tool. It has given rise to several discussions in the organizational field of corporate strategy (following an interactionist and relational approach), and has since become a theory with strong explanatory potential. Freeman (1984) defines the notion of stakeholder as any group or groups in a relationship affecting and affected by the decisions of the organization. Stakeholder theory focuses specifically on the average interests of stakeholders as the primary determinant of corporate policy.

For the insurance company, operational risk[9] is largely intertwined with stakeholder integrity and ethics. Indeed, stakeholder theory is an organizational management and ethics theory that emphasizes values and morality as basic characteristics of organizational management (Phillips et al, 2003). Shareholders, directors, senior managers, and functional heads must be approved by the regulator before they are confirmed by insurance companies (as required by the new draft Moroccan insurance prudential regulations).

The theory of optimal capital structure has been extensively discussed in the theoretical and empirical literature. The translational approach of this theory assumes that there is an optimal level of debt by which an organization's financial leverage would be balanced. This has an impact on the cost of financing and the total value of the firm.

The trade-off theory, initially developed by Kraus and Litzenberg (1973) and extended by Modigliani and Miller (1958 and 1963), takes into account new parameters (probability of financial distress and the resulting costs) to explain the existence of an optimal capital structure.

Recently, and in the case of insurance companies, Perroti and Laeven (2010) argue that there is another element to consider in the analysis of insurance capital, namely the trade-off between the costs of holding and increasing solvency capital on the one hand, and the willingness to pay for insurance provided by a financially sound insurance institution on the other.

In the presence of imperfect capital markets and the persistence of taxes and agency problems, the provision of excess capital on the balance sheet is costly for the shareholders of an insurance company. As a result, shareholders have new incentives to delineate the amount of excess capital on the balance sheet. On the other side, the insurance regulator will demand regulatory capital that will ultimately result in adequate solvency margins for insurance companies.

From an empirical point of view, Grace et al (2003) have shown the existence of a significant relationship between the demand for insurance and the financial situation of insurance companies. Indeed, any changes in the financial situation of the insurer can modify its insurance demand. First, there are changes in the premium that an insurance company can charge, and second, there is a change in the quantity that the insurer can sell. It is in this context that insurance companies are expected to maintain a suitably large level of surplus capital on their balance sheet.

Optimal capital structure theory concludes that insurance contract (policy) holders not directly subject to risk are primarily willing to pay higher premiums to more solvent

[7] That is, incoming premiums and outgoing claims.

[8] A Poisson process or a fish law is a probabilistic process that describes the realization of rare phenomena. In our case it is a matter of counting the realizations of the number of claims at a given interval.

[9] It is the risk of direct or indirect losses due to a failure of procedures that concern the organization, its personnel, its internal systems or its external risks.

insurance companies. This compels the higher costs associated with the provision of excess capital, and compromises this willingness which increases with the degree of risk aversion of the policyholders.

4. Methodological Framework

The measurement of the relationship between risk and capital of Moroccan insurance companies is considered in two stages: the first is a measurement under the current prudential regulations, and the second is a treatment of the relationship in terms of the new regulation.

In this case, it will be a question of studying the impact of the change of the solvency regulation on the capital and risk management of Moroccan insurance companies. Indeed, given the regulatory pressure (Risk Based Solvency), in the long run insurance companies wish to reach optimal levels of ratios (capital and risk) following a partial adjustment. Modelling with a partial adjustment is justified by the theory of buffers or reserve capital and by the theory of asymmetric information.

The idea is that Moroccan insurance companies adopt target values (fixed, objectives) to be reached. This desired level is determined by an auxiliary model noted:

$$CAP^{*}_{i,t} = X^{'}_{i,t}\gamma \qquad \text{Equation 1}$$

By replacing this identity in the starting equation :

$$\Delta CAP_{i,t} = \alpha\,(CAP^{*}{}_{i,t} - CAP_{i,t-1}) + \xi_{i,t}$$
$$\Delta CAP_{i,t} = \alpha\,(X^{'}_{i,t}\gamma - CAP_{i,t-1}) + \xi_{i,t}$$
$$CAP_{i,t} - CAP_{i,t-1} = \alpha\, X^{'}_{i,t}\gamma - \alpha CAP_{i,t-1} + \xi_{i,t}$$
$$CAP_{i,t} = \alpha\gamma\, X^{'}_{i,t} - \alpha CAP_{i,t-1} + CAP_{i,t-1} + \xi_{i,t}$$
$$CAP_{i,t} = \alpha\gamma\, X^{'}_{i,t} + CAP_{i,t-1}(1-\alpha) + \xi_{i,t}$$

And assuming that X is a matrix grouping a set of control variables, and $\alpha\gamma = \theta$we will have:

$$CAP_{i,t} = \theta_0 + \theta_1 X_{i,t} + (1-\alpha)CAP_{i,t-1} + \xi_{i,t} \qquad \text{Equation 2}$$

Similarly we can write for the equation of the risk level for an insurance company i:

$$RISK_{i,t} = \vartheta_0 + \vartheta_1 X'_{i,t} + (1-\beta)RISK_{i,t-1} + \eta_{i,t} \qquad \text{Equation 3}$$

With : $\xi_{i,t}$and $\eta_{i,t}$, which express the residual terms of the capital level and credit risk level equations for insurance company (i) in year (t), respectively. We also note that $\theta_j\,(j = 1 \,....J)and\vartheta_k\;(k = 1 \ldots K)$, are the model parameters assigned to the different variables. θ_0 andϑ_0 are the respective constants to the two chosen model equations.

Technically and after presenting the theoretical model, it is important to present the main endogenous variables of this work. Indeed, the measurement of the long-term impact of a change in the solvency regulation on the capital and risk management of Moroccan insurance companies implies taking into consideration two capital measures, notably one that only takes into consideration the usual risks taken into account in the current regulation. This variable is measured by the solvency ratio defined in the previous paragraph. The associated risk is the non-life underwriting risk.

In a second step, a re-reading of the solvency margin of insurance companies requires an understanding of the different internal and external risks. Indeed, the regulatory pressure is raised in relation to another measure of capital: the SCR, it is the economic capital and the respective risk of it.

The literature shows that there is general agreement on the reaction of insurance companies to a solvency ratio requirement. For the definition of an adequate solvency ratio, the insurance company must reduce the equity by its respective risk. In order to present an adequate definition or to define a common solvency ratio, the insurance company must reciprocally manipulate the denominator and numerator in order to calibrate the equity or own funds according to the exposed risks.

Finally, it is necessary to retain the solvency ratio defined by the European regulatory reform but modified by the Moroccan Insurance and Reinsurance Companies Control Authority. The objective being to adapt the equity required by the insurance companies with the risks that they incur in relation to their activities.

The simultaneity of reaction and the interaction between capital and risk have been modeled in the literature through simultaneous equation modeling. In this sense, determining the variables defining equity and risk in an endogenous way makes these two variables different from other predetermined explanatory variables.

The objective is to measure or analyze the interrelation between these two vectors makes it necessary to consider a simultaneous equation model that includes two interdependent equations.

Any empirical methodology based on the estimation of an equation or system of equations must be carried out by means of a univariate analysis between the variables used in the model. Indeed, it is necessary to verify the nature and strength of the univariate relationships between each component of the model, as this is essential to identify the overall significance and trends of the series used.

5. Data and variables used

The first dependent variable that refers to the measurement of capital under current regulations is regulatory capital (CAP^{R_1}) : this is the most basic capital ratio that was first used before the advent of the risk weighting requirement. However, it only takes into account the basic risks of the insurance company. This ratio is therefore less related to changes in regulation and captures less of the high quality and quantity of capital instruments increasingly allowed by regulation (Shrieves and Dahl, 1992)[10].

In this study, we use the following formula as a measure of regulatory capital for insurance companies:

[10] See also (Rime, 2001), (Awdeh et al, 2011), (Heid et al, 2004), (Bougatef and Mgadmi, 2016).

$$Cap^{R_1} = Solv_t = \frac{Fonds\ propres_t}{Total\ actif_t} \qquad \text{Equation 4}$$

In order to take into account the changes in the regulations and the variety of capital instruments eligible for the calculation of the solvency ratio under the new regulations, another evaluation of the solvency margin is taken into consideration. This variable, noted (Cap^{R_2}) is measured by the SCR. ratio. This ratio is calculated from a standard formula in order to be able to apply it to all the insurance companies considered in our sample.

Since the general interest for an insurance company is to compute the aggregate SCR associated with all modules (risks), then compute the individual SCR of each risk class in order to observe the effects of risk diversification or the weight of each risk in the decomposition of the aggregate SCR. The insurance company seeks benefits and returns when the SCR of a risk class is lower than the overall SCR of that company.

It can also estimate the capital requirement for each risk class (but this is costly based on an internal model for identifying each risk class). Thus, an SCR that foresees high capital values is logically the one that attracts our attention.

As already mentioned in the previous paragraph, the analysis of the majority of Moroccan insurance companies' balance sheets shows that the provisions for claims payable are an important part of the liability structure. In this research, we will mainly focus on the non-life branch (premium risk (or pricing risk), reserve risk (or reserving risk) and catastrophe risk (or extreme risk)) in the calculation of the SCR in the standard formula.

We assume that January 1, 2019 is the last date that reinsurance treaties were written. And after that date the insurance company only pays the claims so that the insurance company will no longer receive a premium and the contracts will not be renewed beyond December 31, 2018. In addition, it is assumed that the claims occurred in the year of subscription. This means that an insurance company can only stop its activity after covering its solvency capital and not before (this can take several years).

The calculation of the SCR_{NV} is based on the following standard formula:

$$Cap^{R_2} = SCR_{NV} = \sqrt{NL_p + NL_c} \qquad \text{Equation5}$$

Where NL_p represents the capital change due to a change in pricing and reserving. And NL_c represents the capital change following a capital change due to catastrophe risk.

The variable that represents any changes in capital for pricing and reserving risk constitutes the majority of the underwriting risk. For this reason, we have limited ourselves to determining the SCR by pricing and reserving risk. It is determined by the following relationship:

$$NL_c = f(\sigma) \times V$$

The function f is set to produce a change in capital consistent with a $VaR(99{,}5\%)$[11]. We assume that the underlying risk follows a lognormal distribution[12]. This function is measured by the following relationship:

$$f(\sigma) = \frac{\exp\left(N_{99{,}5\%} \times \sqrt{\ln(\sigma^2+1)}\right)}{\sqrt{\ln(\sigma^2+1)}} - 1 \approx 3\sigma \qquad \text{Equation 6}$$

Where $N_{99{,}5\%}$ is a 99.5% quantile of the standard Gaussian distribution. The measurement of V and the standard deviations were made on the basis of a classical calculation on Excel that we implemented.

The second endogenous variable is risk. It is well known in the literature and widely discussed. The risk decision depends on three main actors: the regulator (notably through requirements such as the risk-splitting instrument or the limitation of risk-weighted assets in relation to available capital), managers (through their portfolio choices) and shareholders (based on their expectations of profitability). In addition to these main factors, there is the influence of macroeconomic parameters such as recession or other exogenous tensions over which the insurance company has no control. It therefore seems complex to find a variable that aggregates the real risk in all the insurance company's assets.

It should first be clarified that the literature on our problematic studies mainly the impact of regulatory solvency ratio requirements on insurance management and risk taking. By this we mean the risk on its portfolio, on the adjustment of its assets and on its positions vis-à-vis certain categories of risk. It is a complex measure with no consensus on the variable that best captures risk-taking.

However, the empirical work that has been done mainly on the banking sector has approached risk through two main ratios: the risk-weighted assets ratio (RWA/total assets) and the z-score. In our case, it is essential to decide on a basic measure of risk associated with regulatory capital (solvency ratio). Indeed, the indicator chosen is the Altman(1967) z-score calculated on the basis of the current prudential regime. It is a tool widely used in the financial field and is calculated on the basis of the following formula:

$$Risk_t^1 = z - score = \frac{Solv_t - \overline{Solv}}{\sigma_{Solv}} \qquad \text{Equation 7}$$

This ratio is negatively correlated with the risk of failure of insurance companies, i.e. the higher the z-score, the lower the risk of failure of these companies.

The use of this ratio named $Risk^1$ as a measure of risk will allow to follow the evolution of risky assets in relation to

[11] It is measured according to the Value-at-Risk (VaR) method. It is the maximum potential loss following an unfavorable variation in market prices, for a specified period of time and at a well-defined confidence threshold (one year and 99.5% for Solvency II).

[12] That is, the log(SCR) variable follows a normal distribution, because the SCR is a decomposition of several independent specific risks.

the total assets of the insurance company in a relative way. Its variation ($\Delta Risk^1$) reflects the fluctuation of asset risk over time. The assets at risk during the period of application (current period) of the current regulations covered only the risk associated with a change in capital. By extending the analysis according to the new recommendations, the non-life underwriting risk is taken into account in the risk assessment.

To measure the risk taken into consideration by Moroccan prudential regulations, we will assume that the risk is measured by the non-life subscription risk. The formula adopted is the following:

$$Risk_t^2 = \sigma_{SCR_t} \qquad \text{Equation 8}$$

The risk SCR is the standard deviation of the coverage rate of the required solvency capital, this ratio informs us on the degree of risk present in the balance sheets of insurance companies within the framework of the standards prescribed by the new regulation.

We consider that this annual ratio aggregates several information on the annual risk taking of the insurance company through the analysis of its annual provisions (reflecting its risk expectation).

To estimate the determinants of the capital and risk ratios simultaneously, we will use some explanatory variables and some control variables. The purpose of these so-called exogenous variables will be to approximate and describe all observed and unobserved changes in the endogenous variables considered by the theoretical model, and their parameters will consequently condition the dynamic changes in the ratios themselves.

The first exogenous variable is the size of the insurance company noted: SIZE. The variable SIZE is used as the main variable in the work of (Shrieves and Dahl, 1992) and is taken up by other authors afterwards. It is introduced simultaneously into the capital equation and the risk equation. The measurement of this variable takes into account an approximation of the insurance company's assets. The formula used is as follows:

$$Size_t = \log(Total\ asset_t) \qquad \text{Equation 9}$$

This variable theoretically tends to have a negative sign. This is because the larger the insurance company's assets, the less capital it will need to tie up, as it can easily obtain some of this capital on the domestic market or even on the international market (Ghosh, 2014).

(Berger et al, 2008, Ahmed et al, 2009) argue that the ability of the large company to use the capital markets leads it to hold less capital because it has access to other sources of funding. In addition, these companies make a large profit and can rely on their reserves (provisions) to increase their capital whenever they want. On the other hand, this relationship can have an opposite sign when the information asymmetry is sustainable. In this case, large companies can demand more capital (Gropp and Heider, 2010).

In terms of the second equation (risk), it appears that the larger an insurance company's total assets, the more diversified its assets are, and therefore the less risk it takes on. A large company multiplies its investments due to economies of scale (Altunbas et al 2007), and will allow itself to diversify, which negatively impacts its risk levels (Jacques and Nigro, 1997) (Aggarwal and Jacques, 2001)(Rime, 2001)[13].In this case, the expected sign of the coefficient associated with the size variable in the risk equation is negative.

The return on assets called ROA or profitability is measured by the following formula:

$$ROA_t = \frac{Net\ income_t}{Total\ asset_t} \qquad \text{Equation 10}$$

Here profitability is examined by the consolidated net income which provides an idea of the overall profitability of the insurance company, as opposed to the net results by group share published by analysts and which are based on the profitability of the parent company. This ratio is more appropriate than the ratio of capital profitability called ROE.

Rime (2001) notes that in a system characterized by asymmetric information, high profits provide shareholders with the opportunity to increase capital, which provides a strong signal to the market.

In the capital equation, insurance companies prefer to increase their regulatory capital in line with results, rather than by issuing new shares, as this is considered a bad signal to the market (Rime 2001, Van Roy 2005). This is a reality that weighs more heavily in environments with high information asymmetry where it can increase the cost of external capital and initiate shareholders to choose the option of incorporating reserves.

Indeed, it is also less costly for a company to increase capital by incorporating profits because this will not affect shareholders' rights and sends a good signal to markets in the presence of information asymmetries (Aggrawal and Jaques 1998). Thus, the profitability of an insurance company can positively impact the level of capital.

With regard to the test of the hypothesis that the profitability of an insurance company modifies its risk behavior, several studies in this area have reached mixed conclusions (sometimes positive, sometimes negative). The research that has found a positive sign (Ramessur and Polodoo 2011) assumes that the more profitable a company is, the more it will be able to reduce its risks by employing more expensive experts. The research that has raised a positive sign (Ramessur and Polodoo 2011) assumes that the more a company is profitable, the more it will be able to reduce its risks by employing more expensive experts for a better selection of clients. Other works have assumed a positive relationship because the company has an incentive to maximize profits, even with a higher price. Some other works have found a positive correlation between

[13] See also the findings of (Heid et al, 2003), (DasetGhosh, 2004), (MurindeandYaseen, 2004), (Godelewski, 2005), (Van Roy, 2005), (Floquet andBiekpe, 2008) and (Matejašák et al, 2009).

profitability and risk taking where the bank is tempted by maximizing earnings even at the cost of greater risk.

The annual provisioning charge noted DP is measured by the following formula:

$$DP_t = \frac{Technical\ provisions_t}{Total\ asset_t} \qquad \text{Equation 11}$$

This variable is not included in the risk equation. In the capital equation, however, reserves allocations are taken into account to assess the evolution of the company's technical reserves. In theory, the greater the change in provisions, the more the regulatory capital decreases[14] (Rime 2001) and (Heid et al. 2004). Thus, the expected sign of this relation is necessarily negative.

The interest margin is also an explicative variable considered in both the capital and risk equations. This variable relates to the net interest income ratio, and is measured by the following formula:

$$Margin_t = \frac{(interest\ income - interest\ expense)_t}{\text{interest generating assets}} \qquad \text{Equation 12}$$

In fact, the volatile evolution of interest margins reflects the Herculean competition between insurance companies. Depending on the intensity of this competition, margins change freely. If margins fall, insurance companies will tend to open up to other revenue-generating opportunities by offering other "package" insurance products to customers. This type of action undoubtedly contributes to the reduction of margins, which may result in the insurance company adopting a riskier behavior in its assets. Ultimately, because of this margin, insurance companies must comply with the solvency rules in force. The sign of this variable is really a function of the financial situation of the insurance company and the prudent behavior to meet the requirements, it can be positive as well as negative.

The proposed methodology is based on the analysis of panel data. Indeed, the data used includes observations concerning four insurance companies: Saham Company, Atlanta Company, Wafa Insurance Company and Rma Company.

The insurance sector in Morocco has 20 commercial insurance companies[15]. The sample chosen for this study took into consideration some restrictions that were legitimate in order to have a good representation of the sector. In fact, we had to take into consideration only those companies that are operational and have not been the object of merger and acquisition operations.

In this context, during the period 2010-2018 only less than half of the insurance companies comply with some necessary sampling requirements. Indeed, most of these companies are either newly created or were the result of a merger and acquisition operation. We proceeded with a purely random sampling and identified only 7 insurance companies with a homogeneous width of available data (company in activity between 2010 and 2018), we also retained four of them that do not have missing values.

6. Results

The econometric model can be written as follows, with X and Y being the respective variables retained for the two equations, the capital and the risk:

$$\begin{cases} CAP_{i,t} = \theta_0 + \theta_1 X_{i,t} + (1-\alpha)CAP_{i,t-1} + \theta_6 RISK_{i,t} + \xi_{i,t} \\ RISK_{i,t} = \vartheta_0 + \vartheta_1 Y_{i,t} + (1-\beta)RISK_{i,t-1} + \vartheta_7 CAP_{i,t} + \eta_{i,t} \end{cases}$$

By introducing all the explanatory variables, the estimated model is :

$$\begin{cases} Cap^{R_s}_{i,t} = \theta_0 + \theta_1 Taille_{i,t} + \theta_2 Roa_{i,t} + \theta_3 Marge_{i,t} + (1-\alpha \\ \qquad +\theta_5 Risk^s_{i,t} + \xi_{i,t} \\ Risk^s_{i,t} = \vartheta_0 + \vartheta_1 Taille_{i,t} + \vartheta_2 Roa_{i,t} + \vartheta_3 DP_{i,t} + \vartheta_4 Mar \\ \qquad +(1-\beta)Risk^s_{i,t-1} + \vartheta_6 Cap^{R_s}_{i,t} + \eta_{i,t} \end{cases}$$

Equation 1

The choice of the estimation method for solving the model with simultaneous equations on stacked data requires us to deal with the endogeneity problem arising from the simultaneity between capital and risk. In this context, the use of stacked data is becoming increasingly popular with most researchers. This is because it makes it possible to solve the problem of "heterogeneity" between individuals and to carry out estimates in the presence of several constraints (restrictions) that are not confirmed with the classic methods of ordinary regressions.

Moreover, the use of a methodology based on panel data does not allow for the dynamic nature of the variables or equations in the model to be taken into account, particularly because of the strong impact between the endogenous variables and their history[16].

Specification tests imply checking the validity of the panel structure before undertaking any analysis or estimation of the variables in the models. In other words, it is a question of examining the existence of a form of heterogeneity between individuals, and whether it is relevant to consider the data as panel data[17].

We can confirm the panel structure and consider individual effects in the panel structure. Thus, the Hausman test statistic indicates that individual effects are more random in the capital equation than in the risk equation.

Table 1: Specification tests of the two models

Equations	F-Stat			Chi-deux
	H[1]	H[2]	H[3]	Hausman test

[14] Regulatory capital is supposed to cover unexpected losses, expected losses are covered by provisions.

[15] From the report of the Insurance and Social Security Supervisory Authority, "Insurance and Reinsurance Sector, Situation 2018".

[16] See (Bouheniet Rachdi, 2015)and (Moussa, 2015), these authors use a static model that does not consider lagged risk and capital variables.

[17] Many research studies begin econometric estimation before checking the panel structure. This approach does not identify the estimation method to be chosen and would lead to biased estimates.

$Cap_{i,t}^{R_1}$	5.56E+24***	1.85E+24***	23.52961***	6,80
$Risk_{i,t}^{1}$	1.40E+24***	9.42E+23***	7.054318***	3,24
$Cap_{i,t}^{R_2}$	10.35***	1.38*	33.29***	2,24
$Risk_{i,t}^{2}$	0.926**	0.627**	2.522**	2,33

*,** and *** represent the significance at the 10%, 5% and 1% level.

Indeed, this heterogeneity is explained by the predominance of inter-individual disparities in the total variance. There are two major factors that can be advanced to explain the heterogeneous nature of the panel. The first is the result of the aggregation of the data that brings together two potential sources of variability (insurance companies and time). The second factor relates to unobserved disparities among insurance companies in Morocco that appear to persist over time.

In addition, if the insurance companies were not randomly selected (i.e. the individuals in the population were selected) then the fixed effects model would be the most appropriate. However, by using the randomized scheme, the marginal (unconditional) inference is made on the total population, in which case the justification for using random effects is assured because the insurance companies are randomly selected from the population of Moroccan companies.

Table 1 also gives the results of the specification tests of the panel structure that concerns the first model for the risk equation. Indeed, the results show that the panel structure is confirmed, the data can therefore be considered as panel data. The question of homogeneity is also rejected, therefore we can consider the presence of effects in the panel structure. The results confirm that these effects are individual effects by looking at the value of the Fisher statistic. The Hausman test indicates that these effects are random by verifying the rejection of the alternative hypothesis that stipulates that the effects are fixed.

The second test is stationarity. The basic models retain the dynamics between the variables in the same equation (interaction between the past and current values of the ratios) and a simultaneous dimension between the equations of the system (interaction between the values of the capital and their associated risk over time).

To proceed to these stationarity tests, we will use the "unit root tests on panel data". These are the tests of Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS) and Maddala and Wu (ADF-Fisher) are applied on the level series and on the first difference series. Considering the results of the previous analysis, it is important to point out that these stationarity tests were performed by taking into account the specificity of the panel model in the models[18] (in level and in differences). In other words, by including a constant in each model, the estimation can take into account the fixed effects recognized in the structure of the panel model.

Finally, these tests were performed on the basis of an automatic selection of the delay[19], using the Schwarz information criterion and a spectral estimation of Kernel with the Newey-West selection.

Table 2: Unit root tests in panel data

	LLC		LPS		ADF-Fisher		Decision :
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	Stationary in
$Cap_{i,t}^{R_1}$	-5,01 ***	-3,45 ***	-2,32 ***	-1,16	20,97 ***	14,10 ***	Level
$Risk_{i,t}^{1}$	-5,02 ***	-3,46 ***	-2,33	-1,17	20,99 ***	14,09 ***	Level
$Cap_{i,t}^{R_2}$	-3.01 ***	-1.50 **	20.78 ***	13.31 *	54.91 ***	10.71	Level
$Risk_{i,t}^{2}$	-2,93 ***	-3,43 ***	14,04 ***	28,92 ***	5,49 ***	21,53 ***	Level
$ROA_{i,t}$	0,17	-6,39 ***	0,59	-2,50 ***	7,31	22,93 ***	Difference
$MARGE_{i,t}$	-2,75 ***	-5,99 ***	-1,42 *	-2,98 ***	16,28 **	25,69 ***	Difference
$TAILLE_{i,t}$	-0,46	-23,65 ***	0,98	-7,79 ***	2,98	34,70 ***	Difference
$DP_{i,t}$	-4,04 ***	-20,96 ***	-2,21 ***	-7,27 ***	20,49 ***	39,23 ***	Level

I(0) and I(1) Present respectively the test in level and the test in difference

*,** and *** represent the significance at the 10%, 5% and 1% level.

The results of the unit root tests on the variables studied show that most of the explanatory variables retained at the level of the two models are stationary after differentiation. For the series $Cap_{i,t}^{R_1}, Risk_{i,t}^{1}, Cap_{i,t}^{R_2}, Risk_{i,t}^{2}$ relating to the dependent variables, the null hypothesis of non-stationarity of the series is accepted by the three tests with a significance level of 1%. We can then deduce that at the level, the tests conclude the absence of a common unit root and/or an individual unit root in the structure of each dependent variable in the models.

For the other series, SIZE, MARGIN_(i,t), ROA_(i,t), the results of the unit root tests, notably the Levin, Lin and Chu, Breitung, Im, Pesaran and Shin and ADF Fisher tests, show that these variables are stationary in difference. Indeed, the null hypothesis of non-stationarity of the series is rejected by the three tests with a significance level of 1%. We can then deduce that in level, the tests conclude that there is a common unit root and/or an individual unit root in the structure of each exogenous variable retained. In first difference, the panel stationarity tests show that differentiation makes the series stationary. Therefore, this analysis will retain the differentiated transformation of these variables in the simultaneous models. Only, for the variable DP_(i,t) the common and individual tests of the presence of unit root in the panel affirm that this variable is stationary in level. Thus there will be no transformation required for this variable in the final specification of the simultaneous models.

[18] Note that unit root tests are generally performed for three models: model with constant and trend, with constant only, and without constant and trend. In the results of the panel structure analysis (fixed effects), i.e., the constant only must be taken into account in the model.Le logiciel Eviews version 9 est l'outil adopté pour réaliser nos estimations.

[19] The software Eviews version 9 is the tool adopted to realize our estimations.

However, the unit root tests conducted on the series of dependent variables in difference show a significant statistic (5%) in level for the LPS test and the ADF-Fisher test, which may weaken the cointegration relationship.

The third test corresponds to the problem of identifying systems of simultaneous equations. In a system of two simultaneous equations, which jointly determine the values of two endogenous variables ($Cap_{i,t}^{R_s}$et $Risk_{i,t}^{s}$), at least one of the two variables must be absent in a given equation for the estimation of its parameters to be possible. When estimation of the parameters of an equation is possible, the equation is said to be identified and its parameters can be estimated consistently. If at least one of the variables of interest is omitted from an equation, then it is said to be unidentified, and its parameters cannot be estimated consistently. As for the over-identified situation, this is the case where the model incorporates a superfluous variable.

The identification conditions according to (Godlewski, 2004),(Hussain and Kabir, 2006) and (Awdeh, El-Moussawi and Machrouh, 2011) are determined equation by equation. We can distinguish three cases of identifications: An under-identified model, a just-identified model and an over-identified model. For each system, the results are presented in the following table.

Table 3: Unit root tests in panel data

Systems	Capital equation	Risk equation
Current regulations	Over-identified	Over-identified
Risk-based solvency	Over-identified	Over-identified

The conclusions obtained on the identification conditions allow us to continue the estimation of the system of equations. However, the verification of the correlation between the variables is undeniable.

We will then estimate the dynamic panel model with the Generalized Moment Estimator (GMM of Arellano and Bond 1991). However, we will not conduct this investigation on the system of equations, but on the equations individually in order to verify the robustness of the estimates already made on the system.

The Generalized Method of Moments is an estimation technique defined by its quality of minimization of certain criteria, as opposed to estimators of the "maximum likelihood" type which are more demanding on the conditions of the parameters to be estimated. Its basic idea is to specify only the parametric form of some moments, in general the expectation, and to use these moments to construct the identification conditions, while making the sample analogous to the population. The advantage of this estimator is also that it does not require exact information on the distribution of the residuals. In this sense, the GMM estimator is robust to model misspecification.

Moreover, the GMM belongs to the family of methods using instrumental variables (such as the 3OLS). In this sense, it solves the endogeneity problem by replacing the variables "suspected" of being endogenous with appropriate instruments. Recall that the endogenous variable contains a part that is correlated with the error term and a part that is not. The instrumental variable is an external variable that explains the part of the endogenous variable that is correlated with the error term without being correlated with it. Thus, the use of instrumental variables for estimation allows for a better explanation of the variations, keeping only the variables that are not correlated with the error term.

Estimating the equations by the GMM estimator should give more robustness to our results. Table 4 presents the results of the dynamic estimates of the different endogenous variables, estimated in system using the GMM method of Arellano and Bond 1991 in system. This method removes the impact of fixed effects and leaves only the relationships varying between time and individuals.

Table 4: Generalized method of moments estimation (model 1)

Model	System of equations for regulatory standards			
Variables	$Cap_{i,t}^{R_1}$		$Risk_{i,t}^{1}$	
Constant	6,821***	(5,176)	5,428***	(2,383)
$d(SIZE_{i,t})$	-3,359*	(-1,780)	-2,004	(-0,820)
$d(ROA_{i,t})$	19,114	(1,606)	29,230***	(1,919)
$d(MARGIN$	1,030***	(3,370)	1,750***	(6,546)
$DP_{i,t}$	-0,517***	(-2,786)	-	-
$Risk_{i,t}^{1}$	-0,491***	(-2,239)	-	-
$Risk_{i,t-1}^{1}$	-	-	0,151**	1,934)
$Cap_{i,t}^{R_1}$	-	-	-0,318***	(-3,113)
$Cap_{i,t-1}^{R_1}$	0,581***	(5,741)	-	-
$SIZE_{i,t}^{2}$	-0,063***	(-4,620)	-0,052***	(-2,216)
J-statistic	**0,1982**			
Number of instruments	12		12	
Determinantresidual covariance	0,0324			
(AR1)	2,1123			
(AR2)	5,1514			

Notes: *, **, and *** represent significance at the 10%, 5%, and 1% levels.
T-stat values are shown in parentheses.

A general reading of the results of this system of simultaneous equations shows that they are satisfactory. Indeed, the global evaluation of this estimation of the GMM model in system is apprehended by the J-Stat. This statistic is above the critical value of 5% in all models means that all instruments used for this regression are exogenous when taken together. In other words, the instrumental variables through which we conducted the estimation do not correlate with the error terms and validate our estimates. Similarly, the probabilities of the autocorrelation tests (AR1) and (AR2) broadly confirm the absence of serial correlation between the residuals of the equations.

Also for model 2, we estimated the system through the GMM estimator in system which should give more robustness to our results. Table 5 shows the results of the dynamic estimations of the different endogenous variables retained in the system, which only detects the relationships varying between time and individuals.

Table 5: Generalized method of moment's estimation (model 2)

Model	System of equations for risk-based solvency standards			
Variables	$Cap_{i,t}^{R_2}$		$Risk_{i,t}^{2}$	
Constant	7,710***	(0,101)	-817,72***	(306,97)
$d(SIZE_{i,t})$	0,005***	(0,001)	-2,81	(2,69)
$d(ROA_{i,t})$	0,029***	(0,009)	34,14***	(16,73)
$d(MARGIN_{i,t})$	0,0002	(0,000)	1,00***	(0,37)
$DP_{i,t}$	0,0001	(0,0008)	-	-
$Risk_{i,t}^{2}$	0,0001	(0,0004)	-	-
$Cap_{i,t-1}^{R_2}$	0,0009	(0,000)	-	-
$Risk_{i,t-1}^{2}$	-	-	0,37***	(0,14)
$Cap_{i,t}^{R_2}$	-	-	0,44***	(0,13)
$SIZE_{i,t}^{2}$	-0,003***	(0,000)	1,56***	(0,65)
J-statistic	0,2395			
Number of instruments		12		12
Determinantresidual covariance				0,0001
(AR1)				2,505
(AR2)				3,121

Notes: *, **, and *** represent significance at the 10%, 5%, and 1% levels.
T-stat values are shown in parentheses.

The results of the GMM estimates generally confirm that they are satisfactory. Indeed, the J-Stat statistic shows a value higher than the critical value of 0.05 considered as confidence threshold. This means that at the 5% threshold all the instruments used in the estimation of the simultaneous equations system are valid when considered in the panel. Similarly, the statistics relating to the autocorrelation tests confirm the rejection of the alternative hypothesis that stipulates that the residuals are historically auto-correlated.

7. Conclusion

The theoretical partial adjustment model that we have proposed to describe the revealed annual changes in the capital and risk of insurance companies using a methodology based on simultaneous equation modeling presents generally satisfactory results. In what follows, we will first present a reading of the results based on the dynamic panel GMM estimation. Then in a second point, we will prospect concrete answers to the starting hypotheses that we have already presented in the introduction of this research work.

As it has been well argued, the choice of this method of estimation has been confirmed by respecting the various tests and statistical and econometric requirements. In relation to this complex field of investigation we conclude, to our knowledge, there is no similar work on the Moroccan insurance sector, which gives a particular originality to this work.

The desire to respect during the estimation process a perfect adequacy of data, forced us to retain four Moroccan insurance companies observed from 2010 until 2018. This helped us to maintain the initial position of neutrality and distance from the research object. In this context, we will try to present the fruit of this methodological process as faithfully as possible.

The relationship of simultaneity is significant between capital and risk in System 1. Indeed, the associated coefficients are significantly different from zero; the effects of the lagged variables of capital and risk are positive and significant. The exogenous variables are practically all statistically significant except for the variable measuring the growth rate in the capital equation and the variable measuring the variation in size in the risk equation.

For the second system which refers to the new Moroccan insurance regulation, the simultaneity relationship is not verified for the capital equation measured by the SCR, with the existence of influence of only two endogenous variables, namely the variation of the size and the growth rate. Regarding the risk equation, the GMM results show that there is a significantly positive impact of the capital variable on risk.

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Annexes

Estimation of System 1 by the generalized method of moments

System: SYS01
Estimation Method: Generalized Method of Moments
Date: 01/04/20 Time: 17:34
Sample: 2012 2018
Included observations: 28
Total system (balanced) observations 56
Kernel: Bartlett, Bandwidth: Fixed (4), No prewhitening
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(11)	6.821455	1.317937	5.175857	0.0000
C(12)	-3.358784	1.887191	-1.779780	0.0825
C(13)	19.11434	11.90283	1.605865	0.1160
C(14)	1.029679	0.305527	3.370169	0.0016
C(15)	-0.516569	0.185439	-2.785652	0.0081
C(16)	-0.490973	0.219313	-2.238689	0.0307
C(17)	0.580698	0.101150	5.740985	0.0000
C(18)	-0.063269	0.013696	-4.619525	0.0000
C(21)	5.428269	2.277827	2.383091	0.0219
C(22)	-2.004313	2.445217	-0.819687	0.4171
C(23)	29.23044	15.23103	1.919138	0.0619
C(24)	1.750718	0.267440	6.546200	0.0000
C(26)	-0.317627	0.102017	-3.113455	0.0034
C(27)	0.150686	0.077898	1.934393	0.0600
C(28)	-0.052050	0.023493	-2.215590	0.0323

Determinantresidual covariance	0.032430
J-statistic	0.198180

Equation: SOLV = C(11) + C(12)*D(SIZE) + C(13)*D(ROA) + C(14)
*D(MARGIN) + C(15)*DP + C(16)*ZSCORE + C(17)*SOLV(-1) +
C(18)*(SIZE * SIZE)
Instruments: SIZE ROA MARGE SOLV(-1) SOLV(-2) ZSCORE(-1)
ZSCORE(-2) D(TAILLE) DP D(MARGIN) D(ROA) C
Observations: 28

R-squared	0.605287	Meandependent var	3.020750
Adjusted R-squared	0.467137	S.D. dependent var	0.851040
S.E. of regression	0.621237	Sumsquaredresid	7.718714
Durbin-Watson stat	1.716736		

Equation: ZSCORE = C(21) + C(22)*D(SIZE) + C(23)*D(ROA) +
C(24)*D(MARGIN) + C(26)*SOLV + C(27)*ZSCORE(-1) + C(28)
*(SIZE * SIZE)
Instruments: SIZE ROA MARGIN SOLV(-1) SOLV(-2) ZSCORE(-1)
ZSCORE(-2) D(SIZE) DP D(MARGIN) D(ROA) C
Observations: 28

R-squared	0.148392	Meandependent var	-0.241984
Adjusted	-0.094925	S.D. dependent var	0.671344

R-squared			
S.E. of regression	0.702485	Sumsquaredresid	10.36320
Durbin-Watson stat	1.576625		

Estimation of System 2 by the generalized method of moments

System: SYSMODEL2
Estimation Method: Generalized Method of Moments
Date: 01/05/20 Time: 17:51
Sample: 2012 2018
Includedobservations: 28
Total system (balanced) observations 56
Kernel: Bartlett, Bandwidth: Fixed (4), No prewhitening
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(11)	7.709578	0.101160	76.21139	0.0000
C(12)	0.004522	0.001245	3.631180	0.0008
C(13)	0.029064	0.009366	3.103109	0.0035
C(14)	-0.000185	0.000219	-0.841599	0.4049
C(15)	0.000168	0.000299	0.561229	0.5777
C(16)	-7.60E-05	8.93E-05	-0.850978	0.3997
C(17)	9.72E-06	4.55E-05	0.213784	0.8318
C(18)	-0.002541	0.000211	-12.05394	0.0000
C(21)	-817.7187	306.9687	-2.663850	0.0110
C(22)	-2.807443	2.686828	-1.044891	0.3022
C(23)	34.13869	16.73356	2.040133	0.0478
C(24)	1.001387	0.366504	2.732268	0.0092
C(26)	0.374279	0.137450	2.723010	0.0095
C(27)	0.435895	0.125678	3.468349	0.0012
C(28)	1.564149	0.654878	2.388459	0.0216

Determinantresidual covariance 1.09E-07
J-statistic 0.239546

Equation: LOG(SCR) = C(11) + C(12)*D(SIZE) + C(13)*D(ROA) + C(14)*D(MARGIN) + C(15)*DP + C(16)*ECART_SCR + C(17) *SCR(-1) + C(18)*(SIZE * SIZE)
Instruments: SIZE ROA MARGIN SCR(-1) SCR(-2) ECART_SCR(-1) ECART_SCR(-2) D(TAILLE) DP D(MARGIN) D(ROA) C
Observations: 28

R-squared	0.994301	Meandependent var	7.501964
Adjusted R-squared	0.992306	S.D. dependent var	0.007244
S.E. of regression	0.000635	Sumsquaredresid	8.07E-06
Durbin-Watson stat	1.931472		

Equation: ECART_SCR = C(21) + C(22)*D(TAILLE) + C(23)*D(ROA) + C(24)*D(MARGIN) + C(26)*SCR + C(27)*ECART_SCR(-1) + C(28) *(SIZE * SIZE)
Instruments: SIZE ROA MARGIN SCR(-1) SCR(-2) ECART_SCR(-1) ECART_SCR(-2) D(SIZE) DP D(MARGIN) D(ROA) C

Observations: 28

R-squared	0.530221	Meandependent var	-1.520862
Adjusted R-squared	0.395999	S.D. dependent var	1.068472
S.E. of regression	0.830390	Sumsquaredresid	14.48049
Durbin-Watson stat	1.751078		