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Competition and risk-taking behavior in Iranian insurance industry

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In the Name of God
The Most Compassionate
The Most Merciful

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Abstract

Competition is widely accepted as an important factor that affects Risk-taking behavior and profitability. In the formulation of regularity policies, regulators are faced with the difficult decision of whether competition is good or bad for market stability. Furthermore, Risk-taking behavior in different countries and different insurance firms are not the same. The aim of this study is to realize the effect of competition on Risk-taking behavior and solvency in insurance market in Iran. We utilize firm-level annual data on 17 Iranian insurance companies from 2007 to 2017 to estimate the Lerner index as the proxy for competition, while the z_{score} and standard deviation of loss ratio are employed as proxies for risk-taking behavior. Using the seemingly unrelated regression (SUR), ordinary least square panel corrected standard error (OLS-PCSE) and quantile regression (QR), we find evidence in support of competition-fragility hypothesis which suggests a negative effect of competition on risk-taking behavior and stability. Other significant predictor of solvency in the insurance market are identified as firm size, capitalization, reinsurance and business line diversification and the results also indicate that the effect of each variable vary at different levels of insurance solvency. The findings offer several policy implications for the regulation and management of insurance stability.

Keyword: solvency risk, Lerner Index, Competition, Seemingly Unrelated Regression, Quantile regression, Insurance, Iran.

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1 . INTRODUCTION

1.1 Introduction

Financial services industries are generally fall off to improve efficiency and market stability in financial intermediation. The performance of the financial service industry which encompasses a broad range of businesses that manage money, including, banks, credit -card companies, insurance companies… is the use of many different mathematical measures to evaluate how well a company is using its resources to make a profit. Companies and analysts focus on financial performance because it plays a critical role not only in evaluating the current financial health and stability of a firm but also in achieving high efficiency and growth in the future.

In the formulation of regularity policies, regulators are faced with the difficult decision of whether competition is good or bad for market stability and they want to evaluate the behavior of different companies in industry against competition and assess risk-taking behavior between firms.

Generally, Competition is defined rivalry among sellers where each seller tries to increase sales, profits and market share by varying the marketing mix of price, product, distribution and promotion.

Competition in the financial sector is vital for a number of reasons. In some industries, the degree of competition in the financial sector can affect and change the efficiency of the production of financial services. Also, again as in other industries, it can affect the quality of financial products and the degree of innovation in the sector. It has been shown, theoretically and empirically, that the degree of competition in the financial sector can matter (negatively or positively) for the access of firms and households to financial services, which in turn affects overall economic growth (Claessens,2009).

Hence, understanding the impact of market competition on financial institutions, including banks and insurers, is important because it considerably affects firm’s profitability and solvency.

Solvency and profitability are two distinct yet interdependent aspects of a company’s financial health. A solvent company has assets that exceed its liabilities sufficiently to provide for reinvestment in the company’s growth. The standard for profitability requires that income derived from the company’s business activities exceeds the company’s expenses. While a company can be solvent and not profitable, it cannot be profitable without solvency.

Therefore, the concepts of solvency, profitability, interposition and influence of competition on market efficiently and solvency is consequential for financial industries.

1.2 Justification of the study

Insurance industry has an essential role in financial industry. Investigating Risk-Taking behaviors against external factors like competition is critical in order to achieving better company performance.

In order to fulfill the aim of Islamic republic of Iran in the context of rapid and productive economic growth for achieving the first place in economy, science and technology in region, and also have productive and effective interaction with world, moving forward more competitive in industry seems necessary. Considering competition in insurance market is one of the policymaker’s scheme. Competition is one of the factor that causes economic growth and increasing consumer welfare. Furthermore, Unlike banking markets, these theoretical expositions have rarely been examined empirically in insurance markets. However, Insurance companies occupy a pivotal position in the economy. Hence, evaluating the behavior of this industry around the inclusion of competition is serious which in turn affects overall economic growth in a country. To the best knowledge of authors, this is the first time that this subject will be studied in Iran.

The relationship between competition and stability can tell us a lot of information about insurance firm's risk-taking behavior. Traditionally, two schools of thought have been advanced to explain the relationship between competition and stability. The first, referred to as the competition-fragility hypothesis, suggests that competition is detrimental to stability (Alhassan and Biekpe, 2017). The second school of thought, as advanced by Boyd and De Nicolo (2005), argues in favor of the competition–stability hypothesis which suggests that improving market competitiveness enhances stability. In recent years, a third view has been advanced by Martinez-Miera and Repullo (2010) which suggests a non-monotonic relationship between competition and stability. Specifically, the authors argue that lower levels of competition are assumed to be stability enhancing while higher levels of competition result in market instability

1.3 Study aim and Methodology

The aim of this study is to realize the effect of competition on Risk-taking behavior and solvency in insurance market in Iran.

We employ annual data in insurance firms to estimate the Lerner Index as the proxy for competition, while the z_{score} and standard deviation of loss ratio are employed as proxies for Risk-taking behavior. Other significant predictor of solvency in the insurance market are identified as Firm size, capitalization, reinsurance and business line diversification and the results also indicate that the effect of each variable vary at different levels of insurance solvency.

With regard to each of these control variables, Firm size at first is measured as the natural logarithm of total assets. The second variable is capitalization which is measured as the ratio of net earned premiums to shareholder's equity.

The third variable is reinsurance which is measured as the ratio of reinsurance premiums ceded to gross premiums underwritten and this occurs through a risk transfer, where primary insurers pass on some premiums (and risk) to reinsurers to reduce their exposure.

The final variable that we should consider, is business line diversification which is refers to the underwriting of insurance policies across a spectrum of product lines, ensuring a diversified revenue source. This reduces the risk inherent in each business line and ultimately the overall portfolio risk.

The findings offer several policy implications for the regulation and management of insurance stability.

The objectives of this thesis are achieved in a three-stage analysis.

- First, we measure risk-taking behavior of insurers using the z_{score} solvency ratio and the underwriting risk using annual firm-level data on 17 insurance companies from 2007 and 2017.

- In a second step, we estimate the Lerner index as our proxy for insurance market competition. The index captures the markup power of firms over marginal cost, and represents the pricing power of firms in a market. The choice of the Lerner index over the market-level approaches in the Panzar and Rosse (1987) and Boone (2008) models is motivated by its ability to allow for the estimation of firm-level pricing behavior.

- In the third step, a battery of panel model regression techniques is employed to examine the effect of the competition (Lerner index) on the two proxies of insurance risk. First, we examine two proxies of insurance solvency and risk (z_{score} and cv_{lr}) around the fixed effect and random effect models by applying Hausman test in order to characterize the model of them. Then, the iterated seemingly unrelated regression (ISUR) model is used to account for correlation among the error terms of the system of equations[1]. This approach increases the efficiency of the parameter estimates compared to the step-by-step estimation of the system of equations (Zellner, 1962). Second, we provide robustness to ISUR estimates by employing the ordinary least squares (OLS) and quantile regression (QR) techniques to estimate static models. We will find evidence to understand which schools of thought have been advanced to explain the relationship between competition and stability.

The key questions and hypothesis of this study are given as follow,

1.4 Key Questions

- Does competition have effect on risk-taking behavior in insurance market in Iran?
- Which proxies should be used for competition and risk-taking behavior?
- Which schools of thought have been advanced to explain the relationship between competition and stability in Iranian insurance markets?

1.5 Hypothesis

- There is a negative relationship between the proxy of competition as Lerner index with risk-taking behavior.

[1] This refers to two equations with the same set of independent variables but different dependent variables

- There is a negative relationship between the proxy of competition as Lerner index with stability.

In the next section, we explain data requirements including sources, name of the insurance companies that we used them in this study and also the exact number of the years.

1.6 Data requirements

All data is extracted from data source of annual reports of the Central Insurance of Islamic Republic of Iran (C.I. IRAN) and Balance sheet of insurance companies. We use the data from 2007 to 2017 that included 17 insurance companies which have been founded 2007 such as Iran, Asia, Alborz, Dana, Parsian, Razi, Karafarin, Sina, Mellat, Omid, Hafez, Day, Saman, Iran Moein, Novin, Pasargad, and Moallem. The data covers entire 11 years' activity of Iranian insurance market from period 2007 until 2017.

1.7 Structure of the study

To achieve the aims and objectives, this study is formed to realize the effect of competition on Risk-taking behavior and solvency in insurance market in Iran.

The study consists of five chapters with their content briefly describe below.

- **Chapter1. Introduction**

This chapter gives a briefly introduction about the study, proposed methodology, justification of the study, and also sequential structure of the study chapters.

- **Chapter2. Literature review**

This chapter discuss the theoretical and empirical underpinning of the competition and risk relationship in the financial service industry. In theoretical framework three main hypothesizes is defined and in empirical section a range of research about effect of competition on different variables are discussed.

- **Chapter3. Models' explanation and their algorithms**

This chapter illustrates the algorithms of each models with a brief definition of each model and description of the applied methodology used in analysing risk-taking behaviour of insurance companies.

- **Chapter4. Regression Results of each model**

This chapter identify a brief definition of data, identify empirical strategies for accounting risk-taking behavior and competition and finally, different outcomes of each model (ISURE, OLS-PCSE and QR) are presented to make decision around the risk-taking behavior of Iranian insurance companies against competition.

- **Chapter5. Summary and conclusion**

This chapter shows the precautions and data analysis of the application result and the conclusion of this study, and a brief description on how the study aims and objectives are achieved.

2 . LITERATURE REVIEW

2.1 Introduction

As we go through literature of competition and risk relationship in the financial services industry study, we face with inadequate empirical studies on the relationship in insurance markets, hence the empirical discussions are extended to studies on risk determinants in insurance markets. In this section we discuss the theoretical and empirical underpinning of the competition and risk relationship in insurance markets.

2.2 Theoretical framework

- **Competition-fragility hypothesis (CFH)**

The competition-fragility hypothesis (CFH) supports a negative effect of competition on risk-taking behavior and stability, suggesting that competition is detrimental to market stability. With regard to the previous studies, this school of thought gives three main transmission mechanisms for the relationship.

First, Petersen and Rajan (1994) provided a simple model showing that the extent of competition in credit markets was important in determining the value of lending relationships. They showed that Creditors were more likely to finance credit constrained firms when credit markets were concentrated because it was easier for these creditors to internalize the benefits of assisting the firms. Their model had implications about the availability and the price of credit as firms' age in different markets. Their study also offered evidence for these implications from small business data. It concluded with conjectures on the costs and benefits of liberalizing financial markets, as well as the timing of such reforms.

Overall, the general point of their paper was that competition and long-term relationships were not necessarily compatible, whether the markets being analyzed were labor or capital markets. Reformers in relationship-based economies were not always right, if they thought that adding a dose of competition to their systems would necessarily make it better off. Conversely, it may be equally wrong to expect firm-creditor or firm-worker relationships to be as strong or valuable in the competitive U.S. markets as in the cartelized markets elsewhere.

Second, Allen and Gale (2004) considered a variety of different models of competition and financial stability including general equilibrium models of financial intermediaries and markets, agency models, models of spatial competition, Schumpeterian competition, and contagion in order to find out the efficient levels of competition and financial stability. There was a very wide range of possibilities concerning the relationship between competition and financial stability. In some situations, there was a trade-off as was conventionally supposed but in others there was not. Since competition was generally viewed as being desirable because it leaded to allocation efficiency, this perceived trade-off leaded to calls for increased regulation of the banking sector to ensure the coexistence of competition and financial stability. The most popular instrument for achieving this end was the imposition of minimum capital requirements on banks. If the owners of banks were forced to put up significant amounts of capital, they would be unwilling to take risks because they would again stand to lose large amounts of funds. Their analysis suggested that the issue of regulation and its effect on competition and financial stability was complex and multi-faceted. Careful consideration of all the factors at work both at a theoretical and empirical level was required for sound policy.

The third mechanism, as explained by Keeley (1990), tested the hypothesis that increases in competition caused bank charter values to decline, which in turn caused banks to increase default risk through increases in asset risk and reductions in capital. The potential loss of a charter in the event of bankruptcy created, in effect, a regulatory bankruptcy cost, which counterbalanced the incentive for excessive risk taking due to fixed-rate deposit insurance. The empirical results were consistent with this hypothesis. Thus, they concluded that at least some of the increase in bank and thrift failures and payouts from the deposit insurance funds may be due to a general decline in the value of bank charters associated with increased competition within the banking and financial service industry. In the past, the perverse incentives created by the deposit insurance system were countervailed by the potential loss of a valuable charter that induced banks to limit their own risk taking. This does not mean that it is desirable or even possible to return to a system of anticompetitive restrictions in order to reduce banking risk. But it does mean that the deposit insurance system must be reformed to reduce the rewards it provides for excessive risk taking.

Generally, if we want to categorize the competition-fragility hypothesis based on these three studies, we will have the results as follow;

- First, increasing market competition can exacerbate the information asymmetry problem. As argued by Petersen and Rajan (1995), competition shortens relationships and increases the cost of acquiring information and monitoring customer behavior.
- Second, increasing competition also affects the quality of supervision by regulatory authorities in checking excessive risk-taking.

- Third, competition for profits in competitive markets increases the incentives for excessive risk-taking. This also lower the capital buffers and exposes firms to adverse economic conditions. As a result, there is a tendency to increase the loss distribution of insurance pools and create a high probability of market insolvency

- **Competition-stability hypothesis (CSH)**

A positive effect of competition on stability is defined by the competition–stability hypothesis (CSH). According to this school of thought, Boyd and de Nicolo (2005), analyzed the theory of bank risk taking and competition revisited and they concluded that, moral hazard was exacerbated and banks intentionally took on more risk when confronted with increasing competition. They argued that this literature had had a significant influence on regulators and central bankers. They reviewed the empirical literature and concluded that the evidence was best described as "mixed." They then showed that existing theoretical analyses of this topic were fragile, in other words, they showed that a positive relationship between the number of bank competitors and risk seeking is fragile since there exist fundamental risk-incentive mechanisms that operated in exactly the opposite direction, causing banks to become riskier as their markets became more concentrated. These mechanisms should be essential ingredients of models of bank competition.

Generally, when this hypothesis applied to insurance markets, the reduction in competitive conduct (increasing concentration) has the potential to raise the price of insurance policy premiums through the wielding of market power by dominant firms. This could lead to the adverse selection of high-risk policyholders in an insurance pool, increasing the probability of loss occurrence and market instability.

- **Martinez-Miera and Repullo (MMR) hypothesis**

Based on the assumption of a non-monotonic relationship between competition and risk, Martinez-Miera and Repullo (2008) investigated the effects of increased competition on the risk of bank failure in the context of a model in which (1) banks invested in entrepreneurial loans, (2) the probability of default of these loans was endogenously chosen by the entrepreneurs, and (3) loan defaults were imperfectly correlated. They showed that there were two opposite effects. The risk-shifting

Effect and the margin effects. Their results showed that the risk-shifting effect tended to dominate in monopolistic markets, whereas the margin effect dominated in competitive markets, so a U-shaped relationship between competition and the risk of bank failure generally obtained. In general, when this hypothesis applied to insurance markets, both CFH and CSH hypotheses combined over time. With regard to MMR hypothesis, at lower levels of competition (high market power), insurers benefited from information advantages, resulting in a lower likelihood of switching by policyholders, and bridging the information asymmetry that characterized insurance markets. However, increasing competitive conditions (low market power) caused excessive risk-taking in competition for market share and profits. In insurance markets, excessive risk-taking resulting from price wars has the potential to attract high-risk policyholders into the insurance pool, increasing the probability of claim development. The net margin effect results in a non-linear relationship between competition and stability. This effect could either be a U-shape or an inverted U-shape, depending on the direction of the net effect.

- **Empirical literature**

Empirical studies on the competition-risk relationship have been tested several times in banking markets. However, to date only Cummins et al. (2017) and Shim (2015) have examined the relationship in insurance markets in Europe and the U.S., respectively.

This review extends the discussion to involve studies on the determinants of risk in insurance markets in order to help identify relevant research gaps. We will mention this empirical literature with different determinants and different authors in foreign and domestic studies in order to identify competition-risk relationship in insurance market.

Baranoff and Sager (2003) examined the interrelationships between asset risk, capital structure, distribution and organizational forms of a sample of life insurance companies in the U.S. from 1993 to 1999. Their study was the first step toward integrating in a single framework two previously separate lines of research on major structural decisions of life insurers. The literature had previously studied the relation between capital structure and asset risk on the one hand, and the relation between organizational form and distribution system on the other hand, without integrating them. They modeled the four key insurer decisions of capital structure, asset risk, organizational form, and distribution system as endogenous choices in a single interrelated set of simultaneous equations. Their model was not only evaluating the nature of the interactions among these decisions but also evaluated the impact of insurers' fundamental business strategy (treated as predetermined) on these choices.

The business-strategy hypothesis regarded other key decisions as jointly determined and driven by the fundamental business strategy, once the latter was set in motion. With regard to the previous studies, they found a positive relation between capital ratios and asset risk. They also found an association in the simultaneous context between stock ownership and brokerage distribution, which was not found in prior studies. Stock ownership was related to greater financial and asset risk taking, whereas brokerage distribution was associated with lower risk taking. These and other results were interpreted in light of several theories, including transaction-cost economics (TCE), agency theory, and regulatory and bankruptcy cost avoidance on the one hand and risk-subsidy hypothesis on the other.

Deriving from these theories, the finite risk paradigm emerged as the most comprehensive interpretation of the results, as opposed to the risk-subsidy hypothesis of the impact of guarantee funds. Of the four major decisions that they examined, the insurer’s business strategy was a significant factor only in the capital structure and distribution system decisions, as predicted by TCE.

Chen and Wong (2004) examined the firm-specific and macro determinants of the financial health (stability) of insurers in four Asian economies. They employed 16 financial ratios which include the effects of factors and market factors on the financial of firm-specific stability for both life and non-life insurance companies in Japan, Singapore, Malaysia and Taiwan from 1994 to 1999. They used a logit regression model. The logistic regressions for the insurers in each economy have generated statistically significant results consistent with majority of the hypotheses formulated on firm-specific factors, which determined an insurer's financial strength.

At the macro level, none of the hypotheses about the effects of market/economic factors on the general insurers' financial strength was supported. However, such an analysis was confined to Singapore only as data are limited for other economies. Their results had some important policy implications for monitoring insurers' financial health in Asian economies. They found that, the factors that significantly affected general insurers' financial health in Asian economies were firm size, investment performance, liquidity ratio, sur-plus growth, combined ratio, and operating margin.

On the other hand, the factors that significantly affected life insurers' financial health were firm size, change in asset mix, investment performance, and change in product mix. Firm size and change in asset mix were the two factors consistently affecting their financial health in all four economies studied. Other factors had different effects on the insurers' financial health in different economies. This together with the different predictors for general insurers in different economies showed that each economy had its own characteristics, which needed a different efficient set of predictors of insurers' financial health.

It was also important to had different regulations for life/health and general insurance companies (even for the same economy), as each operates under different constraints and required more specific management and regulatory structures. They concluded that Insurance authorities should develop their guiding principles according to the stages of economic development of their own country (along with the historical and cultural context of each economy). Thus, insurance regulation was an evolving process and there was a need to be flexible, as there will be continuing changes in the environment and insurance market.

In the U.K., Shiu (2005), also examined the solvency determinants, including economic and firm-specific factors of life insurance companies using panel data for 1986 to 1999. They presented that solvency determinants changed from one epoch to another. The results arising out of a specific period may reflect the features of that period. Their results suggested that both economic and firm-specific variables may affect insurer solvency. A number of variables had been identified and discussed. These variables are regarded as determinants of life insurer solvency. With regard to these variables, they had found that reserves and inflation had a negative impact on the solvency of life insurers, while bond issues, equity and new businesses improved insurance solvency.

Their findings had, at least, two implications for the life insurance industry. The first was that life offices had to evaluate their exposure to unexpected inflation risk and insurance leverage risk, and pay attention to their asset allocation and reserves management. The second implication was that insights into the negative relation between solvency and market competition could help industry regulators and policy-makers to frame licensing regulations that limit the number of insurers. Their implications may be helpful for those involved in monitoring insurer solvency.

Cheng. (2011) In the U.S., investigated the association between the risk-taking behavior of the life–health (LH) insurers and the stability of their institutional ownership within a simultaneous equation system model.

They obtained three main results. First, they found evidence to support the "prudent-man" hypothesis that stable institutional ownership is associated with low risk-taking behavior. Second, when the investors were sorted in terms of stringency of the prudent-man restrictions, the negative effect of institutional investor stability on risk continued to hold for banks, Pensions and Endowments (PNE), and investment advisors but it became insignificant for insurance companies as institutional owners of LH insurers.

Third, the magnitude of the institutional ownership stability effect of different types of investors on risk can be explained by a combination of the prudent-man laws, active versus passive monitoring function of institutional investors, their portfolio concentration in the investee-firms, and their clientele.

Moreover, they had estimated a four-equation model including three channels through which the effect of institutional ownership stability (IOP) was transmitted to total risk. They found that greater IOP was associated with higher capital ratio (lower leverage), lower underwriting risk, and higher investment risk. Their findings manifested a risk-shifting pattern by the institutional investors, through which they switched from insurance underwriting where they have little expertise, as outsiders to the insurance industry, to financial investment, where their expertise resided. Their results on risk reduction suggested that regulators can strengthen the prudent-man laws in order to curtail insurer risks by encouraging stable institutional ownership in the insurance industry.

Ho et al. (2012) undertook an analysis of the impact of organizational structure and board composition on risk-taking in the U.S. non-life insurers. Property casualty insurance industry revealed some interesting findings. The risk-taking measures included total risk, underwriting risk, investment risk, and leverage risk. Their evidence showed that mutual insurers had lower total risk, underwriting risk, and investment risk than stock insurers. These overall results suggested that mutual insurers are generally associated with lower risk and that organizational structure was an important factor that determined an insurer's risk-taking behavior. In terms of board composition variables, they found that some board composition variables not only had impact on risk-taking behaviors but also affect different risk measures differently. Thus, using different risk measures was better than using one risk measure to assess risk-taking behavior. They also found CEO[2]/chairperson of board duality was associated with higher leverage risk. Because large board size can be interpreted as associated with powerful CEOs, it seemed a powerful CEO/chairperson of the board might be inclined to choose high leverage for his or her own personal benefits. On the other hand, they found the impact of board size on different risk-taking

[2] Chief Executive Officer

measures varied. Specifically, the relation between board size and investment risk was negative whereas the relation between board size and total risk (leverage risk) was positive. Their evidence also suggested that mutual insurers with duality tend to have higher investment risk, but lower leverage risk relative to stock insurers.

They also found the relation between size and investment risk was negative while the relation between size and leverage was positive. The relation between business line concentration and underwriting risk was positive whereas the relation between business line concentration and investment risk was negative. Finally, they concluded that an insurer can control its total risk through management of underwriting, investment, and leverage risks that determined an insurer's risk profile.

Cheng and Weiss (2013) also investigated the relationship between capital and risk among a sample of property and liability insurers in the U.S. from 1993 to 2007. The authors employed a Three-stage least squares estimation in order to investigate the relationship between capital and two types of risk: underwriting and asset risk. Their results suggested that risk and capital are positively related. That is, a positive relationship was detected between capital and asset and underwriting risk, so that capital increases are associated with increases in investment and underwriting risk and (vice versa). Further, both marginally adequately capitalized insurers and under-capitalized insurers generally adjusted to their target underwriting and asset risk ratios at a higher speed than well-capitalized insurers in the post-RBC[3] period. But marginally adequately capitalized insurers and under-capitalized insurers also increased their underwriting risk and investment risk ratios (over the period 1994–2007). The net effect of this activity was to increase underwriting risk by almost 5 per cent

[3] Risk Based Capital

for under-capitalized insurers. Generally, they proved evidence suggesting that increases in capital result in increased investment and increased underwriting risk.

Using international dataset of over 1700 firms from 46 countries, Pasiouras and Gaganis (2013) explored the relationship between soundness and regulatory policies in relation to solvency and capital requirements, investments, technical provisions, corporate governance and internal control rules, and supervisory power. Their results provided some evidence that higher stringency in overall capital requirements had a negative impact on the insurers' soundness. However, this impact was not robust across the specifications and became insignificant when they controlled for inflation or the institutional development. Their results also showed that regulations that allowed the early and late intervention of insurance supervisors may have a negative impact on the soundness of the firms. Yet, regulatory powers in relation to enforcement and sanctions have a positive impact on soundness. Higher requirements in relation to technical provisions, more regulatory principles on investments and the adoption of an approach of detailed regulations on admissible assets had a positive and significant influence on soundness that is robust across most of the specifications. However, the authors did not find evidence in favor of corporate governance indicators and capital requirements having any impact on insurance solvency.

From a governance perspective, Marek and Eling (2013) examined the effect of corporate governance variables on risk-taking in two large European insurance markets. They measured asset, product, and financial risk in insurance companies and employed a structural equation model in which corporate governance was modeled as a latent factor. Based on this model, they presented empirical evidence on the link between corporate governance and risk-taking.

Higher levels of compensation, increased monitoring (more independent boards with more meetings), and more block holders are associated with lower risk-taking. Generally, they showed that corporate governance mechanisms, such as compensation, the role of independent directors, or major stakeholders, need to be more closely considered in insurance regulation because they affected risk-taking in companies.

In Malaysia, Ng et al. (2013) provided insights on how a firm's size was related to risk-taking particularly underwriting risk of Malaysia's insurance companies, from 2000-2010. They applied Pearson's correlation, fixed and random effects models, and the system Generalized Method of Moments (GMM) in their study. Both the fixed effects and the system GMM panel data regression models suggested a positive link between the insurance firm size and underwriting risk.

In other words, underwriting risk which represented by the loss ratio, was reported to be positively related to insurance firm size. This finding was consistent with prior studies and the hypothesis that risk level increases when the company size is larger. More specifically, the moral hazard theory predicted that the TBTF[4] doctrine distorted market discipline and leaded to excessive risk taking due to the certainty of possible bailouts. As a result, a firm would most likely be a greater risk-taker and engaged in expansion activities to achieved a larger size, in order to be entitled to a government bailout should the need arise. Based on these findings, several recommendations were made in this study to minimize the negative impacts of excessive risk taking in relation to size. Since it was not easy to determine the correct size threshold, capping the size of a firm was not always the best regulatory response. Recognizing this, it was important

[4] Too-Big-To-Fail theory which believes that government support and the guarantee of a financial bailout are warranted for large financial institutions facing crises, for the main purpose of avoiding disruptions within a country's economy.

to distinguish between the safest and riskiest insurance company across the category of firm size through periodic monitoring.

Using a sample of life insurance companies in Taiwan, Hu and Yu (2014) analyzed the interrelationships between investment risk, underwriting risks and capital ratio from 2004 to 2009. They applied two-stage least square regression (2SLS) and the two-stage quantile regression (2SQR) to capture the effects of low capital (or risk) levels and high capital (or risk) levels. In 2SLS, they did not find a relation between investing risk and capital, but found underwriting risk had a positive impact on the capital level. The 2SQR method analyzed the capital-risk relation in greater detail and provided stronger evidence than 2SLS.

In the 10th, 50th and 90th conditional quantiles, their empirical results indicated that the capital level was negatively related to investing risk level as the moral hazard hypothesis predicts, while the capital level was positively related to the underwriting risk level, lending support to the transaction cost hypothesis and regulatory cost hypothesis.

Their overall results had important implications for life insurer examination and surveillance.

If insurers hold too much capital over the regulatory minimum, then the investing risk may be reduced, but they have to give up some potential opportunities that have high expected returns. As Dickinson (1997) noted, too little capital was unable to fully absorbed the business risks in financing future growth. Lee and Chih (2013) also warned that, for financial institutions, stricter regulation may be good for their stability, but not for efficiency.

Life insurers should control investing risk according to their tolerance for risk or their sensitivities to the cost of capital so as to prevent their failure. Regulators also recognized that, even though increased capital requirements may diminish life insurers' risk and enhance safety, regulatory constraints also hold them back from investing in potential opportunities or push them to shift toward inefficient activities. For the health and stability of the insurance industry, the regulator should temporarily relax the RBC regulation, while at the same time insurers learn to be in a position to skirt market volatility when facing adverse market conditions. Therefore, both regulators and insurers should strengthen their awareness of the relation between capital and risk, particularly in the management of different kinds of risk.

Closely related to this thesis are studied by Shim (2015), Cummins et al. (2017) and Alhassan and Biekpe (2017). Shim (2015) examined the empirical relationship between market concentration and the stability of the property-liability market in the U.S. over the period 1992–2010. He measured the insurer's financial stability with an accounting measure of insolvency risk, the z_{score}. In the state-level market analysis, he used the standard deviation of statewide loss ratio and combined ratio as alternative measures of an insurer's financial stability. 2SLS estimation method along with instrumental variables was employed in order to deal with potential indigeneity problems. The results of empirical tests showed that the impact of market concentration was significant on the insurer's financial stability. He found evidence supporting the concentration-fragility view when using industry-level market concentration, indicating that higher national insurance market concentration was associated with lower financial stability of U.S. property–liability insurance companies. The results using state-level market concentration also supported the concentration-fragility view.

The outcomes of this research suggested that regulators should be more concerned about increasingly concentrated market structure where a few very large firms dominated market share rather than the competitive market structure with many firms, each with a small share of the market, because the risk of firm failures would be more pronounced in a concentrated market.

Empirical results showed other important determinants in ensuring a safe and sound insurance system. Among them, large insurers are likely to be financially more stable than small insurers. However, the nonlinear relationships between firm size and its insolvency risk implied that an extreme increase in firm size may have a negative influence on the insurer's financial stability. He provided evidence that the increase in natural catastrophes undermined the insurer's financial strength. The inverse relationship between leverage and the z_{score} suggested that higher premium growth without corresponding policyholders' surplus may harm the insurer's financial stability. Both product and geographical diversification appeared to have a positive impact on the insurer's financial strength. Mutual insurers tend to have lower probability of insolvency relative to stock firms. They found that interest rate changes were positively associated with the insurer's financial strength. By identifying the firm-specific factors along with market structure and macroeconomic status that affected insurers' financial stability, their results should offer regulators and industry practitioner's important implications about the determinants of the firm's financial health.

Similar to this research Cummins et al. (2017) examined the effect of competition on stability in selected life insurance markets in the European Union. The authors estimated the Boone indicator as the proxy for competition for insurance markets in 10 European countries using annual data from 1999 to 2011.

Their investigation of the relationship between competition and financial soundness revealed a positive link between the two: higher levels of competition were found to significantly increase the financial soundness of the industry which was in favor of competition-stability hypothesis.

However, this effect was not homogeneous across financially weak and financially healthy life insurers. They found evidence that higher levels of competition had a larger impact on the solvency of weaker insurers than on healthier insurers.

In other words, positive effect of competition on solvency was stronger for less solvent insurers than highly solvent ones.

Their findings offered some potentially useful insights to policymakers in terms of designing policies to promote competition. The fact that competition levels, as measured in this paper, did not improve, and even deteriorated, should raise concerns about the workings of the single life insurance market, nearly two decades after the Third Insurance Directive. It was possible that country specific factors such as legal systems, institutional and cultural characteristics, tax systems, and language acted as significant "natural" entry barriers, hampering competition. In designing policies to promote competition in this sector, their results suggested that weaker insurers would benefit from increased levels of solvency if exposed to higher levels of competition.

Alhassan and Biekpe (2017) had also analyzed competition and risk-taking behavior in the non-life insurance market in South Africa. They examined the non-linear effect of competition on risk-taking behavior in an emerging insurance market using annual firm-level data on 79 non-life insurance firms from 2007 to 2012. They employed two proxies of insurance risk in the solvency ratio of z_{score} and operational risk, while insurance market competition was analyzed using the Lerner index.

In the empirical relationship they used Seemingly Unrelated Regression technique of Zelner (SUR). Ordinary Least Square Panel Corrected Standard Error (OLS-PCSE), Quantile Regression (QR) and System Generalized Method of Moments techniques (GMM) were also employed to account for modeling failures of the SUR estimates.

From the panel regression estimates, they provided strong evidence in support of the Martinez-Miera and Repullo hypothesis which confirmed a non-linear, inverted U-shaped relationship. This suggested that at lower levels of concentration (high competition), competitive pressures were stability enhancing (instability). However, the stabilizing effect of concentration diminished after a certain threshold point for competition in the non-life insurance market.

They used significant predictors of solvency in the insurance market which identified as firm size, capitalization, reinsurance, business line diversification and foreign ownership.

The results also indicated that the effect of each variable varied at different levels of insurance solvency. Specifically, the competition-fragility effect was more pronounced among weaker insurers while the competition–stability effect was found to be pronounced among stronger insurers. This suggested that competition has a greater destabilizing effect on weaker insurers.

The review undertaken in this section identifies the following research gaps. First there is a dearth of studies on the competition-risk relationship in insurance markets. Second, empirical evidence on the determinants of risk-taking behavior in insurance markets in Iran appears to be non-existent. For this reason, we introduce some studies which relates to the microeconomics studies in different countries in which mostly have been limited to efficiency and competition among several others. Hence, regarding to the microeconomics studies on insurance markets, Ansah-Adu et al. (2012) and Alhassan and Biekpe (2016) studied around the efficiency and competition in insurance markets. For instance, Ansah-Adu et al. (2012) evaluated the cost efficiency of insurance companies in Ghana using a cross-sectional data set of 30 firms over the period 2006-2008. They applied two-stage procedure to ascertain whether insurance companies are cost efficient and also to examine the efficiency determinants of insurance companies. The study evaluated the efficiency scores by applying a data envelopment analysis that allowed the inclusion of multiple inputs and outputs in the production frontier and also it employed a regression model to identify the key determinants of efficiency of the Ghanaian insurance industry.

The empirical results in the first stage suggested higher average efficiency scores for life insurance business than non-life insurance companies. In the second stage, the authors observed that the drive for market share, firm size and the ratio of equity to total invested assets were important determinants of an insurance firm's efficiency. Their findings provided insights into the cost efficiency of insurance companies in Ghana.

Besides Alhassan and Biekpe (2016) also examined the effect of competition on cost and profit efficiency in the non-life insurance market in South Africa. They employed The stochastic frontier analysis to estimate cost and profit efficiency of 75 non-life insurers from 2007 to 2012.

Competition of Insurance market was analyzed by cross sectional estimations of the Panzar-Rosse (1987) revenue model. The findings in the first stage indicated high levels of efficiency in cost and low levels in profit. The results of ordinary least square estimations of the P-R models in the second stage indicated a monopolistic competitive non-life insurance industry.

In the third stage analysis, they employed a fixed effects multiple regression analysis to examine the effect of competition and other contextual variables on cost and profit efficiency. They found a positive effect of competition on cost efficiency to supports the 'quiet-life' hypothesis of Hicks (1935) which suggested that competitive insurance markets lead to improvements in cost efficiency. The positive relationship between competition and profit efficiency also indicated that competition improved profit efficiency to invalidate the market power hypothesis.

These findings suggested the absence of information asymmetry in the non-life markets.

Their findings also suggested that small insurers are more efficient in controlling cost and maximizing profits compared to large insurers. This reflected the monitoring and control difficulties associated with the management of large scale operations. Older insurers were also found to be less cost and profit efficient.

With regard to the Iranian research around the subject of this dissertation there is only one thesis which studied by Esmailei (2012). He explored and measured competition in the non-life insurance industry in Iran during the period of 2008 to 2010, using Panzer-Ross methodology. He used panel data with fixed effects due to the results that he gained by Chow test, Bruesch-Pagan test and Hausman test. He applied Stata software for estimating coefficients. H value in Panzar-Rosse method was sum of the coefficients of the three variables: unit price of labor, unit price of business services and unit price of financial capital. Based on the value of H in different models, he concluded that non-life insurance industry in Iran over the period 2008-2010 had been monopolistic competition.

As far as we aware, the effect of competition on risk-taking behavior has not been examined in insurance literature in Iran. This study significantly addresses these research gaps.

3 . Empirical Model

3.1 Introduction

In this chapter we describe a brief explanation and characteristics of panel data and some benefits of this method and then, we define a battery of panel model regression techniques which is used to examine the effect of the competition (Lerner index) on the two proxies of insurance risk including solvency risk and underwriting risk. Each method (ISUR, OLS-PCSE and QR) is extended to complete definition and formulas.

3.2 Panel Data

The term "panel data" refers to the pooling of observations on a cross section of individuals, countries, firms, etc. over several time periods. This can be done by surveying a number of individuals or countries and following them over time. (Baltagi, 2005)

A panel or longitudinal data set are multidimensional data including measurements over time. They involve observations of multiple phenomena gained over multiple time periods for the same firms or individuals. Panel data analysis indicates a joining of regression and time-series analysis. Unlike regression and time-series data we can study many subjects over time with panel data. Observing a broad cross section of subjects over time allows us to study dynamic, as well as cross-sectional, aspects of a problem.

Panel data require special statistical methods because the set of observation on one subject tends to be intercorrelated. This correlation must be taken into account to draw valid scientific inference.

3.3 The benefits of Panel Data

Panel data sets for economic research maintain several main advantages over conventional cross-sectional or time-series data sets. Therefore, we specify some benefits of panel data as follow.

- Panel data propose more variability, more informative data, less collinearity among the variables. In addition, this set of data give more degrees of freedom and more efficiency.
- Controlling for individual heterogeneity. Panel data implies that individuals, firms, states or countries are heterogeneous. Time-series and cross-section studies not controlling this heterogeneity run the risk of obtaining biased results.
- Panel data are better able to study the dynamics of adjustment. Cross-sectional distributions that look relatively stable hide a multitude of changes. Spells of unemployment, job turnover, residential and income mobility are better studied with panels.
- Panel data are better able to identify and measure effects that are simply not detectable in pure cross-section or pure time-series data.
- Panel data models allow us to construct and test more complicated behavioral models than purely cross-section or time-series data.

3.4 Panel data formulas

Generally, we will apply capital letters to show random variables or matrices, relying on context to distinguish the two, and small letters for specific observations. Scalars and matrices will be in normal type; vectors will be in bold type.

Turning to specific points of notation we let Y_{ij} represent a response variable and X_{ij} a vector of length p (p -vector) of explanatory variables observed at time t_{ij} , for observation j=1, …, n_i on subject i =1,...,m .

The mean and variance of Y_{ij} are represented by E($Y_{ij}) = \mu_{ij}$ and Var (Y_{ij})=v_{ij}.

The set of repeated outcomes for subject *i* collected into an n_i-vector, Y_i =(Y_{i1} , …, Y_{in}) with mean E($\boldsymbol{Y_i}) = \boldsymbol{\mu_i}$ and $n_i \times n_j$ covariance matrix Var ($\boldsymbol{Y_i}$)=v_i, where the jk element of v_i is the covariance between Y_{ij} and Y_{ik} denoted by Cov (Y_{ij}, Y_{ik})=v_{ijk}.

We use R_i for the $n_i \times n_j$ correlation matrix of Y_i . The responses for all units are referred to as

$\boldsymbol{Y}$ =($\mathbf{Y_{1,\dots,}}\mathbf{Y_m}$) , which is an *N*-vector with N=$\sum_{i=1}^{m} n_i$.

Most panel analysis is based on a regression model such as the linear model,

$$\begin{aligned} \mathrm{Y_{ij}} &= \beta_1\mathbf{X}_{\mathrm{ij1}} + \beta_2\mathbf{X}_{\mathrm{ij2}} + \cdots + \beta_{\mathrm{p}}\mathbf{X}_{\mathrm{ijp}} + \varepsilon_{\mathrm{ij}} \\ &= \mathbf{X'}_{\mathrm{ij}}\boldsymbol{\beta} + \varepsilon_{\mathrm{ij}} \end{aligned}$$

Where $\beta = (\beta_{1,\dots,}\ \beta_p\ )$is a p-vector of unknown regression coefficient and ε_{ij} is a zero-mean random variable illustrating the deviation of the responses from the model prediction, $x'_{ij}\boldsymbol{\beta}$. Assume that, $x_{ij1} = 1$ for all *i* and all *j*, and β_1 is then the intercept term in the linear model. In the matrix notation, the regression equation for the *ith* subject takes the form

$$\mathrm{Y_{i=}X_i\beta + \varepsilon_i}$$

Where X_i is a $n_i \times p$ matrix with X_{ij} in the jth row and $\varepsilon_i = (\varepsilon_{i1,\dots,}\ \epsilon_{im})$, (Verbeek, 2004).

3.5 Fixed Effect and Random Effect

An important benefit of panel data compared to time series or cross-sectional data sets is that it allows identification of certain parameters or questions, without the need to make restrictive assumptions. For example, panel data make it possible to analyze changes on an individual level. Consider a situation in which the average consumption level rises with 2% from one year to another. Panel data can identify whether this rise is the result of, for example, an increase of 2% for all individuals or an increase of 4% for approximately one half of the individuals and no change for the other half (or any other combination). Meaning that, panel data are not only suitable to model or explain why individual units behave differently but also to model why a given unit behaves differently at different time periods (for example, because of a different past).

We shall, in the sequel, index all variables by an i for the individual *(i* = 1, . . ., *N)* and a t for the time period *(t* = 1, . . ., *T)*. In very general terms, we could specify a linear model as

$$y_{it=}x'_{it}\beta_{it}+\varepsilon_{it},$$

Where β_{it} measures the partial effects of x_{it} in period t for unit i. Of course, this model is much too general to be useful, and we need to put more structure on the coefficients β_{it}. The standard assumption, used in many empirical cases, is that β_{it} is constant for all *i* and *t*, except; possibly; the intercept term. This could be written as

$$y_{it=}\alpha_i x'_{it}\beta+\varepsilon_{it}, (3\text{-}1)$$

Where x_{it} is a *K*-dimensional vector of explanatory variables, not including a constant. This means that the effects of a change in *x* are the same for all units and all periods, but that the average level for unit *i* may be different from that for unit j. The α_i therefore capture the effects of those variables that are peculiar to the *i*-th individual and that are constant over time. In the standard case, ε_{it} is assumed to be independent and identically distributed over individuals and time, with mean zero and variance σ_ε^2 . If we treat the α_i as *N* fixed unknown parameters, the model in (3-1) is referred to as the standard **fixed effects model**.

An alternative approach assumes that the intercepts of the individuals are different but that they can be treated as drawings from a distribution with mean μ and variance σ_α^2. The required assumption here is that these drawings are independent of the explanatory variables in x_{it} . This leads to the **random effects model**, where the individual effects α_i are treated as random. The error term in this model consists of two components: a time-invariant component[5] α_i

[5] In the random effects model, the α_i s are redefined to have a zero mean.

and a remainder component ε_{it} that is uncorrelated over time. It can be written as

$$y_{it=}\mu + x'_{it}\beta + \alpha_i + \varepsilon_{it}, \quad (3\text{-}2)$$

Where μ denotes the intercept term.

The possibility of treating the α_i s as fixed parameters has some great advantages, but also some disadvantages. Most panel data models are estimated under either the fixed effects or the random effects assumption.

To decide between fixed and random effect, we must run a Hausman test where the null hypothesis is that the preferred model is random effects (difference in coefficients is not systematic) vs. the alternative the fixed effects. The Hausman test for the fixed and random effects regressions is based on the parts of the coefficient vectors and the asymptotic covariance matrices that corresponded to the slopes in the models, that is, ignoring the constant term(s), (Verbeek, 2004). In the following step we take a brief look at the definitions and algorithms of each panel data technique in details.

3.6 Seemingly Unrelated Regression

A seemingly unrelated regression (SUR) system consist of several individual relationships that are linked by the fact that their disturbances are correlated and this due the fact that in the estimation of regression models with different dependent variables and the same independent variables, there is a high possibility of correlations among the residuals. To account for these correlations, we employ the seemingly unrelated regression (SUR). We employ the seemingly unrelated regression (SUR) using William_H_Green (2012) and zelner (1962) to estimate the models.

There are two main motivations for use of SUR. The first one is to obtain efficiency in estimation by combining information on different equations. The second motivation is to impose and/or test restrictions that involve parameters in different equations (Roger and Perron, 2006).

Let

$$y_M = X_M \beta_M + \varepsilon_M. \quad (3\text{-}1)$$

We shall denote the matrix of independent variables for all observations as **X** and the vector of observations on the dependent variable as Y. There are *M* equations and *T* observations in the sample of data used to estimate them.

The seemingly unrelated regressions (SUR) model in (3-1) is

$$Y_i = X_i \beta + \varepsilon_i \quad i = 1, \dots, M \ (3\text{-}2)$$

Define the MT × 1 vector of disturbances,

$$\varepsilon = [\varepsilon'_1 \varepsilon'_2 \dots \varepsilon'_M]'.$$

We assume strict exogeneity of X_i ,

$$E[\boldsymbol{\varepsilon} \mid X_1, X_2, \ldots, X_M] = \mathbf{0},$$

and homoscedasticity,

$$E[\varepsilon_M \varepsilon'_M \mid X_1, X_2, \ldots, X_M] = \sigma_{MM} I_t$$

We assume that a total of T observations are used in estimating the parameters of the M equations. Each equation involves K_i regressors, for a total of $K = \sum_{i=1}^{M} K_i$.

We will require $T > K_i$. We also assume that disturbances (errors) are uncorrelated across observations but correlated across equations. Therefore, $E[\varepsilon_{it}\varepsilon_{js} \mid X_1, X_2, \ldots, X_M] = \sigma_{ij}$ if t=s and 0 otherwise. The disturbance formulation is, therefore,

$$E[\varepsilon\varepsilon' \mid X_1, X_2, \ldots, X_M] = \sigma_{ij} I_t, = \Omega \quad (3\text{-}3)$$

The special case of the seemingly unrelated regressions model is called Generalized Least Squares (GLS) which is a multivariate regression model, meaning that the data matrices are group specific data sets on the same set of variables. Zellner (1962) and Dwivedi and Srivastava (1978) have analyzed that If the equations have identical explanatory variables, that is, if $\mathbf{X}_i = \mathbf{X}_j$, then OLS and GLS are identical. The equations that are used in this study have identical explanatory variables, hence, generalized least squares is equivalent to equation by equation ordinary least squares.

The model has a particularly convenient form. For the *t*th observation, the $M\times M$ covariance matrix of the disturbances is

$$\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1M} \\ \sigma_{21} & \sigma_{22} & \cdots & \sigma_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{M1} & \sigma_{M2} & \cdots & \sigma_{MM} \end{bmatrix}, \quad (3\text{-}4)$$

So in (3-3),

$$\Omega = \Sigma \otimes \mathbf{I} \quad (3\text{-}5)$$

and

$$\Omega^{-1} = \Sigma^{-1} \otimes I$$

Denoting the *ij*th element of $\Sigma^{-1}$by σ^{ij}, we find that the GLS estimator is

$$\hat{\beta}=[X'\Omega^{-1}X]^{-1}\, X'\Omega^{-1}y= [X'(\Sigma^{-1} \otimes I)X]^{-1}X'(\Sigma^{-1} \otimes I)y. \quad (3\text{-}6)$$

Regarding our model based on identical repressors, Impose the assumption that$\boldsymbol{X_i} = \boldsymbol{X_j} = \boldsymbol{X}$, so that $\boldsymbol{X'_i X_j} = \boldsymbol{X'X}$ for all *i* and *j* in (3-6).

The inverse matrix on the right-hand side now becomes$[\Sigma^{-1} \otimes \boldsymbol{X'X}]^{-1}$, which, using the rule of $\{(A \otimes B)^{-1} = (A^{-1} \otimes B^{-1})\}$, equals $[\Sigma \otimes (\boldsymbol{X'X})^{-1}]$. In addition to on the right-hand side, each term $X'_i y_j$ equals $\mathbf{X}' y_j$, which, in turn equals $\mathbf{X'X}b_j$. With these results, after moving the common $\mathbf{X'X}$ out of the summations on the right-hand side, we obtain

$$\hat{\beta}=\begin{bmatrix} \sigma_{11}(X'X)^{-1} & \sigma_{12}(X'X)^{-1} & \dots & \sigma_{1M}(X'X)^{-1} \\ \sigma_{21}(X'X)^{-1} & \sigma_{22}(X'X)^{-1} & \dots & \sigma_{2M}(X'X)^{-1} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{M1}(X'X)^{-1} & \sigma_{M2}(X'X)^{-1} & \dots & \sigma_{MM}(X'X)^{-1} \end{bmatrix}^{-1} \begin{bmatrix} (X'X)\sum_{l=1}^{M}\sigma^{1l}b_l \\ (X'X)\sum_{l=1}^{M}\sigma^{2l}b_l \\ \vdots \\ (X'X)\sum_{l=1}^{M}\sigma^{Ml}b_l \end{bmatrix}. \quad (3\text{-}7)$$

Now, we set apart one of the sub vectors, say the first, from $\hat{\beta}$. After multiplication, the moment matrices cancel, and we are left with

$$\hat{\beta}_1=\sum_{j=1}^{M}\sigma_{1j}\sum_{l=1}^{M}\sigma^{jl}b_l=b_1(\sum_{j=1}^{M}\sigma_{1j}\sigma^{j1})+b_2(\sum_{j=1}^{M}\sigma_{1j}\sigma^{j2})+\dots+b_M(\sum_{j=1}^{M}\sigma_{1j}\sigma^{jM}).$$

The terms in parentheses are the elements of the first row of $\mathbf{\Sigma\Sigma^{-1}= I}$, so the end result is $\hat{\beta}_1 = \boldsymbol{b}_1$. For the remaining subvectors, which are obtained the same way

$\hat{\beta}_i = b_i$, which is the result we sought.

To review, the important result we have here is that in the SUR model, when all equations have the same regressors, the efficient estimator is single-equation ordinary least squares; OLS is the same as GLS. Also, the asymptotic covariance matrix of $\hat{\beta}$ for this case is given by the large inverse matrix in brackets in (3-7), which would be estimated by

$$Est.\ Asy.\ Cov\ [\widehat{\beta_\iota}, \widehat{\beta_J}\ ] = \hat{\sigma}_{ij}(X'X)^{-1},\ i, j=1,\ \ldots,\ M,\ where\ \hat{\Sigma}_{ij} = \hat{\sigma}_{ij} = \frac{1}{T}e'_i e_j.$$

Except in some special cases, this general result is lost if there are any restrictions on $\boldsymbol{\beta}$, either within or across equations.

3.7 Ordinary Least Square Panel Corrected Standard Errors (OLS-PCSE)

Time-series–cross-section (TSCS) data are characterized by having repeated observations over time on some set of units, such as states, nations or firms. The number of units analyzed would typically range from about 10 to 100, with each unit observed over a relatively long time period. Both the temporal and spatial properties of TSCS data make the use of ordinary least squares (OLS) problematic. In particular, TSCS data typically illustrates both contemporaneous correlation across units and unit level heteroscedasticity making inference from standard errors produced by ordinary least squares incorrect. Beck and Katz (1995) examined some issues in the estimation of TSCS models. They have provided an alternative estimator of the standard errors called OLS-PCSE that is correct when the error structures show complications found in this type of model. In addition, they have presented Monte Carlo evidence to analysis their results. The Monte Carlo evidence showed that panel-corrected standard errors perform extremely well, even in the presence of complicated panel error structures.

Based on their research the generic TSCS model defined as:

$$y_{i,t} = X_{i,t}\beta + \epsilon_{i,t};\ i=1,\ldots,\ N;\ t=1,\ \ldots,\ T\ (3\text{-}1)$$

where $X_{i,t}$ is a vector of one or more (k) exogenous variables and observations are indexed by both unit (i) and time (t). As we mentioned in the previews part we shall show the matrix of independent variables for all observations as **X** and the vector of observations on the dependent variable as Y. We assume that the data are stacked by unit[6]. We denote the NT×NT covariance matrix of the errors with typical element E($\epsilon_{i,t}\epsilon_{j,s}$) by **Ω**.

Equation (3-1) can be estimated by generalized least squares (GLS) regardless of any complexities of the error process, so long as the covariance matrix of those errors, **Ω**, is known (up to a scale factor). Given that assumption, GLS is completely efficient and provide consistent estimates of the standard errors (Kmenta 1986, 609-16). The GLS estimates of β are given by

$$[X'\Omega^{-1}X]^{-1}\, X'\Omega^{-1}Y \quad (3\text{-}2)$$

with estimated covariance matrix

$$[X'\Omega^{-1}X]^{-1} \quad (3\text{-}3)$$

The problem is that the covariance matrix of the errors, **Ω**, is never known in practice (even up to a scale factor). Hence, an estimate of **Ω**, $\boldsymbol{\hat{\Omega}}$, is applied in expressions (3-2) and (3-3). With this trend, FGLS, provides consistent estimates of β if $\hat{\Omega}$ is estimated by residuals computed from consistent estimates of β. Ordinary least squares provides such consistent estimates. Based on Parks (1967), FGLS estimates of β denoted by $\hat{\beta}$. Beck and Katz (1995) have also examined the parks method which results in the application of ordinary least squares panel corrected standard errors (OLS-PCSE). The Parks method is FGLS for TSCS models where the errors depicts panel heteroscedasticity, contemporaneous correlation, and unit specific serial correlation. The parks

[6] That is, the data are ordered so that the second observation is the observation on unit 1 for the second time period and, in general, the observation following unit i for time period t is the observation for unit i for time period t + 1 (or, following the last observation on unit i, it is the first observation on unit i +1).

method refers to Beck and Katz (1995) article which described the method completely.

If the errors in equation (3-1) meet one or more of the panel error assumptions, then OLS estimates of β will be consistent but inefficient; the degree of inefficiency depends on the data and the exact form of the error process. The OLS standard errors will also be inaccurate[7], but they can be corrected so that they provide accurate estimates of the variability of the OLS estimates of β. This correction takes into account the contemporaneous correlation of the errors (and perforce heteroscedasticity). Any serial correlation of the errors must be removed before the panel-corrected standard errors are calculated. The correction for contemporaneous correlation of the errors is only possible because we have repeated information on the contemporaneous correlation of the errors; the proposed method does not work outside the TSCS context. The correct formula for the sampling variability of the OLS estimates is given by the square roots of the diagonal terms of

$$Cov\ (\hat{\beta}) = (X'X)^{-1}\{X'\Omega X\}(X'X)^{-1} \quad (3\text{-}4)$$

If the errors obey the spherical assumption, this make it easier to the usual OLS formula, where the OLS standard errors are the square roots of the diagonal terms of $\widehat{\sigma^2}(\boldsymbol{X'X})^{-1}$, where $\widehat{\sigma^2}$ is the usual OLS estimator of the common error variance, σ^2.

If the errors obey the panel structure, then this formula provides incorrect standard errors. Expression 3-4, however, can still be used, in combination with that panel structure of the errors, to provide accurate, panel-corrected standard errors (PCSEs).

[7]The OLS standard errors will not be consistent. The degree of inaccuracy is a complicated function of the relationship between the **X'X** matrix and the variances and covariance of the error process. If these are only slightly related, then the OLS standard errors will only be slightly incorrect.

For panel models with contemporaneously correlated and panel heteroscedastic errors, **Ω** is an NT×NT block diagonal matrix with an N×N matrix of contemporaneous covariances, **Σ**, along the diagonal. To estimate equation 3-4, we need an estimate of **Σ**. Since the OLS estimates of expression 3-1 are consistent, we can use the OLS residuals from that estimation to provide a consistent estimate of **Σ**. Let $e_{i,t}$ be the OLS residual for unit i at time t. We can estimate a typical element of **Σ**: by

$$\hat{\Sigma}_{i,j} = \frac{\sum_{t=1}^{T} e_{i,t} e_{j,t}}{T}$$

with the estimate $\hat{\boldsymbol{\Sigma}}$: being comprised of all these elements. We then use this to form the estimator $\hat{\boldsymbol{\Omega}}$ by creating a block diagonal matrix with the $\hat{\boldsymbol{\Sigma}}$ matrices along the diagonal. As the number of time points increases, $\hat{\boldsymbol{\Sigma}}$: becomes an increasingly better estimator of **Σ**.

Beck and Katz (1995) have argued that the Parks method may not perform well in correcting for a variety of TSCS complications and, in particular, may lead to substantial underestimates of variability in finite samples they have also argued that using OLS with PCSEs is a reasonable estimation strategy. They designed a series of Monte Carlo experiments to assess Parks, PCSEs, and OLS in the TSCS context.

With regard to the PCSEs experiments they assessed The Accuracy of Panel-corrected Standard Error. The experiments illustrate that OLS standard errors are strictly correct in the presence of either panel heteroscedasticity or contemporaneous correlation of the errors if the terms in the error covariance matrix, **Ω**, are not related to the squares and cross products of the independent variables.

3.8 Quantile Regression

Quantile regression is a statistical technique aimed to estimate either the conditional median or other quantiles of the response variables. Just as classical linear regression methods based on minimizing sums of squared residuals enable one to estimate models for conditional mean functions, quantile regression methods over a mechanism for estimating models for the conditional median function, and the full range of other conditional quantile functions. By supplementing the estimation of conditional mean functions with techniques for estimating an entire family of conditional quantile functions, quantile regression is capable of providing a more complete statistical analysis of the stochastic relationships among random variables. Quantile regression has been used in a broad range of application settings. Quantile regression methods may be used to estimate upper and lower quantile reference curves as a function of age, size, and other covariates without imposing stringent parametric assumptions on the relationships among these curves (Roger koenker, 2000).

In this section we briefly discuss the theoretical background of QR analysis based on Micro econometrics using Stata by Cameron and Trivedi (2009).

Let e_i illustrate the model prediction error. Then Ordinary least squares minimizes$\sum_i e_i{}^2$, median regression minimizes $\sum_i |e_i|$, and QR minimizes a sum that gives the asymmetric penalties (1-q) $|e_i|$ for under prediction.

3.8.1 Conditional quantiles

Econometrics studies model conditional moments, especially the conditional mean function is applied widely. Assume that the main objective of modeling is the conditional prediction of y given x.

Let $\hat{y}$(x) denote the predictor function and e(x) = y- $\hat{y}$(x) denote the prediction error. Then L{e(x)}=L{y-$\hat{y}$(x)} denotes the loss associated with the prediction error e. the optimal loss-minimizing predictor depends upon the function L(e).

If L (e) = e^2, then the conditional mean function, E (y|x) =x′β in the linear case, is the optimal predictor. If the loss criterion is absolute error loss, then the optimal predictor is the conditional median, showed by med (y|x).

If the conditional median function is linear, so that med (y|x) = x′β, hence, the optimal predictor is $\hat{y} = x'\hat{\beta}$ where $\hat{\beta}$ is the least absolute-deviations estimator that minimizes$\sum_i |y_i - x'_i \beta|$. Both the squared-error and absolute-error loss functions are asymmetric, which expresses that the same penalty is imposed for prediction error of a given magnitude regardless of the direction of the prediction error. The asymmetry parameter q is specified. It lies in the interval (0, 1) with symmetry when q=0.5 and increasing asymmetry as q approaches 0 or 1. So, the optimal predictor is the *qth* conditional quantile, illustrated by $Q_p(y|x)$, and the conditional median is a special case when q = 0.5. QR includes inferences regarding the conditional quantile function.

There are several attractive features of QR. First, unlike the OLS regression that is sensitive to the presence of outliers and can be inefficient when the dependent variable has a highly non normal distribution, the QR estimates are more robust, second, QR also provides a potentially richer characterization of the data. Third, unlike OLS, QR estimators do not require existence of the conditional mean for consistency. Finally, it is equivarient to monotone transformation which means that the quantile of a transformed variable y, denoted by h(y) equal the transforms of the quantiles of y, so Q_p{h(y)}=h{$Q_p(y)$}. Hence, if the quantile model is expressed as h(y), e.g., lny, then one can use the inverse transformation to translate the results back to y. this is not possible for the mean, because E{h(y)} ≠h{E(y)}.

3.8.2 Computation of QR estimates and standard errors

Like OLS and maximum likelihood, QR is an extremum estimator. Computational implementation of QR is different, however, because optimization uses linear programming methods. The *qth* QR estimator $\hat{\beta}_q$ minimizes over β_q the objective function

$$Q\ (\beta_q) = \sum_{i:y_i \geq x'_i\beta}^{N} q\left|y_i - x'_i\beta_q\right| + \sum_{i:y_i \geq x'_i\beta}^{N}(1-q)\left|y_i - x'_i\beta_q\right| \quad (3\text{-}1)$$

Where 0 < q < 1, and we use β_q rather than β to make clear that different choice of q estimate different values of β. If q = 0.9, for example, then much more weight is placed on prediction for observations with y ≥ x′β than for observations with y < x′β. Often, estimation sets q = 0.5, giving the least absolute-deviations estimator that minimizes $\sum_i |y_i - x'_i\beta_{0.5}|$.

The objective function (3-1) is not differentiable, so the usual gradient optimization methods cannot be applied. Instead it is a linear program. The classic solution method is the simplex method that is guaranteed to yield a solution in a finite number of simplex iterations.

The estimator that minimizes $Q\ (\beta_q)$ is an *m* estimator with well-established asymptotic properties. The QR estimator is asymptotically normal under general conditions. It can be shown that

$$\hat{\beta}_q \sim N\ (\beta_q, A^{-1}BA^{-1}) \quad (3\text{-}2)$$

Where $A = \sum_i q(1-q)x_i x'_i$, $B = \sum_i f_{u_q}(0|x_i)\, x_i x'_i$, *and* $f_{u_q}(0|x_i)$ is the conditional density of the error term u_q= y-x$'\beta_q$ evaluated at u_q=0.

This analytical expression involves $f_{u_q}(0|x_i)$, which is awkward to estimate.

4 . RESULTS

4.1 Introduction

In this chapter we perform analysis around the results of the panel model regression techniques that we discussed about them in the previews chapter. First of all, we need to take a brief definition about our data including the nature of the data and some descriptive statistics in univariate analysis. Then we need to discuss about empirical strategies which included two parts and each part gives relevant formulas for accounting risk-taking behavior and competition. In the next step the empirical model is defined to examine the relationship between insurance market competition and risk-taking behavior in the Iranian insurance market. In the final step different outcomes of each model (ISURE, PLS-PCSE and Quantile regression) are presented to make decision around the risk-taking behavior of Iranian insurance companies against competition during 2007 to 2017 to manipulate total strategy.

4.2 Data

With regard to the aim of this study which is to realize the effect of competition on Risk-taking behavior and solvency in insurance market in Iran, we employ insurance firms' annual data in order to estimate the Lerner Index as the proxy for competition, while the z-score and standard deviation of loss ratio are employed as proxies for Risk-taking behavior in which we will define them completely in the following pages. Other significant predictors of solvency in the insurance market are identified as firm size, capitalization, reinsurance and business line diversification.

With regard to each of these control variables, Firm size is calculated as the natural logarithm of total assets.

The second variable is capitalization (Npe) which is measured as the ratio of net earned premiums to shareholder's equity. The third variable is reinsurance (Reins) which is measured as the ratio of reinsurance premiums ceded to gross premiums underwritten and this occurs through a risk transfer, where primary insurers pass on some premiums (and risk) to reinsurers to reduce their exposure.

The final variable is business line diversification (Bdiv) which is refers to the underwriting of insurance policies across a spectrum of product lines, ensuring a diversified revenue source. This reduces the risk inherent in each business line and ultimately the overall portfolio risk.

The Herfindahl-Hirschman index of premiums concentration is used to estimate this variable (Alhassan and Biekpe, 2017). The index is computed as the sum of the squares of percentages of net written premiums across the seven business lines including life insurance, third party and accident insurance for drivers, vehicle body insurance, health insurance, fire insurance, liability insurance and other products lines insurance. The equation for computing the index is given as

$$bdiv = \sum_{i=1}^{7} \left(\frac{GWP_{i,t}}{GIPW_t}\right)^2,$$

Where GWP_i is the premium written in business line i at time t, and $GIPW_t$ is the gross premiums written for an insurer at time t. (Alhassan and Biekpe,2017).

Table 4-1 and 4-2 display the summary of (dependent and independent) variables.

Table 4-1: Summary of dependent variables

Dependent variables	Symbol
Solvency risk	$\mathbf{z_{score}}$
Coefficient of variation of the loss ratio (underwriting risk)	$\mathbf{cv_{lr}}$

Table 4-2: Summary of Control variables

Control variables	Symbol
Proxy of competition in Lerner index	Lerner
Quadratic term for the Lerner index	Lerner^2
Natural logarithm of total assets	Firm size
Ratio of net earned premium to equity	Npe
Ratio of reinsurance premiums ceded to gross premiums written	Reins
Diversification of income across business lines	Bdiv

All data is extracted from data source of annual reports of the Central Insurance of Islamic Republic of Iran (C.I. IRAN) and Balance sheet of insurance companies. We use data from 2007 to 2017 for 17 insurance companies including Iran, Asia, Alborz, Dana, Parsian, Razi, Karafarin, Sina, Mellat, Omid, Hafez, Day, Saman, Iran Moein, Novin, Pasargad, and Moallem. The data covers entire 11 years' activity of Iranian insurance market from period 2007 until 2017. In fact, during these 11 years there are only 17 insurance companies that have completed information.

Generally Iranian insurance firms divided into two categories; government-owned and private entity. Here Iran Insurance Joint-stock Company is the only Iranian government-owned corporation providing a wide range of insurances and other firms (Asia, Alborz, Dana, Parsian, Razi, Karafarin, Sina, Mellat, Omid, Hafez, Day, Saman, Iran Moein, Novin, Pasargad, and Moallem) are private entity insurers.

Our data called panel data since we followed information of number of insurance companies over 11 years. As mentioned before, our data set starts from year 2007 and ended to year 2017 with 17 companies which is obviously leads to balanced longitudinal data.

4.3 Univariate Analysis

The summary statistics of the regression variables are presented in Table 4-3. The mean values of the risk variables in the solvency ratio (z_{score}) and underwriting risk (cv_{lr}) are 10.30183 and -1.01e-09 respectively. The Lerner index averaged -0.3809227, suggesting that the average insurance premiums are about 38.09 per cent under the marginal cost incurred in the production of the insurance policy. This reflects the low pricing power. The average growth in insurance asset was 20.76851 per cent over the study period while the reinsurance ratio (Reins) of 0.1647197 million Rial indicates that insurers retain about 99/8352803 per cent of their gross premium revenues. The business line diversification (Bdiv) of 0.3252211, suggests that most of insurance premium revenue is generated from a smaller number of business lines.

Table 4-3: Descriptive statistics

Variable	Observation	Mean	Standard. Deviation	Min	Max
z_{score}	187	10.30183	8.61432	-6.618236	35.50456
cv_{lr}	187	$-1.01e^{-09}$	1	-3.29124	3.99624

Lerner	187	-0.3809227	3.958578	-54.12436	0.9140726
$Lerner^2$	187	15.73165	214.2175	$1.96e^{-10}$	2929.446
Firm size	187	20.76851	5.981841	12.71755	30.29212
Npe	187	3.827394	7.023736	-26.0931	47.90882
Reins	187	0.1647197	0.3386609	-0.5821376	2.930183
Bdiv	187	0.3252211	0.1083258	0.1685925	0.784236

Note: z_{score} = solvency ratio; cv_{lr} = the coefficient of variation of the loss ratio (standard deviation of underwriting risk); Lerner = estimated Lerner index; Firm size = natural logarithmic of total assets with the scale of million Rial; Npe = net earned premiums to equity in which the scale is in million Rial; Reins = reinsurance to gross premium with the scale of million Rial; Bdiv = business line diversification.

Based on the objectives of this thesis we have to measure the risk-taking behavior of insurers using the z_{score} solvency ratio and the underwriting risk using annual firm-level data on 17 insurance companies from 2007 and 2017.

4.4 Empirical Strategy

4.4.1 Measuring of risk-taking behavior

One of the important indicators in deciding to buy insurance policies from various insurance companies is solvency. This index gives information about the ability of an insurance company in order to fulfill its obligations. Moreover, is measured as the ratio of available capital to the capital requirements.

With regards to the regulatory authorities there are two perspectives around solvency:

The first one is a solvency floor which is determined by the regulatory authorities of each country (considering 100 as criterion for Insurance companies in Iran) in which different levels of solvency are determined.

Levels of solvency are divided into 5 categories. Level 1 has the highest ability meaning that these companies have a higher ability to fulfill their obligations to insurers and their shareholders. On the other hand, Level 5 has the lowest financial ability implying that the central insurance of Islamic republic of Iran (C.I. IRAN) company is allowed to suspend or cancel the license of the insurance company in one or more insurance fields. Hence, the negative indicators are firmed.

The second one is for the higher levels of solvency relating to internal calculations of a company. This is based on regulatory authorities' demand in which it would be a little harder than the standards setting by the insurance company.

The solvency which we applied in this study is completely different from the requirements of central insurance of Islamic republic of Iran (C.I. IRAN). Here solvency ratio in the z_{score} denotes a proxy for insurance risk.

In the estimation of insurance risk, we follow the formula in both the banking and insurance literature and use the solvency ratio in the z_{score} as the proxy for insurance risk.

Generally, z_{score} is a numerical measurement used in statistics of a value's relationship to the mean (average) of a group of values, measured in terms of standard deviations from the mean. Moreover, z_{score} measures the observation's variability and can be put to use by traders in determining market volatility.

In this study the z_{score} reflects the firm's buffer in equity and profits with the standard deviation of profits. As a solvency indicator, the z_{score} measures the distance to default and represents the number of standard deviations by which the firm's income must fall to erode equity capital. Hence, a higher value indicates a high distance to default and consequently high solvency and stability, and vice versa (Alhassan and Biekpe,2017). The equation for estimating the z_{score} is given as:

$$z_{score\ i,t} = \frac{\boldsymbol{roa_{i,t}+eqr_{i,t}}}{\boldsymbol{\sigma roa_i}} \quad (4\text{-}1)$$

where subscripts i and t represent the insurer and the year, respectively; roa is return on assets measured as the ratio of profit before tax to total assets; eqr is the equity ratio measured as the ratio of book value of equity to total assets and σroa is the standard deviation of return on assets. To address the extreme variations in the variable, the estimated values are transformed by taking the natural logarithm as employed by Laeven and Levine (2008) and Shim (2015).

According to prior studies by Adams and Buckle (2003) and Ng et al. (2013) on insurance markets, we also consider underwriting risk as another proxy for insurance risk. The underwriting risk illustrates the risk associated with the insurance portfolio. This standard deviation of the loss ratio measured as the ratio of incurred losses to net earned premiums has generally been employed as the proxy for underwriting risk. In this study, we standardized this measure by dividing by the mean to obtain the coefficient of variation of the loss ratio.

In the second step, we estimate the Lerner index as our proxy for insurance market competition.

The index captures the markup power of firms over marginal cost, and represents the pricing power of firms in a market. The choice of the Lerner index over the market-level approaches in the Panzar and Rosse (1987) and Boone

(2008) models is motivated by its ability to allow for the estimation of firm-level pricing behavior.

4.4.2 Insurance market competition: Lerner index

There are two approaches to the estimation of competition; structural and non-structural. The structural measures of competition are introduced on the Structure-Conduct-Performance (SCP) hypothesis of Bain (1951) which infers competition from the structure of the market. The competitive view of industry structure suggests that rapid changes in concentration are brought about by changed cost conditions and not by alterations in the height of entry barriers. Industries experiencing rapid increases in concentration should exhibit greater disparities between large and small rates of return because of the more significant cost differences which are the root cause of rapid alternations in industry structure. These classes of measures have been found to have a weak theoretical basis since concentrated markets could also be competitive (Demsetz,1973).

The non-structural measures are premised on the new empirical industrial organization (NEIO) literature. According to Casu (2009) research on competition issue in European banking they state that factors other than market structure and concentration may affect competitive behavior, such as entry/exit barriers and the general contestability of the market. Additionally, differently from structural methods, the competitive environment is not implied but is usually measured, as with the price mark-ups approach (the Lerner index of monopoly power and conjectural variations models) and the correlations of input costs with output prices (the Panzar-Rosse (P-R) H-statistic). Probably, the most important advantage of non-structural approaches is that they do not assume a priori that concentrated markets are not competitive because contestability may depend on the extent of potential competition (Goddard et al., 2001) and not necessarily on market structure. Another advantage of non-structural models is that there is no need to specify a geographic market, since the behavior of individual firms give an indication of their market power. Generally, there are four kinds of non-structural models in evaluating competition, such as H-statistic of Panzer and Rosse (1987), the conjectural variation of Bersnaham (1982) and Lau (1982). All these non-structural models need to estimate the function of supply and demand in market. Bersnaham and Lau have been rarely experimental application because they need a lot of information compared to Panzer and Ross model which need fewer information. The P-R model uses bank-level data and measures how a change in factor input prices is reflected in equilibrium revenues earned by banks; it offers a direct measure of banking competitiveness, called the H-statistic. The H-statistics, is an indicator of the degree of market competition developed in the context of the NEIO (Panzar and Rosse, 1987).

The H-statistic achieves the relationship between input prices and equilibrium revenues and it is calculated using a reduced form revenue equation that measures the sum of elasticities of total revenues with respect to the firm's input prices.

In this study, we employ Lerner index as an indicator of insurance market competition. The Index infers competition from the firm's pricing conduct. This approach is preferred over other non-structural measures of competition for the following reason:

The index obtains the firm's ability to charge prices above their marginal costs, depending on the competitive conditions in the market over time. Moreover, the index measures the market power and also because of the fact that there are variety of studies around competition in banking market, this index compared to other measures is a well-established measure of competition in the banking literature. Hence, this is suitable for the industry-level data used in this study. We define Lerner index as

$$li_{i,t}=\frac{p_{i,t}-mc_{i,t}}{p_{i,t}} \qquad (4\text{-}2)$$

Where $p_{i,t}$ is the output price set by an insurer *i* at time *t*, and $mc_{i,t}$ is insurer's marginal cost at time *t*.

Output price is proxies as the ratio of total revenue (net earned premiums and investment income) to total assets. The marginal cost, $mc_{i,t}$ of producing insurance policies is derived through estimation of a translog cost function in

Eq.4-3 as follow:

$$ln(\frac{tc}{w_3})_{i,t}=\alpha_0+\alpha_1 lny_{i,t}+0.5\alpha_2 lny^2{}_{i,t}+\beta_1\ln(\frac{w_1}{w_3})_{i,t}+\beta_2 ln(\frac{w_2}{w_3})_{i,t}$$

$$+0.5\beta_3 ln\left(\left(\frac{w_1}{w_3}\right)_{i,t}\right)^2+0.5\beta_4 ln\left(\left(\frac{w_2}{w_3}\right)_{i,t}\right)^2+\gamma_1 lny_{i,t}ln(\frac{w_1}{w_3})_{i,t}$$

$$+\gamma_2 lny_{i,t}ln(\frac{w_2}{w_3})_{i,t}+\delta_1 trend_t+\delta_2 trend_1^2+\delta_3 trend_t lny_{i,t}$$

$$+\delta_4 trend_t ln(\frac{w_1}{w_3})_{i,t}+\delta_5 trend_t ln(\frac{w_2}{w_3})_{i,t}+\varepsilon_{i,t}, \qquad (4\text{-}3)$$

Where subscripts *i* and *t* are as defined before; *tc* is the insurer's total cost consisting of claims paid, management expenses and commission paid; *y* represents insurance outputs in total assets. In Eq.4-3, w_1 is the price of labour; w_2 is the price of equity capital and w_3 is the price debt. We define the price of labor and business services as the ratio of management expenses and commissions paid to total assets (w_1). In line with Cummins et al. (1999), Hardwick et al. (2011) and Alhassan and Biekpe (2016), the price of equity capital (w_2) is measured as the ratio of net income to equity capital. In order to account for the possibility of negative profits, a constant is added to the price of equity to allow for logarithmic transformation.

Similar to the approach employed by Hardwick et al.(2011) and Alhassan and Biekpe (2016), the price of debt capital (w_3) is also measured as the ratio of investment income to total reserves (unearned premiums and outstanding claims).

We normalize *tc*, w_1 and w_2 by w_3 to impose homogeneity conditions. Taking the first derivative of the cost function in Eq.4-3 with respect to output gives the marginal cost of production:

$$mc_{i,t} = \frac{\partial tc_{i,t}}{\partial y_{i,t}} = \frac{tc_{i,t}}{y_{i,t}}\left[\alpha_1 + \alpha_2 lny_{i,t} + \gamma_1 \, ln\left(\frac{w_1}{w_3}\right)_{i,t} + \gamma_2 ln\left(\frac{w_2}{w_3}\right)_{i,t} + \gamma_3 trend_t\right]. \quad (4\text{-}4)$$

4.5 Empirical model

To examine the relationship between insurance market competition and Risk-taking behavior in IRAN, we use the models of Jimenez et al. (2013), Cummins et al. (2013) and Shim (2015). The model is defined in Eq.4-5 as

$$Risk_{i,t} = \theta_0 + \theta_1 comp_{i,t} + \theta_2 comp_{i,t}^2 + \sum_{j=2}^{k} \theta_{j,it} x_{j,it} + \varpi_{i,t} \quad (4\text{-}5)$$

Where $Risk_{i,t}$ refers to insurance risk-taking behavior; $comp_{i,t}$ and $comp_{i,t}^2$ are the linear and quadratic terms of competition, respectively; $x_{j,it}$ is a vector of control variables; $\varpi_{s,t}$ represents the time varying error terms.

Equation 4-5 is extended to include the proxies of insurance solvency and risk and competition to form Eqs.4-6

and 4-7:

$$z_{score\ i,t} = \phi_0 + \phi_1 lerner_{i,t} + \phi_2 lerner_{i,t}^2 + \phi_3 size_{i,t} + \phi_4 npe_{i,t} + \phi_5 reins_{i,t} + \phi_6 bdiv_{i,t} + \varepsilon_{i,t} \qquad (4\text{-}6)$$

$$cv_{lr\ i,t} = \psi_0 + \psi_1 lerner_{i,t} + \psi_2 lerner_{i,t}^2 + \psi_3 size_{i,t} + \psi_4 npe_{i,t} + \psi_5 reins_{i,t} + \psi_6 bdiv_{i,t} + \xi_{i,t} \qquad (4\text{-}7)$$

Where i and t represent insurers and years, respectively; z_{score} and cv_{lr} denote solvency risk and coefficient of variation of the loss ratio (underwriting risk), respectively; Lerner is the proxy of competition in the Lerner index; Lerner^2 is the quadratic term for the Lerner index; size is the natural logarithm of total assets; Npe is the ratio of net earned premium to equity; reins is the ratio of reinsurance premiums ceded to gross premiums written; Bdiv is the diversification of income across business lines; ε and ξ are the two-sided error terms for Eqs. 4-5 and 4-6, respectively.

Before entering into the discussion of panel data techniques, we shall examine our dependent variables (z_{score} and cv_{lr}) in Eq.4-6 and 4-7 around fixed and random effects to understand the nature of these variables. Hence, we estimate the models using Stata15 software in order to understand them. The consequences of these results presented in table 4-4. In order to find out the consequence of fixed and random effects, we should apply Hausman test which implies the hypothesis as below:

H_0: random effect model is appropriate

H_1: fixed effect model is appropriate

If the amount of p-value becomes less than 0.05 we reject the null hypothesis and accept alternative hypothesis which states that fixed effect model is appropriate for regression estimation otherwise, choose random effect model.

Table 4-4: Fixed and Random effects results

Dep Vars.	z_{score} **Random effect Coef.**			cv_{lr} **Fixed effect Coef.**		
	Coef.	Std. Error.	t. Statistic	Coef.	Std. Error.	t. Statistic
Constant	8.675***	1.645	5.273	0/0001	0.461	0.0003
Lerner	3.350***	1.183	2.830	-0/194	0.332	-0.584
$Lerner^2$	0.062***	0.021	2.860	-0/003	0.006	-0.592
Firm size	0.089*	0.052	1.702	-0/015	0.014	-1.056
Npe	-0.054	0.048	-1.138	-0/021	0.013	-1.598
Reins	-0.717	0.877	-0.817	-0/161	0.246	-0.656
Bdiv	1.167	3.162	0.369	1/282	0.887	1.445
R-squared	0.871			0.248		
F-statistic	48.016			2.347		
Prob (F-statistic)	0.000			0.001		
Parameters	6			6		
Observation	187			187		

Table 4-4: z_{score} = solvency ratio; cv_{lr} = the coefficient of variation of the loss ratio (standard deviation of underwriting risk); Lerner = estimated Lerner index; $Lerner^2$ = quadratic term of the Lerner index; Firm size = natural logarithmic of total assets with the scale of million Rial; Npe = net earned premiums to equity in which the scale is in million Rial; Reins = reinsurance to gross premium with the scale of million Rial; Bdiv = business line diversification. ***p<0.01, **p<0.05, *p<0.1

Table 4-5: The results of the Hausman test

Statistic	Value	p-value	Result
z_{score} hausman test	7.012	0.319	Random effect
cv_{lr} hausman test	16.480	0.011	Fixed effect

The results of the panel regression around fixed and random effect is presented as follow in table 4-5 in which for z_{score}, random effect and for cv_{lr}, fixed effect model is accepted.

With regard to the z_{score} coefficients, both linear and quadratic coefficients of Lerner index are positive and significant at 1 per cent level in which illustrates that, when Lerner index increases meaning that the amount of output price is higher than its marginal costs and this is shown as market power. Hence, when market power increases the solvency indicator increases as well. Higher amount of z_{score} illustrates the higher stability between insurance firms. With regard to the control variables, only Firm size has positive and significant coefficients at 10 per cent level which means that Firm size is positively related to the solvency of insurance firms.

We will discuss about them completely in different models (ISUR, OLS-PCSE and QR) in this chapter later.

In the next step, we employ a battery of panel model regression techniques that we introduced them in the previews chapter to examine the effect of the competition (Lerner index) on the two proxies of insurance risk.

4.6 Seemingly Unrelated Regression (SUR) Analysis

The results of the Iterated Seemingly Unrelated Regression (ISUR) estimation of regression models z_{score} and cv_{lr} is presented in table 4-6 .

The dependent variable in column 1 is the solvency ratio of the z_{score} while the standard deviation of the loss ratio is the dependent variable in column 2. The results of the correlation among the independent variables presented in Appendices, table A suggest low correlation.

As a matter of fact, initial levels of market power (high Lerner index) result in high z-score to indicate improved stability and solvency. In other words, high levels of Lerner index result in high amount of solvency ratio which boost stability and solvency in insurance markets. With regard to ISUR table, the coefficients of both linear and quadratic terms of Lerner index is positive but not significant. For this point of view, we cannot analysis about the relationship between Lerner index with solvency and stability, hence, we only consider independent variables which are significant and then discuss about their efficiency in these models.

From the results, it can be observed that the coefficients of Lerner and Lerner^2 both have a negative and significant relationship with underwriting risk. It means that Lerner index has a negative effect on underwriting risk.

When the value of both Lerner and Lerner^2 becomes higher it means that insurance firm's output price is bigger than its marginal cost (high market power). Thus, the underwriting risk is consistently decreasing during the time and all are according to our expectations. In other words, when we face with low market power (negative Lerner index) it means that the probability of lowering portfolio in insurance companies is high hence, we would expect that the risk of portfolio or underwriting risk becomes higher.

Additionally, as an indicator of pricing and market power, the increasing Lerner index also reflects the insurer's information advantages in the market, hence the ability to reduce portfolio risk. However, more market power reflected in high pricing power has a tendency to price out less risky clients from the insurance pool in favor of risk individuals. This in turn increases the variations in underwriting risk as well as overall market insolvency.

With regard to the control variables, their effect on insurance solvency appears to be mixed with the theoretical expositions.

First, we consider the effect of capitalization differences on insurance solvency and risk with the inclusion of Npe as an equity variable as the first significant control variable.

We can see a negative and significant relationship between Npe and z_{score} in this model. According to our expectance as the amount of capitalization differences increased in Iranian insurance companies, it can affect the solvency of firms more. The amount of solvency comes lower and additionally the stability decreased hence, the risk of insolvency increases as well. In other words, when Npe as the ratio of net earned premium to shareholder's equity increase, it is obviously indicating that insurers have higher amount of net earned premiums however they have to cover more exposure in Iranian insurance companies compared to their previous situation therefore, with regard to the net earned premiums received from insureds, insurers should cover more risk which is related to solvency. Thus, the amount of solvency becomes lower and its risk becomes higher as well.

The reinsurance coefficient has a significant positive relationship with z_{score} and this coefficient has a significant but negative relationship with the coefficient of the loss ratio in the model.

As a risk management strategy, conventional wisdom suggests that the use of reinsurance contracts enhances the solvency of insurance companies. This occurs through a risk transfer, where primary insurers pass on some premiums (and risk) to reinsurance to reduce their exposure. According to our anticipation the results of these study around reinsurance indicates that the use of reinsurance contracts increases the solvency of Iranian insurance companies and when the amount of reinsurance use/contracts increased, the coefficient of loss ratio decreased which decreases insurance insolvency and underwriting risk.

The business line diversification (Bdiv) coefficient also exhibits a significant and positive relationship with the coefficient of variation of the loss ratio (cv_{lr}). Diversification of income across business lines reduce insurer's portfolio risk. Hence, they have to concentrate on more business lines.

Table 4-6: Seemingly Unrelated Regression

	1				**2**			
Dep Vars.	z_{score}				cv_{lr}			
	Coef.	Std. Error.	Z	P>Z	Coef.	Std. Error.	Z	P>Z
Constant	7.931**	3.058	2.59	0.01	-0.423	0.328	-1.29	0.198
Lerner	3.615	2.644	1.37	0.172	-1.500***	0.284	-5.28	0.00
$Lerner^2$	0.691	0.0488	1.42	0.157	-0.027***	0.005	-5.25	0.00
Firm size	0.092	0.108	0.86	0.39	-0.007	0.011	-0.63	0.53
Npe	-0.182**	0.088	-2.07	0.039	0.010	0.009	1.09	0.275

Reins	4.548**	1.805	2.52	0.012	-0.754***	0.194	-3.89	0.00
Bdiv	2.095	5.679	0.37	0.712	1.600***	0.610	2.62	0.009
Wald $>X^2$	15.48	_	_	_	49.09	_	_	_
Prob$>X^2$	0.0168	_	_	_	0.00	_	_	_
R-squared	0.0765	_	_	_	0.2079	_	_	_
RMSE	8.25629	_	_	_	0.8876064	_	_	_
Parameters	6	_	_	_	6	_	_	_
Observation	187	_	_	_	187	_	_	0.198

Table4-6: z_{score} = solvency ratio; cv_{lr} = the coefficient of variation of the loss ratio (standard deviation of underwriting risk); Lerner = estimated Lerner index; $Lerner^2$ = quadratic term of the Lerner index; Firm size = natural logarithmic of total assets with the scale of million Rial; Npe = net earned premiums to equity in which the scale is in million Rial; Reins = reinsurance to gross premium with the scale of million Rial; Bdiv = business line diversification. ***p<0.01, **p<0.05, *p<0.

4.7 Sensitivity Analysis

We examine the robustness of the results of ISUR estimation by using standard static panel data techniques. With regard to the static model, we employ the ordinary least squares panel corrected standard error (OLS-PCSE) and quantile regressions (QR) techniques to estimate the model.

4.7.1 Ordinary Least Squares Panel-Corrected Standard-Error (OLS-PCSE) Analysis

The results of the Ordinary Least Squares Panel-Corrected Standard-Error (OLS-PCSE) estimation of regression models z_{score} and cv_{lr} is presented in table 4-7.

The dependent variable in column 1 is the solvency ratio of the z_{score} while the standard deviation of the loss ratio is the dependent variable in column 2.

Consistent with ISUR estimates, we observe that the coefficients of the linear and quadratic terms of the Lerner index are positive but they were not significant. However, the coefficients of both linear and quadratic terms in OLS-PCSE are positive and also at a significance of 5 per cent in this model. Additionally, there is a negative and significant relationship between Lerner index and cv_{lr} with the same significant level that we saw in ISURE model. As we mentioned before OLS-PCSE model is employed to account for modeling failure of the ISUR estimates. Hence, the results of OLS-PCSE model around the Lerner index convinced us to accept the effect of competition on insurance firms in Iran.

With regard to the sign of the coefficients in Lerner and Lerner^2, if we want to make decision around hypothesis tested in equation 4-6 and 4-7 based on Alhassan and Biekpe research (2017) in which they concluded that,

in Eq.4-6, positive signs for both the linear ($ø_1$) and quadratic ($ø_2$) coefficients indicate that increasing competition (decreasing market power) diminishes insurance solvency, while negative signs for ψ_1 and ψ_2 in Eq. 4-7 are expected to arrive at the same conclusions. This supports the competition-fragility hypothesis that competition is detrimental to stability.

Hence, the results of these model support the competition-fragility hypothesis that competition is detrimental to stability. Generally, when Lerner index increases meaning that the amount of output price is higher than its marginal costs and this is shown as market power. Hence, increasing market power enhances solvency indicators. Higher amount of z_{score} illustrates the higher stability between insurance firms. Moreover, increasing market power decreases the coefficient of the loss ratio. Thus, increasing competition in Iranian insurance market (decreasing market power) diminishes insurance solvency and then stability which support competition-fragility hypothesis.

With regard to the control variables, the results of OLS-PCSE model is different from ISUR model but without a lot of changes for example the coefficient of Firm size as the first control variable was not significant for both z_{score} and cv_{lr} in this model.

The other control variables like Npe, Reins and Bdiv have the same results (with a little change in significant level) that we met in ISURE model. In summary, We saw a negative and significant coefficient with 1 per cent level between Npe and z_{score} in both linear and quadratic models. As we see the significant level becomes better in this model, therefore, we can analysis their relationship accurately. Based on our expectations as the amount of capitalization differences increased in Iranian insurance companies, it can affect the solvency of firms more so the amount of solvency comes lower hence the risk of insolvency increases as well. Furthermore, Iranian insurance firms' stability decreased respectively.

The reinsurance coefficient has a significant (at 10 per cent level) and positive relationship with z_{score} in both linear and quadratic models and this coefficient has a significant (at 1 per cent level) but negative relationship with the coefficient of the loss ratio in both linear and quadratic models. According to our expectancy the results of these study around reinsurance indicates that the use of reinsurance contracts expanded the solvency of Iranian insurance companies and when the amount of reinsurance use/contracts increased, the coefficient of loss ratio decreased which decreases insurance insolvency and underwriting risk.

Finally, the business line diversification (Bdiv) coefficient also demonstrate a significant at 10 per cent level and positive relationship with the coefficient of variation of the loss ratio (cv_{lr}). The positive effect of Bdiv on cv_{lr} indicates that if insurers focus on fewer diversified product lines, they will have more underwriting risk. Thus, they have to concentrate on more business lines.

Consequently, OLS-PCSE model is better than ISURE model, because this model examined the robustness of ISURE model. However, we saw lots of similarity between the results of

these two model but in some variables such Lerner index and other control variables illustrates more accurate results than ISURE model.

Table 4-7: : Ordinary Least Square Panel Corrected Standard Error (OLS-PCSE)

	OLS-PCSE							
	z_{score}				**cv_{lr}**			
	Coef.	**Std. Error.**	**Z**	**P>|Z|**	**Coef.**	**Std. Error.**	**Z**	**P>|Z|**
Constant	7.931***	2.489	3.19	0.001	-0.423	0.323	-1.31	0.192
Lerner	3.615**	1.786	2.02	0.043	-1.500***	0.337	-4.44	0.000
$Lerner^2$	0.069**	0.032	2.12	0.034	-0.027***	0.006	-4.43	0.000

Firm Size	0.092	0.065	1.42	0.156	-0.007	0.014	-0.51	0.608
Npe	-0.182***	0.058	-3.12	0.002	0.010	0.006	1.61	0.107
Reins	4.548*	2.538	1.79	0.073	-0.754***	0.192	-3.92	0.000
Bdiv	2.095	4.643	0.45	0.652	1.60*	0.655	2.44	0.015
Wald χ^2	31.62	_	_	_	47.36	_	_	_
Prob> χ^2	0.000	_	_	_	0.000	_	_	_
R-squared	0.0765	_	_	_	0.2079	_	_	_
Insurers	17	_	_	_	17	_	_	_
Observations	187				187			

Table 4-7: z_{score} = solvency ratio; cv_{lr} = the coefficient of variation of the loss ratio (standard deviation of underwriting risk); Lerner = estimated Lerner index; Lerner^2 = quadratic term of the Lerner index; Firm size = natural logarithmic of total assets with the scale of million Rial; Npe = net earned premiums to equity in which the scale is in million Rial; Reins = reinsurance to gross premium with the scale of million Rial; Bdiv = business line diversification. ***p<0.01, **p<0.05, *p<0.1

4.7.2 Quantile Regression (QR) Analysis

The results of the quantile regression (QR) estimation models z_{score} and cv_{lr} is presented in tables 4-8 and 4-9.

we classify the insurers as

- Under 25th percentiles and the exact 25th percentile as weaker insurers,
- 50th as moderately stronger insurers,

- 75th percentile and over as stronger insurers.

Considering the coefficient of Lerner index in z_{score} equation, higher and significant (at 5 per cent) coefficients are observed for the 75th percentile and over. Through the classification of the insurers, the results indicate that Lerner index has a positive and significant relationship with solvency of the insurance firms for just 75th and over in which these percentiles related to the stronger insurers. In other words, increasing Lerner index can improve the solvency ratio of stronger insurers and reduce the solvency risk and this has no effect on weaker and moderate insurers. Thus, stronger insurers are affected by increasing competition and they have to pay more attention to their solvency in order to be stable and solvent compared to weak and moderate firms in this industry.

With regard to the control variables, in contrast with prior models, the positive coefficient for Firm size at 25th percentiles and under25th percentiles in the quantile regression with the significance levels of 5 per cent illustrates that weaker insurers compared to moderate and stronger insurers are more affected by solvency risk, hence, weaker insurers should expand their solvency ratio in order to prevent insolvency in the firms.

We can see a significant negative coefficient for Npe (The effect of capitalization differences on insurance solvency) in almost all percentiles, which means that unlike Firm size or Lerner index, equity variable is significant for almost all kinds of insurers. This means that insurers should concentrate more on equity level and keep their current condition in order not to face solvency risk. Moreover, the higher amount of Npe shows higher amount of net earned premiums. This can be recognized as a kind of asset which is in favor of insurance firms; however, this can be defined as high risk absorption hence it can increase the solvency risk.

The reinsurance coefficient has a significant positive relationship with z_{score} equation. The results indicate that the use of reinsurance contracts increases the solvency of weaker (Q10 and Q25) and moderately stronger (Q50) insurers compared to stronger ones. In general, weaker and moderate insurers are more affected by solvency risk and destabilization. Thus, these firms should use more reinsurance contracts in order to be solvent in this industry.

The business line diversification (Bdiv) coefficient also demonstrates a significant negative coefficient for the z_{score} at 25th percentile and also a significant positive coefficient at 75th percentiles. This infers that the effect of increasing business line diversification is serious for both weaker and stronger insurers but with different consequences. As a result, because of the solvent status of stronger insurers, if they face with solvency risk, they can tolerate the risk better than weaker insurers against the effect of business line diversification. However, weaker insurer should focus more on their spectrum of product lines and they need to be more diversified in this industry. It would better for them to expand their income across business lines instead of focusing on fewer lines. Therefore, diversification of income across multiple business lines improves their stability.

The same estimations are undertaken with the proxy for underwriting risk in the standard deviation of the loss ratio (cv_{lr}). We find significant negative coefficients for the linear terms of the Lerner index in all quantiles. This indicates that increasing competition reduces the underwriting risk of firms. When we face with low market power (negative Lerner index) it means that the probability of lowering portfolio in insurance companies is high. Hence, we would expect that the risk of portfolio or underwriting risk becomes higher. This has an effect on all insurance companies.

Considering the control variables, Firm size is negatively significant (with 5 per cent) at Q50 and Q75 percentiles. This indicates that increasing firm size (natural logarithmic of total assets) in moderately strong and stronger insurers causes fewer underwriting risk compared to weaker insurers, hence, they have to concentrate more on their portfolios against of risk.

Npe as the second variable has significant positive coefficient at 25th percentiles and under with the significance levels of 5 per cent. This represents that increasing equity level increases the coefficient of loss ratio and this could raise the underwriting risk for weaker insurers. In other words, weaker insurers compared to moderate and stronger ones are more affected by underwriting risk. For this reason, weaker insurers should focus on their portfolios more in order to prevent them from risk.

The reinsurance coefficients have significant negative relationship with the cv_{lr} in almost all of the categorization of firms. This indicates that increasing the usage of reinsurance contracts in all insurance firms may lead to decrease the risk which relates to the portfolios. This is the positive point in this industry. Hence, Iranian insurance firms should keep this situation. Using reinsurance contracts transfer the risk to reinsurance to reduce their exposure and also reduces their underwriting risk.

The Bdiv as the last variable exhibits significant positive coefficients at the percentiles of Q50, Q75 and over. This shows that moderately strong and also stronger insurers are more influence by diversification of businesses lines compared to weaker ones. Moderate and strong insurers suffer more underwriting risk than weaker insurers. Thus, diversification of income across business lines in moderate and stronger insurers reduce their portfolio risk. They have to concentrate on more business lines.

Table 4-8: Quantile Regression

z_{score}	Q25 Coef.	Q50 Coef.	Q75 Coef.
Constant	5.079	6.429	11.354***
Lerner	-0.369	4.060	12.470**
$Lerner^2$	-0.002	0.077	0.230
Firm Size	0.101**	0.108	-0.038
Npe	-0.172**	-0.317***	-0.360*
Reins	3.764***	4.514*	3.387
Bdiv	-10.327**	3.083	23.117**
Pseudo R-square	0.0893	0.0913	0.0897
Insurers	17	17	17
Observations	187	187	187

Table 4-9: Quantile Regression

cv_{lr}	Q25 Coef.	Q50 Coef.	Q75 Coef.
Constant	-0.804*	0.233	0.291
Lerner	-1.338***	-1.152***	-1.151**
$Lerner^2$	-0.024	-0.021	-0.021
Firm Size	-0.004	-0.016**	-0.027**

Npe	0.027**	0.013	0.003
Reins	-0.841***	-0.557**	-0.593**
Bdiv	1.090	1.654***	2.065***
Pseudo R-square	0.1323	0.1087	0.1062
Insurers	17	17	17
Observations	187	187	187

Table 4-8 and 4-9: z_{score} = solvency ratio; cv_{lr} = the coefficient of variation of the loss ratio (standard deviation of underwriting risk); Lerner = estimated Lerner index; $Lerner^2$ = quadratic term of the Lerner index; Firm size = natural logarithmic of total assets with the scale of million Rial; Npe = net earned premiums to equity in which the scale is in million Rial; Reins = reinsurance to gross premium with the scale of million Rial; Bdiv = business line diversification. ***p<0.01, **p<0.05, *p<0.1

5 . SUMMERY, CONCLUSION AND SUGGESTIONS

5.1 Summary, Conclusion and Suggestions

In this thesis we provided an on-going debate on the relationship between competition and solvency in the financial service industry. To promote a stable financial services industry for efficient financial intermediation, regularity authorities are normally face with the age old dilemma whether competition policies are stability enhancing or not. In this study, we examined the effect of competitive pressure on the stability and solvency of the insurance market in Iran. Using firm-level annual data on 17 Iranian insurance companies from 2007 to 2017 in order to estimate the Lerner index as the proxy for competition, while the z_{score} and standard deviation of loss ratio (cv_{lr}) are employed as proxies for risk-taking behavior. The empirical relationship was examined using the seemingly unrelated regression technique of Zelner (1962) to estimate a system of equations to increase the efficiency of regression coefficients. The OLS-PCSE and QR techniques were also put to use to account for modeling failures of the SUR estimates. These battery of panel regression techniques were applied to understand which schools of thought have been advanced to explain the relationship between competition and stability. Other significant predictor of solvency in the insurance market were identified as Firm size, capitalization, reinsurance and business line diversification and the results also indicated that the effect of each variable vary at different levels of insurance solvency. The findings offer several policy implications for the regulation and management of insurance stability.

Considering our results, we realized the effect of competition on Risk-taking behavior and solvency in insurance market in Iran.

With regard to the Lerner index as our proxy for competition, higher amount of z_{score} illustrates the higher stability between insurance firms specially for stronger insurers compared to weaker ones. Furthermore, increasing market power decreases the coefficient of variation of the loss ratio. Thus, increasing competition in Iranian insurance market (decreasing market power) diminishes insurance solvency and then stability which support competition-fragility hypothesis. Considering this school of thought, first, increasing market competition in Iran can exacerbate the information asymmetry problem. Competition has a tendency to increase the frequency of policyholders switching insurers over the course of time. This makes it difficult for insurers to fairly mobilize historical information on claim behavior and pricing policies, thereby, increasing the probability of policyholder claims.

The second mechanism of this hypothesis, represent that competition for profits in competitive markets increase the incentives for excessive risk-taking. This also reduces the capital buffers and exposes firms to adverse economic conditions. The undercutting of premiums to generate higher sales of insurance policies (a characteristic of competitive insurance markets) supports this hypothesis. As a result, there is a tendency to increase the loss distribution of insurance firms and create a high probability of market insolvency.

With regard to the other significant predictors of solvency in the insurance market, the results of the Firm size represented that weaker insurers are more affected by solvency risk compared to the stronger ones. Hence, they should expand their solvency status in order to prevent destabilization. On the other hand, moderately strong and stronger insurers compared to weaker insurers are more affected by underwriting risk. hence, they have to concentrate more on their portfolios or may increase their portfolios against of risk.

Our finding indicated that as the amount of Npe increased in Iranian insurance companies, the amount of solvency comes lower. Moreover, the higher amount of Npe shows higher amount of net earned premiums. This can be recognized as a kind of asset which is in favor of insurance firms; however, this can be defined as high risk absorption hence it can increase the solvency risk. Thus, the risk of insolvency increases as well and Iranian insurance firms' stability decreased respectively. Additionally, weaker insurers compared to moderate and stronger ones are more affected by underwriting risk. They should focus on their portfolios more in order to prevent them from risk.

The results of Reins indicated that the use of reinsurance contracts increases the solvency of weaker and moderately stronger insurers compared to stronger ones. In general, weaker and moderately stronger insurers are more affected by solvency risk and destabilization. Thus, these firms should use more reinsurance contracts in order to be solvent in this industry. On the other hand, increasing the usage of reinsurance contracts in all insurance firms may lead to decrease the portfolios risk. This is the positive point in this industry. Hence, Iranian insurance firms should keep this situation due to the fact that using reinsurance contracts transfer the risk to reinsurance in order to reduce their exposure and also reduces their underwriting risk. This effect is consistent for on all kinds of Iranian insurance companies.

From the results of Bdiv as the last control variable, we observed that in quantile regression the effect of increasing business line diversification on solvency is serious for both weaker and stronger insurers but with different consequences. As a result, because of the solvent status of stronger insurers, if they face with solvency risk, they can tolerate the risk better than weaker insurers against the effect of business line diversification. However, for weak insurers is better to diversify their products lines because if they face with any risk or loss, their total business line will have broken. It would better for them to expand their income across business lines instead of focusing on fewer lines. Therefore, their stability improves as well. Moderate and strong insurers on the other hand, suffer more underwriting risk than weaker insurers. Thus, diversification of income across business lines in moderate and stronger insurers reduce their portfolio risk. They have to concentrate on more business lines and become more diversified.

Suggestions

These findings offer several policy implications for the regulation and management of insurance stability. With regard to the competition-fragility effect of competition on stability, increasing competition between Iranian insurance firms may affect the quality of supervision by regularity authorities in checking excessive risk-taking. For example, if policyholders switch their insurers, regularity authorities should confront with them. In some ways, they are content to accept lower rates and this makes it difficult for regularity authorities. Hence, they would better consider the identification of the optimal level of competition in policy design. The results of the quantile regression also suggest that weaker, moderately strong and stronger insurers should consider their solvent status and portfolios against of solvency and underwriting risks. Additionally, regularity policies should also consider the financial health of insurers in the design of competition policies.

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Appendix

Table A: Correlation Matrix

	Lerner	Lerner^2	Firm size	Npe	Reins	Bdiv
Lerner	1.0000					
Lerner^2	-0.9982*	1.0000				
Firm size	0.0673	-0.0494	1.0000			
Npe	0.0097	-0.0138	-0.1919*	1.0000		
Reins	-0.0157	0.0115	-0.0776	0.0764	1.0000	
Bdiv	0.0461	-0.0406	0.0937	-0.1112	0.0715	1.0000

Note: lit = estimated Lerner index; lit2 = quadratic term of the Lerner index; Firm size = natural logarithm of total assets; Npe = net earned premiums to equity; Reins = reinsurance to gross premiums; Bdiv = business line diversification; *p<0.01

چکیده فارسی

فرم گردآوری اطلاعات پایان نامه/رساله

کتابخانه مرکزی دانشگاه علامه طباطبائی

عنوان به زبان فارسی: رقابت و رفتار ریسک پذیری در صنعت بیمه ایران
عنوان به زبان انگلیسی: Competition and risk-taking behavior in Iranian insurance industry
نویسنده/ پژوهشگر: سیده سحر شیرازی
استاد/استادان راهنما: دکتر رضا افقی   **استاد / استادان مشاور:** دکتر آتوسا گودرزی
استاد/استادان داور: دکتر غدیر مهدوی کلیشمی
مقطع تحصیلی: کارشناسی ارشد   **رشته تحصیلی:** بیم سنجی
کلید واژه ها به زبان فارسی: ریسک توانگری، شاخص لرنر، رگرسیون به ظاهر نامرتبط، رگرسیون چندکی، بیمه، ایران
کلید واژه ها به زبان انگلیسی: solvency risk, Lerner Index, Competition, Seemingly Unrelated Regression, Quantile regression, Insurance, Iran
چکیده به زبان فارسی:

رقابت به طورگسترده به عنوان یک عامل مهم که بر رفتار ریسک پذیری و سودآوری تأثیر میگذارد، پذیرفته شده است. در سیاست های نظارتی، تنظیم کنندگان بازار با این تصمیم مواجه‌اند، که آیا رقابت برای ثبات بازار مفید است یا خیر؟! علاوه براین، رفتارهای ریسک پذیری در کشورهای مختلف و شرکتهای بیمه مختلف یکسان نیست. هدف از این مطالعه بررسی تأثیر رقابت بر رفتار ریسک پذیری و توانگری شرکت های بیمه در ایران است. ما از داده های سالانه 17 شرکت بیمه از سال 1386 تا 1396 به منظور برآورد شاخص لرنر به‌عنوان نماینده‌ای برای رقابت، وهمچنین از z_{score} و انحراف استاندارد نسبت خسارت به عنوان نمایندگانی برای رفتار ریسک پذیری استفاده کرده ایم. با استفاده از مدل های رگرسیون به ظاهر نامرتبط (SUR)، خطای معیار تصحیح شده پنل حداقل مربعات معمولی (OLS-PCSE) و رگرسیون چندکی (QR) شواهدی را مبنی بر فرضیه رقابت-شکنندگی که حاکی از تأثیر منفی رقابت بر رفتار ریسک پذیری و ثبات است، به‌دست آورده‌ایم. اندازه شرکت، سرمایه، بیمه اتکایی و تنوع محصولات بیمه‌ای به عنوان دیگر پیشبینی کننده های توانگری در شرکت های بیمه به کاربرده شده‌اند و نتایج آن ها نشان می‌دهند که تأثیر هر متغیر در سطوح مختلف توانگری بیمه متفاوت است. این یافته ها کاربردهای سیاستی متعددی را برای تنظیم و مدیریت ثبات بیمه ارائه می دهد.

چکیده به زبان انگلیسی:

Competition is widely accepted as an important factor that affects Risk-taking behavior and profitability. In the formulation of regularity policies, regulators are faced with the difficult decision of whether competition is good or bad for market stability. Furthermore, Risk-taking behavior in different countries and different insurance firms are not the same. The aim of this study is to realize the effect of competition on Risk-taking behavior and solvency in insurance market in Iran. We utilize firm-level annual data

on 17 Iranian insurance companies from 2007 to 2017 to estimate the Lerner index as the proxy for competition, while the z_{score} and standard deviation of loss ratio are employed as proxies for risk-taking behavior. Using the seemingly unrelated regression (SUR), ordinary least square panel corrected standard error (OLS-PCSE) and quantile regression (QR), we find evidence in support of competition-fragility hypothesis which suggests a negative effect of competition on risk-taking behavior and stability. Other significant predictor of solvency in the insurance market are identified as firm size, capitalization, reinsurance and business line diversification and the results also indicate that the effect of each variable vary at different levels of insurance solvency. The findings offer several policy implications for the regulation and management of insurance stability.

صحت اطلاعات این فرم را براساس محتوای پایان نامه/رساله گواهی می نمایم.

نام و نام خانوادگی

امضاء

به نام خدا

منشور اخلاق پژوهش

با یاری از خداوند سبحان و اعتقاد به این که عالم محضر خداوند است و همواره ناظر به اعمال انسان و به منظور پاس داشت مقام بلند دانش و پژوهش و نظر به اهمیت جایگاه دانشگاه در اعتلای فرهنگ و تمدن بشری ما دانشجویان دانشکده های دانشگاه علامه طباطبائی متعهد می گردیم اصول زیر را در انجام فعالیت های پژوهشی مد نظر قرار داده و از آن تخطی نکنیم:

1- اصل حقیقت جوئی: تلاش در راستای پی جویی حقیقت و وفاداری به آن و دوری از هرگونه پنهان سازی حقیقت،

2- اصل رعایت حقوق: التزام به رعایت کامل حقوق پژوهشگران و پژوهیدگان (انسان، حیوان و نبات) و سایر صاحبان حق،

3- اصل مالکیت مادی و معنوی: تعهد به رعایت کامل حقوق مادی و معنوی دانشگاه و کلیه همکاران پژوهش،

4- اصل منافع ملی: تعهد به رعایت مصالح ملی و در نظر داشتن پیشبرد و توسعه کشور در کلیه مراحل پژوهش،

5- اصل رعایت انصاف و امانت: تعهد به اجتناب از هرگونه جانب داری غیر علمی و حفاظت از اموال، تجهیزات و منابع در اختیار،

6- اصل رازداری: تعهد به صیانت از اسرار و اطلاعات محرمانه افراد، سازمان هاو کشور و کلیه افراد و نهادهای مرتبط با تحقیق،

7- اصل احترام: تعهد به رعایت حریم ها و حرمت ها در انجام تحقیقات و رعایت جانب نقد و خودداری از هرگونه حرمت شکنی،

8- اصل ترویج: تعهد به رواج دانش و اشاعه نتایج تحقیقات و انتقال آن به همکاران علمی و دانشجویان به غیر از مواردی که منع قانونی دارد،

9- اصل برائت: التزام به برائت جوئی از هرگونه رفتار غیر حرفه ای و اعلام موضع نسبت به کسانی که حوزه علم و پژوهش را به شائبه های غیر علمی می آلایند.

نام و نام خانوادگی: **:** تاریخ و امضاء:

تعهدنامه ی اصالت پایان نامه / رساله

اینجانب.....................................دانش آموخته مقطع تحصیلی کارشناسی ارشد / دکتری در رشته...................... که در تاریخ .... از پایان نامه / رساله خود تحت عنوان .... با کسب نمره / درجه .... دفاع نموده ام، متعهد می شوم:

1- این پایان نامه / رساله حاصل تحقیق و پژوهش انجام شده توسط اینجانب بوده و درمواردی که از دستاوردهای علمی و پژوهشی دیگران (اعم از مقاله، کتاب، پایان نامه و غیره) استفاده نموده ام، مطابق ضوابط ورویه موجود، نام منبع مورد استفاده و سایر مشخصات آن را در فهرست مربوط ذکر و درج کرده ام.

2- این پایان نامه / رساله قبلا برای دریافت هیچ مدرک تحصیلی (هم سطح، پایین تر یا بالاتر) در سایر دانشگاه ها و موسسات آموزش عالی ارائه نشده است.

3- چنانچه بعد از فراغت از تحصیل، قصد استفاده از هرگونه بهره برداری اعم از چاپ کتاب، ثبت اختراع و ازین دست موارد از این پایان نامه / رساله را داشته باشم، از حوزه معاونت پژوهشی دانشگاه علامه طباطبائی مجوزهای مربوطه را اخذ نمایم.

4- چنانچه در هر مقطع زمانی خلاف موارد فوق ثابت شود، عواقب ناشی از آن را می پذیرم و دانشگاهی مجاز است با اینجانب مطابق ضوابط و مقررات رفتار نموده و درصورت ابطال مدرک تحصیلی ام هیچ گونه ادعائی نخواهم داشت.

نام و نام خانوادگی:

تاریخ و امضاء:

دانشگاه علامه طباطبائی

بسمه تعالی

صورتجلسه دفاع پایان نامه تحصیلی کارشناسی ارشد

با تأییدات خـداوند متعـال، جلسه دفـاع از پایان نامه کـارشناسی ارشـد خانم سیده سحر شیرازی دانشجـوی دوره شبانه رشته بیم سنجی به شماره دانشجویی ۹۶۱۲۶۳۳۲۱۱ با عنوان :

"Competition and Risk-Taking behavior in Iranian Insurance Industry"

با حضور استادان راهنما، مشاور و داور در دانشکده آموزش عالی بیمه اکو در روز چهارشنبه مورخ ۱۳۹۸/۱۱/۳۰ برگزار و نمره

نمره مقاله از ۱	الف)پذیرش یا انتشار مقاله در نشریات عضوISI، SCOPUS، علمی_ پژوهشی و نشریات داخلی دانشگاه تا ۱ نمره ب)پذیرش یا انتشار مقاله در سایر نشریات نمایه شده معتبر، حداکثر یک مقاله تا ۰/۵ نمره ج) پذیرش یا انتشار مقاله در نشریات علمی_ترویجی، حداکثر یک مقاله تا ۰/۵ نمره د)پذیرش یا انتشار مقاله در مجموعه مقالات همایش های علمی ملی و بین المللی۰/۲۵ نمره و حداکثر تا دو مقاله۰/۵ نمره مقاله(مقالات) ارائه شده از گروه الف□ ب□ ج□ د□ می باشد. مهر و امضاء معاونت پژوهشی دانشکده........................

نهایی به شرح زیر مشروط به انجام اصلاحات اعلام می گردد:

توجه: دانشجو می تواند فقط در سنوات مجاز تحصیلی(۴نیمسال) و حداکثر در نیمسال پنجم و حداکثر تا روز دفاع از امتیاز مقاله استفاده نماید و پس از روز دفاع به هیچ وجه مقاله پذیرفته نخواهد شد.

نمره مقاله:	نمره نهایی	به عدد: ۱۹
نمره پایان نامه از۱۹:		به حروف: نوزده

عالی(۲۰-۱۹)□ بسیار خوب(۱۸/۹۹-۱۸)□ خوب(۱۷/۹۹-۱۶)□ قابل قبول(۱۵/۹۹-۱۴)□ غیر قابل قبول(کمتر از ۱۴)□

اعضاء هیئت داوران:

سمت	نام و نام خانوادگی	امضاء
استاد راهنما	دکتر افقی	
استاد مشاور	دکتر گودرزی	
استاد داور	دکتر مهدوی کلیشمی	
نماینده تحصیلات تکمیلی	دکتر مهدوی کلیشمی	

دانشگاه علامه طباطبایی

دانشکده بیمه اکو

پایان نامه کارشناسی ارشد رشته بیم سنجی

رقابت و رفتار ریسک پذیری در صنعت بیمه ایران

استاد راهنما:

دکتر رضا افقی

استاد مشاور:

دکتر آتوسا گودرزی

استاد داور:

دکتر غدیر مهدوی

پژوهشگر:

سیده سحر شیرازی

زمستان، 1398