



ECO College of Insurance
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A Feasibility Study on Provision of Earthquake Insurance for Tehran

Master of Science

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Abstract

Traditional insurance principles for insurability require that there should be sufficient demand to yield appropriate levels of income revenue for insurers to supply the coverage. In this study, for provision the earthquake insurance coverage we investigated the number of factors influencing on demand for earthquake insurance in metropolitan Tehran, Iran.

We investigated whether individuals' expected utility in the state of insurance is more than the expected utility in the state of no insurance. We also, empirically, investigated the influence of individuals' characteristics such as the age of household head, education, employment, monthly income, distrust to insurance company, and construction characteristics (type of structure, its age, construction quality and construction value), government interference and geophysical risk on demand of purchase earthquake insurance using econometric model.

The main results of this study are summarized as follows: First, the expected utility in the state of insurance is more than the expected utility in the state of no insurance and the expected utility for individuals' willingness to pay is more than the expected utility with real premium. Second, the level of geophysical risk does not have meaningful effect on the demand of earthquake insurance. Third, the premium rate and structure value have significant negative relationship with demand for earthquake insurance. Fourth, Perception of risk has significant positive relationship with demand for residential earthquake insurance. Fifth, individuals' trust to government interference for loss financing negatively affects the purchase of earthquake insurance. Sixth, income level has not significant relationship with insurance demand. Finally, the results show that individuals' risk aversion is significantly related to demand for residential earthquake insurance.

Keywords: earthquake insurance; premium; expected utility; willingness to pay; geophysical risk; and Tehran.

Dedicated to

My family

For their support and love.

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Chapter 1: Introduction and Literature Review

1-1. Introduction

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1-3. Literature Review

1.3.1. Literature on earthquake seismic hazard and geophysical risk

1.3.2. Literature on factors affecting on demand for earthquake insurance and pricing

1-3-3. literature on Characteristics of earthquake insurance system in countries

1-1: Introduction

Natural disasters, for some decades, shown a clearly upward tendency in terms of the figures for financial and insured losses. Concentration of population and property, shortcomings in environmental management and a degree of active influence of climate change, depending on the zone, are factors to be taken into account in explaining the gradual rise of mean financial losses registered as a consequence of natural disasters in the last three decades. The upward tendency in these losses is also reflected in the indemnity liabilities insurers and reinsurers have had to confront.

Following the occurrence of a natural disaster, the return to normality of community can be very costly, so that adequate and abundant financial resources are needed to support the capacity for recovery and reconstruction. The sources of such means are basically of two kinds: relief and risk financing mechanism, which, in turn, without ruling out self-insurance (captive) solutions as well.

Financing economic recovery require both private and public recovery funds. Many people feel loss prevention and loss financing for natural disasters should be provided by government. We should not disregard the necessity for individual efforts. Insurance is one of the most efficient forms of pre-disaster risk financing to reduce losses the financial vulnerability of property owners and governments to earthquake risk exposure. So, we should present some types of earthquake insurance coverage according to our perceived need for protection against the financial losses from earthquakes.

Earthquake coverage must be purchased as an endorsement to an existing homeowner's or *business owner's policy or as a separate policy*. It includes coverage for damage to the building structure, contents or personal property.

This study is the result of a survey of 800 owner-occupiers in Tehran conducted in December, 2010 on the basis of which we investigated the number of factors influencing the purchase rate of earthquake insurance. We used logistic regression model in order to determine the effect of individuals' characteristics such as the age

of household head, unemployment, education, and distrust to insurance company, building characteristics (type of structure, its age, construction quality and construction value), government interference and geophysical risk on decision to purchase earthquake insurance coverage. We also compared individuals' expected utility (EU) in the state of insurance and no insurance in order to investigate whether individuals' trend to purchase earthquake insurance.

Our research hypotheses are as bellow:

- 1- Premium rate has significant negative effect on the demand for residential earthquake insurance.
- 2- Individuals' risk aversion is significantly related to demand for residential earthquake insurance.
- 3- Expected utility in the state of insurance is more than the expected utility in the state of no insurance.
- 4- Insurance demand is not significantly related to geophysical risk.
- 5- Individuals' trust to government interference for loss financing negatively affects on demand of earthquake insurance.

In this study, we also try to answer the following questions:

- 1- Is income level significantly impact on insurance demand?
- 2- Is the demand of earthquake insurance significantly impact on employment, trust to insurance companies, age of household head and their education?
- 3- Are homeowners with higher perception of risk (whether or not they are living in areas of higher actual geophysical risk) more likely to purchase earthquake insurance?

We employed real data in the current study. The data were collected from questionnaires and Disaster Management Organization of Tehran consisting of the following items

- 1- Individuals' characteristics like age, education, unemployment, experience, distrust.

2- Characteristics of construction like structure, construction quality, age, value of house and furniture.

3- The geophysical risk related to under-study zones.

In order to necessary data among house holders, we used two stage stratified sampling method with proportional allocation for selecting householders in three various zones on North Tehran fault with high risk, medium risk and low risk level. We restricted the survey to owner-occupiers residents.

In this chapter, the importance of earthquake insurance as well as the literature review will be reviewed. In second chapter, we will provide introduction of insurance, earthquake risk and earthquake insurance and in third chapter; we will give evolution of worldwide earthquake insurance as well as Iran. In chapter four we will define practical method consist of our data gathering method, reliability of questionnaire and methodology for empirical analysis. In chapter five we will provide the empirical analysis to determine factors affecting on purchase rate and also investigate the individuals' willingness to pay for earthquake insurance. Finally in chapter six conclusions of our study are stated together with recommendations can be found for future research on the same subject.

1.2. The Purpose and Importance of the Thesis:

Iran is one of the most seismic prone countries of the world. It is placed over the Himalayan-Alpied seismic belt and often suffers destructive and catastrophic earthquakes that cause serious loss of human life and extensive damage. For example, Bam earthquake what caused over 26000 casualties is one of these cases. According to the earthquake data of Iran, most activities are collected along the Zagros fold thrust belt in comparison to the central and eastern parts of Iran (Ghodrati Amiri, 2003).

Considering the importance of Tehran as the capital of Iran, the most significant and primary faults include: North Tehran and Niavaran thrust, Mosha, North Rey,

South Rey, Kahrizak, Garmsar and Pishva faults around this city , make it prone to more severe earthquake damage in comparison to other regions. In addition, its special features including highly dense population (more than 10 million people), and also political and economical centralization will affect the whole country, and therefore, the evaluation of the severity of earthquake occurrence is in fact very necessary (Ghodrati Amiri, 2003).

Following the occurrence of a natural disaster, the return to normality of community can be very costly, so that adequate and abundant financial resources are needed to support the capacity for recovery and reconstruction. For example in Manjil-Roodbar earthquake the amount of loss was estimated about 1388 milliard Rial ,that was equivalent to about 8% of the total GDP of Iran in year 1369. Therefore evaluation of the effects of earthquakes on seismic design of buildings of Tehran is indeed very necessary.

Insurance is arguably the most efficient form of pre-disaster risk financing to mitigate losses and reduce the financial vulnerability of property owners and government to earthquake risk exposure. A successful earthquake insurance system should also provide incentives for risk mitigation activities. Therefore, it is necessary to investigate main factors affecting on purchase rate and premium rate of earthquake insurance.

1.3. Literature Review

Studies regarding earthquake and insurance field have been done on several viewpoints. Many papers have studied the historical earthquakes and earthquake insurance authority in varies seismic countries. Several studies have been done on insurance issues of catastrophic disasters and earthquake insurance system and also some others were assessed earthquake loss estimation for buildings.

In various researches propensity to purchase residential earthquake insurance coverage by individual homeowners have been surveyed. Many studies provided information on the factors considered in purchase decision and moreover the issue of low demand for earthquake insurance. Some studies were done on the seismic insurance policy as a tool of catastrophic risk management. Furthermore, many papers evaluated earthquake hazard parameters for seismotectonic zones. There are several studies that utilized models for forecasting the occurrence of earthquakes.

According to above studies, we classify our literature in three major classes, 1-Literatures on earthquake seismic hazard and geophysical risk, 2-Literature on Factors Affecting on Demand for Earthquake Insurance and Pricing, 3-Literature on Characteristics of Earthquake Insurance System in Countries.

1.3.1. Literatures on Earthquake Seismic Hazard and Geophysical Risk

Tavakoli and Ghafory-Ashtiany (2004) integrated the geological and seismological data into a probabilistic seismic hazard model for Iran which located between 25 to 40 degrees north (N) and 44 to 63 degrees east (E). They applied maximum likelihood estimation for fitting the seismicity parameter used in their study. In their method also artificially homogeneous data set is simulated through the determination of the period over which the data in a given time span are completely reported.

In this study, based on the collected data, the earthquake hazard parameters were estimated for each seismotectonic province of Iran. It should be noted that in this work, the Gutenberg-Richter parameters was assumed to be constant for each province. The main parameters of the probabilistic seismic hazard assessment conducted in this study have been summarized as follows:

1- Macroseismic, historical and instrumental seismic data of earthquakes occurrence during the past several hundred years.

2- Seismic source model that based on geological and seismological evidence are identified.

3- Source seismicity information which was estimated recurrence relationships and the assessment of the maximum magnitudes for individual seismic sources.

4- Attenuation of the strong ground motion.

5- Recurrence forecasting which includes statistical methods used in the estimation of source seismicity information and stochastic model (Homogeneous Poisson Process) used in the estimation of seismic occurrences.

They concluded that Seismic hazard maps indicated the earthquake hazard of Iran in the forms of iso-acceleration contour lines, and seismic hazard zonation.

Characteristic of these maps are as follows:

1- The contour levels of the acceleration hazard maps range from 15% to 48% grid (g).

2- The highest acceleration contour encompasses the North Tabriz fault zone, North of Tehran, the Dasht-e-Bayaz fault zone, etc. The maximum mean acceleration in the vicinity of these tectonic elements is predicted to be around 0.45g for a return period of 475 years and 0.30g for a return period of 75 years.

3- The least acceleration contours are expected in two regions. One includes a narrow band which has a NW-SE trend and extends from Urumiyeh to Esfahan. The other one is in the central Lute zone in eastern Iran. Corresponding maximum acceleration values for both of these regions are less than 0.20g, and 0.35g for return periods of 75 and 475 years, respectively.

4- The peak ground acceleration attenuation relationships considered in this study are given for the mean maximum horizontal acceleration in bedrock. In soil

deposits of appreciable depth, the ground accelerations will be somewhat larger than those indicated on these hazard maps.

5-The maps are intended as a pattern for the assessment of the seismic hazard concerning engineering structures.

6-Since only major known sources have been considered in preparation of these maps, it is recommended that for important type of structures, site specific studies which require deterministic hazard investigations, and identified local seismic sources on large scale maps to be performed.

Anderson (1976) computed the coefficient of variation for flood, hurricane, tornado, earthquake and total catastrophe property losses over 51 territories in the U.S.A. (50 States plus Washington, D.C.). The results indicated that, with the exception of tornado losses, an insurer writing an all - risks policy would exhibit less variability between territories in its loss experience than an insurer writing a specified peril only.

Ghodrati Amiri et al. (2004) presented a probabilistic seismic hazard assessment of Tehran. They displayed the probabilistic estimate of Peak Ground Acceleration (PGA) over bedrock for the return periods of 475 and 950 years.

Their research introduced new research using the latest and updated seismic data and provided bedrock design basis acceleration for the calculation of earthquake equivalent static forces in the return period considered by the Iranian seismic code. Moreover, in order to utilize the results of their research for designing critical structures for which the earthquake return period is considered 950 years, the results were also provided for this return period in this research. Earthquake hazard parameters were used in this paper through the logic tree method. In this study the Poisson model was adopted for its popularity, ease of use and its lack of sufficient data for other models.

Mehdi Zaré (2007) studied Iranian strong motion data to find the spectral demand ordinates of the selected records having better signal to noise ratios the capacity spectrum method is used in this study and the spectral demand curves are estimated for 89 records. The records are classified into two major Iranian seismotectonic zones of Alborz-Central Iran (where the strong motions are attenuated slower than Zagros, and are recorded with greater durations) and Zagros, showing faster attenuation and lower durations of strong motions (Zaré, (1999)). In this research, first, the procedure of data processing and records selection represented, and then, the strong motion parameters discussed. Finally, the obtained demand curves and the main results of the study are presented for each site classes and for the major seismotectonic regions of Iran. This study was effective to select the higher qualified strong motion records obtained in Iran (1977-2003) with greater amplitudes for studying the spectral demand curves of different seismotectonic zones and 4 site classes. These curves can be used in the rehabilitation and reinforcement projects in Iran and other parts of the world with the aim of using the damping systems in the important buildings. The mean demand curves, estimated and discussed in this study, showed that the data for site classes 2 and 3 are still insufficient in concluding the systematic changes between different site classes. Therefore, the curves developed in this study is recommended to be used for the site class-1 of the bedrock and then in case of specific site conditions (classes 2, 3 or 4), a “site specific study”, geotechnical profiles is used. In order to complete the dataset and receiving homogeneous number of records for different site classes and near-fault condition the study should be followed.

Yucemen et al. (2008) proposed a simple probabilistic model for the assessment of earthquake insurance rates for important engineering structures. The model integrates the information on seismic hazard and expected earthquake damage on engineering facilities in a systematic way, yielding to estimates of the earthquake insurance premiums. The proposed model is used to estimate the earthquake insurance premiums for the structures taking place in the Bolu Mountain Crossing in the Gumusova–Gerede motorway Section, Turkey.

The model requires two types of studies, namely: (1): seismic hazard analysis and (2) estimation of potential damage to structures based on damage probability matrices (DPM). The computations are carried out according to the proposed model by using the seismic hazard results and the best estimate DPM's developed in the study and the annual pure risk premiums are obtained for the different components of the motorway system by making a distinction between sections completed and sections under construction.

Ghafory (2010) has investigated the disaster insurance pricing with providing a comprehensive definition of risk management and Referring to the status of disaster risk in Iran and Risk Estimation Process. At the beginning, with the definition of risk management principles and factors affecting, the process of risk estimation and how to use the results in determining models for buildings insurance in Iran discussed and the means development of insurance culture in the community associated with the development of insurance in the country is expressed. Afterward, with providing compensation insurance state in Iran, challenges facing the insurance industry for risk reduction process are expressed.

1.3.2. Literature on Factors Affecting on Demand for Earthquake Insurance and Pricing

Kunreuther (1984) suggested two scenarios to explain why consumers behave contrary to standard economic insurance demand theory assuming risk aversion. Consumers may either (1) underestimate the losses and/or probability of disaster so that the benefits of insurance protection appear unattractive relative to the cost of the policy, or (2) they assume the probability of a disaster is sufficiently low that it is not worth worrying about; consequently insurance is not even considered as an option. To deal with the first problem correct information just needs to be provided (but nobody really knows what is correct), and with regard to the second problem either

information must be provided in a manner which impresses upon the consequences of an earthquake or some form of regulatory action must be imposed.

Goltz et al. (1985) in their report examine issues and problems associated with the availability and procurement of earthquake insurance from points of view of both consumers and providers. The discussion outlines the provisions of earthquake insurance policies currently available to homeowners, businesses, local governments and special districts. They examined the extent to which earthquake insurance is purchased or why it may be unattractive to consumers. The Federal role in providing or promoting earthquake insurance is reviewed. Afterward, policies are recommended for the Federal Government and others in order to develop a more adequate system of coverage. This report grew out of the City of Los Angeles Planning Partnership for which the Southern California Earthquake Preparedness Project (SCEPP) was asked to research and report on several issues pertaining to earthquake insurance. The report has five goals which correspond to its organization: (1) to outline the provisions (coverages, rates, deductibles, etc.) of earthquake insurance policies currently available to the major classes of insurance consumers—homeowners, businesses, local governments and special districts; (2) to determine the extent to which earthquake insurance is purchased by these parties and explore the circumstances surrounding purchase or non-purchase; (3) to review the salient issues in earthquake insurance from the standpoints of purchasers and providers; (4) to explore potential Federal roles in resolving these issues and in providing or promoting earthquake insurance; and finally, (5) to make reasonable policy recommendations involving both the Federal Government and other stakeholders in earthquake insurance toward a more adequate system of coverage.

Palm and Hodgson (1991) researched the result of survey of 3500 owner-occupiers in Contra Costa, Santa Clara, Los Angeles, and San Bernardino counties conducted in the summer of 1989. A random sample was drawn from tax assessor's lists of the entire population of owner-occupiers in each study county. This study was limited to single family detached owner-occupiers.