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Original Article

Evidence of Adverse Selection in Iranian Supplementary Health Insurance Market

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Abstract

Background: Existence or non-existence of adverse selection in insurance market is one of the important cases that have always been considered by insurers. Adverse selection is one of the consequences of asymmetric information. Theory of adverse selection states that high-risk individuals demand the insurance service more than low risk individuals do.

Methods: The presence of adverse selection in Iran's supplementary health insurance market is tested in this paper. The study group consists of 420 practitioner individuals aged 20 to 59. We estimate two logistic regression models in order to determine the effect of individual's characteristics on decision to purchase health insurance coverage and loss occurrence. Using the correlation between claim occurrence and decision to purchase health insurance, the adverse selection problem in Iranian supplementary health insurance market is examined.

Results: Individuals with higher level of education and income level purchase less supplementary health insurance and make fewer claims than others make and there is positive correlation between claim occurrence and decision to purchase supplementary health insurance.

Conclusion: Our findings prove the evidence of the presence of adverse selection in Iranian supplementary health insurance market.

Keywords: Asymmetric information, Supplementary health insurance, adverse selection, Logistic regression model

Introduction

Most theoretical works on insurance have shown that the existence of information asymmetry can lead to insufficient provision of insurance services or even market failure. Two main consequences of asymmetric information problems are moral hazard and adverse selection. Each of these problems has a different impact on insurance market. In most theoretical models, the information asymmetry is relative to the level of risk: the buyer is assumed to know better her (his) loss probability than the company.

The conventional theory of demand under asymmetric information that leads to adverse selection problem contains the following assumptions:

1) The difference in exposure to risk: People differ in the level of exogenously determined risk levels. For simplicity, we assume that individuals are divided into two groups of risk levels, high- and low-risk groups.

2) Positive correlation between self-perceived risk level and real risk level

3) No relationship between the level of risk aversion and riskiness

4) Information asymmetry: Customers know more about their riskiness than the insurers and efficiently use their information against the insurers.

Instead of the assumption that individuals differ in the level of exogenously determined risk level that determines the insurance demand, if we con-

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centrate on the assumption that high risk-averse individuals are more likely both to try to reduce hazard by purchasing insurance and taking precautionary efforts, the result will be different. In other words, people who buy more insurance tend to be more safety conscious and thus are more inclined to undertake precautionary efforts. Inversely, less risk-averse individuals are less likely to buy insurance voluntarily, and they are the ones most likely to place themselves deliberately in dangerous situations. Consequently, in this setting, the selection effect will be advantageous to the market as insurers end up with many cautious low-risk individuals who are likely to pay for precautionary efforts. This theory, which leads to favorable situation for insurers, is called advantageous selection theory.

The advantageous selection theory contains the following assumptions:

1. The difference in risk aversion levels: Individuals are dived into different risk aversion groups and the level of attitude toward risk is the most important factor on determining the amount of demand for insurance services.
2. Negative correlation between the level of risk aversion and risk level
3. Effectiveness of precautionary efforts (1).

Adverse selection happens because of hidden information of buyers. Based on adverse selection theory, policyholders claim losses, which are higher than the average rate of loss of population used by the insurer to set their premium.

According to adverse selection theory, individuals can be divided into two groups of risk levels; low- and high-risk individuals, insurance companies cannot distinguish between them but the individuals know the group they belong to. Based on this assumption, the adverse selection theory states that high-risk individuals demand the insurance service more than low-risk individuals do and finally insurance companies end up with high-risk individuals.

Weak underwriting in an insurance market is one of the sources of adverse selection. The main responsibility of an underwriter is to guard against adverse selection problem. If insurance companies have little or no ex-ante information regarding their buyers' risk types, then policy contracts must be priced according to the average level of risk of all buyers in the market. This pricing system leads to exiting of low-risk buyers. In other word, it intensifies adverse selection problem.

Insurance companies to cope with the adverse selection problem increase the premium. The consequence will be the low-risk individuals gradually drop out of the market. This causes a further increase in price, hence the lowest remaining risks cancel their insurance contract, leading to a further increase in price, and so insurance companies become the exclusive domain of high-risk individuals. In addition, presence of adverse selection leads to a level of supply-demand equilibrium for insurance, which is lower than the optimum level. Eventually this problem may lead to the collapse of the insurance market.

Many empirical studies have used data from specific insurance markets to test whether asymmetric information leads to adverse selection or not. They mostly supported the idea of existence of asymmetric information and its effects on insurance market. Some other papers, however, have found no evidence of the effects of information asymmetry on insurance market.

Review of Literature

The study of adverse selection in insurance market originates from Rothschild and Stiglitz (2). Many empirical works have studied the existence of adverse selection in health insurance markets. These studies can be divided into two groups; first group includes the researches that support the existence of adverse selection in health insurance market and the second group found no evidence of adverse selection in this market.

Researches supporting the existence of adverse selection

Marquis and Phelps (3) discussed about adverse selection problem in health insurance market. They analyzed the data from a questionnaire regarding the hypothetical purchase of supplementary insurance and proved the existence of adverse selection in insurance market. Also Marquis

(4), using data from the RAND Health Insurance experiment, observed that individuals who select more generous health insurance plans are more likely to have large health expenditures. This matches the empirical prediction of a positive correlation between risk type and insurance coverage under asymmetric information.

Wolfe and Goddeeris (5) estimated a health care utilization equation using a sample of individuals more than 65 years old that purchased supplementary insurance in the Medigap market. They used self-reported health and self-reported expenditure measures including total medical bills for hospital, physician and prescription expenditures and any amount paid by insurance. They observed that respondents, with better self-reported health more likely to purchase supplemental private insurance also incurred higher expenditures on hospital stays, physician care and prescription drugs. They found evidence of adverse selection in the Medigap market.

Finkelstein and McGarry (6) studied selection based on multi-dimensional private information in the long-term care (LTC) insurance market. Using the AHEAD[1] data, they calculated correlation between LTC coverage and use of nursing home care. They found subjective risk assessment is positively correlated with both LTC coverage and nursing home use in 1995-2000. This suggested the presence of adverse selection based on private information about risk type.

Olivella and Hernandez (7) performed a test of adverse selection using the British Households Panel Survey. In England, private medical insurance is mostly used for hospitalizations. Their test compared the probabilities of hospitalization of employees who had received private medical insurance as a fringe benefit, and those who had bought it directly. Since the benefits offered by corporate policies are very similar to those offered by individually purchased policies, both groups will have the same access conditions to hospitalization. Consequently, any positive difference in the probabilities of hospitalization between the two groups was due to differences in risk. They observed that individuals who had purchased medical insurance had a higher probability of hospitalization than individuals who had received private medical insurance as a fringe benefit. This constituted evidence in favor of the presence of adverse selection in the British private medical insurance market.

Researches that found no evidence of adverse selection

Cardon and Hendel (8) estimated a structural model of health insurance and health care choices using data on single individuals from the National Medical Expenditure Survey. In their structural model, they assumed that individuals have identical preferences. They explored that estimated price and income elasticity, as well as demographic differences can explain the expenditure gap between the insured and the uninsured. They judged that the impact of adverse selection to be economically insignificant. They found no evidence of adverse selection in the U.S employer-provided health insurance market.

Liu (9) tested asymmetric information using NAIC[2] InfoPro databases of Long Term Care Insurance Reports and Life and Health Reports. Actually, he tested whether risk classification can effectively mitigate adverse selection in this market. Liu (9) supplied evidences that risk classification on insurer's intention can effectively mitigate adverse selection. He also detected that insurers in the Long Term Care Insurance (LTCI) market can correctly anticipate the ex-post claim costs, which means there is no asymmetric information (mainly adverse selection) in LTCI market.

Using data from China individual health insurance market, Gao, Powers and Wang (10) studied the problem of information asymmetry. They developed a model to capture the effects of buyers' wealth levels and loss amount on health insurance demand and calculated correlation between buyer's level of risk and the amount of insurance purchased. They proved existence of adverse selection in non-medical expense insurance and advantageous selection in medical expense insurance market.

[1] . Asset and Health Dynamics Among the Oldest Old

[2] .National Association of Insurance Commissioners

Materials and Methods

Original one-period model of information asymmetry in insurance market was introduced by Rothschild and Stiglitz (2). In this model, buyers are assumed heterogeneous with regard to their risk types.

We follow Gao, Powers, and Wang (10) in setting up our theoretical model. They introduced unobservable heterogeneity with regard to wealth levels of buyers (and consequently loss amount) and extended Rothschild and Stiglitz (2) original one-period model. Buyers are divided into two types. Each policyholder is assumed risk averse and has the increasing and concave-downward utility function, *U (.).* There are two types of insurance coverage in most of health insurance contracts: basic coverage and additional coverage. The basic component provides reimbursement for the insured's expenses up to a discretionary limit, whereas the additional component- which cannot be purchased independently of the basic component- pays for expenses that not covered by the basic insurance up to a fixed limit.

We assume that W_i , π_i, L_i and M_i denote the initial wealth level, probability of illness, additional loss amount and basic loss amount for a buyer of type i, respectively.

Suppose $\widehat{W}_i$ denotes the final wealth level for a customer of type *i* and P_i, A_i and B_i denote premium rate, coverage for additional and basic expenses, respectively. Each buyer tries to maximize the following objective function.

$$\begin{aligned} E\,[U(\widehat{W}_i)] &= \pi_i\, U(W_i - M_i - L_i + (B_i + A_i) - P_i(B_i + A_i)) \\ &+ (1-\pi_i)\, U(W_i - P_i(B_i + A_i)) \\ &= \pi_i\, U(W_i - M_i - L_i + (1-P_i)(B_i + A_i)) \\ &+ (1-\pi_i)\, U(W_i - P_i(B_i + A_i)) \end{aligned}$$

By examining the relationship between the decision to purchase additional health insurance (ADD) and the claim occurrence (CLM), the existence of adverse selection is tested. We try to obtain the correlation between the decision to purchase additional health coverage and the occurrence of a claim. Since the response, variables (dependent variable; ADD and CLM) are binary that can have only two possible outcomes, which we will denote as 1 and 0, we utilize logistic regression method to find correlation between these variables.

Let $\pi = P(Y = 1 \mid X = x) = 1 - P(Y = 0 \mid X = x)$

$$\pi = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}$$

$$Logit\,(Y) = \log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

This model is very widely used for analyzing data involving binary or binomial responses and several explanatory variables. In logistic model the vector of dependent factors of X are assumed to influence the outcome Y.

This paper sets up two logistic models, one for the choice of supplementary coverage (ADD) and one of the occurrences of claim (CLM):

$$Logit\,(Y) = \log\left(\frac{p_1}{1-p_1}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

$$Logit\,(Z) = \log\left(\frac{p_2}{1-p_2}\right) = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \cdots + \alpha_n x_n$$

These two logistic regression models are estimated. The first step in process of model assessment is usually to assess the significance of the variables in the model. Next the hypothesis of asymmetric information is tested by obtaining the correlation between two response variables (Y and Z).

The hypothesis of asymmetric information is supported if there is a positive correlation between insurance purchase and claim occurrence. A statistically significant negative correlation between these two variables confirms existence of advantageous selection in insurance market.

Data and Empirical Model

The Data

The required data are collected from questionnaires distributed among practitioner individuals. The study group consists of 420 practitioner individuals aged 20 to 59.All of individuals come from 22 regional districts in Tehran city. Table 1

in appendix defines the variables, and Table 2 provides summary statistics associated with the decision to purchase supplementary health insurance (ADD) and the claim occurrence (CLM).

Table 1: The definition for dummy variables of age, sex, education, occupation, and marital states as explanatory factors, and additional (supplementary) health insurance demand and claim as dependent variables of the models

Variable	Definition
Personal characteristics	
AGE	Dummy; AGE = 0 if aged 20-29, AGE = 1 if aged 30-39, AGE = 2 if aged 40-49, AGE = 3 if aged 50-59
SEX	Dummy; SEX = 0 if female, SEX = 1 if male
EDU	Dummy; EDU = 0 if diploma, ;EDU =1 if collage degree (Collage degree refers to 2 years of schooling after high school) & bachelor, EDU =2 if master & PhD
OCCU	Dummy; OCCU = 1 if management and technical staff, OCCU = 0 if service and production staff
MARRIAGE	Dummy; MARRIAGE =1 if married, MARRIAGE = 0 if single
Policy characteristics	
ADD	Dummy; ADD = 1 if additional insurance purchased, ADD = 0 otherwise Dummy;
CLM	CLM = 1 if claim made, CLM = 0 otherwise

Table 2: summary statistics for dependent variables of additional (supplementary) health insurance demand and claim as dependent variables of the models

Variable	Maximum	Minimum	Mean	Median
ADD	1	0	0.76	1
CLM	1	0	0.34	0

Empirical model

Since management and technical personnel (OCCU =1) generally have higher levels of income than service and production personnel have (OCCU = 0), the occupational variable is used as a proxy for wealth.

Consequently, our implicit empirical model for CLM will be as following:

$$CLM = f_1 (OCCU(-), AGE (+), SEX (+), MARRIAGE (-), EDU (-)) \quad [1]$$

$f_1(\cdot)$ is hypothesized to be a decreasing function of the variable OCCU as the wealthier individuals have less probability of illness and claim. This is shown by the sign (-).Note that the variables AGE, SEX, MARRIAGE and EDU are included in the right-hand side of the equation because they potentially influence the value of CLM and ADD.

Theoretically, age can have positive effect on the amount of claim, since the probability of illness increases with age. This is shown by the sign of (+). It is assumed that males encounter with more accidents. Thus, we expect a positive relationship between SEX and CLM. It is presumed that marriage can strengthen the health condition of individuals and cause the claims on illnesses to decline. Well-educated people theoretically have more precautionary activities and fewer claims

for insurers. Therefore, we expect a negative relationship between EDU and CLM.
The implicit empirical model for ADD is assumed to be as:

$ADD = f_2 (OCCU(-), AGE(+), SEX(+), MARRIAGE(+), EDU(+))$ [2]

where the sign (-) indicate that $f_2(.)$ is a decreasing function of the variables and sign (+) shows positive relationship. Theoretically, we assume that wealthier individuals self-insure themselves and have less demand for supplementary health insurance. Therefore, the effect of OCCU on ADD will be negative. The effect of age and sex is hypothesized to be positive on the purchase of additional health insurance since male and older individuals potentially demand insurance that is more supplementary. Marriage and education increase the knowledge as well as risk aversion level of individuals and increase the demand for insurance as well.

Results

In this paper, we have tested the existence of adverse selection in the Iranian supplementary health insurance. We collected required data by questionnaires distributed among practitioner individuals aged 20 to 59. This data contains information about personal characteristics (such as age, gender, education level, marital status, and career type) and policy characteristics. We could also obtain two important variables: claim occurrence (CLM) and decision to purchase supplementary health insurance (ADD) from this data.
We defined two logistic regression models for claim occurrence and the amount of demand for insurance coverage. In these models, personal characteristics displayed as independent variables. At first, these models were evaluated by Pseudo R-square. R-squares showed that two logistic models are reliable. In addition, we obtained independent variables that affected on claim occurrence (CLM) and decision to purchase insurance coverage (ADD). The results showed that independent variables such age, career type and education level have significant effect on decision to purchase health insurance, while education level and career type have significant effect on claim occurrence (CLM). We found that individuals with higher level of education and income level purchase less additional health insurance and make less claims than others make.
We also examined the hypothesis about existence of adverse selection. We assumed that if correlation between claim occurrence and decision to purchase health insurance is positive, adverse selection in Iranian supplementary heath insurance is evident. Since there is positive correlation between CLM and ADD, the hypothesis of existence of adverse selection in Iranian supplementary health insurance is accepted.

Discussion

Let X_i denotes the set of exogenous variables for individual i, such as age, sex, marital status, career type and education level. Suppose existence of two binary dependent variables:

$$Y_i = \begin{cases} 1 & \text{if individual } i \text{ purchases supplementary health insurance} \\ 0 & \text{otherwise} \end{cases}$$

$$Z_i = \begin{cases} 1 & \text{if individual } i \text{ has claim(loss)} \\ 0 & \text{otherwise} \end{cases}$$

Statistical analyses are performed by models [1] and [2], using two logistic equations: one for purchase of supplementary health insurance coverage (Y_i= ADD) and the other for the occurrence of a loss (Z_i = CLM).

$$\text{logit (Y)} = \ln\left(\frac{\pi_1}{1-\pi_1}\right) = \alpha_0 + \alpha_1 \text{OCCU} + \underline{\alpha}\, X$$

$$\text{logit (Z)} = \ln\left(\frac{\pi_2}{1-\pi_2}\right) = \beta_0 + \beta_1 \text{OCCU} + \underline{\beta}\, X$$

where X denotes the matrix of independent variables (i.e., all the "personal" variables identified in Table 1 except education) and π_1 is the probability of purchasing supplementary health insurance and π_2 refers to the probability of claim occurrence (probability of illness).

At first, the logistic models are evaluated. For this purpose, the Pseudo R-square is calculated. The values of Cox &Snell and Nagelkerke R-squares represent the percentage of the variance in the dependent variable explained by the independent variables.
Based on Table 3, independent variables could explain 84.9% to 91.0% of variation of dependent variable (ADD) and Table 4 shows that independent variables could explain 82.5% to 89.9% of variation of dependent variable (CLM).

Table 3: Goodness of fit statistic for additional (supplementary) health insurance demand (ADD): The table shows independent variables could explain 84.9% to 91.0% of variation of dependent variable (ADD)

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	195.343	0.608	0.709
2	153.879	0.734	0.813
3	102.029	0.849	0.910

The results confirmed that the logistic regression model is a proper model for the purpose. We determine the effect of independent variables on dependent variables (ADD and CLM). The results for these tests appear in Table 5 and 6.

Table 4: Goodness of fit statistic for amount of claim (CLM): The Table shows that independent variables could explain 82.5% to 89.9% of variation of dependent variable (CLM). The results confirmed that the logistic regression model is a proper model for the purpose

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	188.809	0.702	0.818
2	186.554	0.751	0.826
3	182.279	0.787	0.850
4	180.428	0.825	0.899

Table 5: Parameter estimation for additional (supplementary) health insurance demand (ADD): Table indicates that individuals with higher education level and career type 1 (technical and management staff) purchase supplementary health insurance less than others. Individuals with lower levels of income are more enthusiastic to purchase supplementary health insurance and high-income individuals can afford the expenses and self-insure themselves

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
OCCU(1)	-0.649	0.310	4.395	1	.036	0.522
EDU			21.407	2	.000	
EDU(1)	-1.294	0.404	10.241	1	.001	0.274
EDU(2)	0.143	0.344	0.172	1	.678	1.154
AGE			12.646	3	.005	
AGE(1)	-1.590	0.629	6.401	1	.011	0.204
AGE(2)	-0.925	0.613	2.276	1	.131	0.397
AGE(3)	-0.517	0.637	0.659	1	.417	0.596
Constant	2.954	0.665	19.716	1	.000	19.187

Table 6: Parameter estimation for claim (CLM): Only education level and career type variables are significant and effective variables in the model for CLM. Since the sign of parameters are negative, we conclude that individuals with higher income and education level make a claim less than other individuals for insurance companies

Variable						
OCCU(1)	-2.407	0.338	50.680	1	.000	0.090
EDU			19.834	2	.000	
EDU(1)	-0.507	0.279	3.309	1	.069	0.602
EDU(2)	-2.080	0.467	19.809	1	.000	0.125
Constant	0.681	0.206	10.891	1	.001	1.977

The Wald test is a major way of constructing significance test for parameters in this statistical model. If the Wald test is not significant then the effect of explanatory variables on ADD and CLM can be negligible.

All of independent variables except SEX and MARRIAGE are significant in level of significance of 0.05. Thus, SEX and MARRIAGE factors were omitted from the logistic model. Actually, gender and marital status of individuals do not affect the demand of supplementary health insurance (ADD variable) significantly. As expected, individuals with higher education level and career type 1 (technical and management staff) purchase supplementary health insurance less than others. In fact, individuals with lower levels of income are more enthusiastic to purchase supplementary health insurance and high-income individuals can afford the expenses and self-insure themselves.

Only education level and career type variables are significant and effective variables in the model for CLM. So, other independent variables were omitted from the model. Since the sign of parameters are negative, we conclude that individuals with higher income and education level make a claim less than other individuals for insurance companies make.

To determine the existence of adverse selection, the hypothesis of statistical independence between the demand of additional health insurance (ADD) and claim occurrence (CLM) is tested. For this purpose, the independent chi-square test is applied. This test determines the existence and the direction of relationship between them. The results of chi-square test are appeared in Table 7.

Table 7: Chi-square test: The table shows the result of the test for the existence of adverse selection, the hypothesis of statistical independence between the demand of additional health insurance (ADD) and claim occurrence (CLM). According to the Significance level of chi-square tests, the null hypothesis of statistical independence is rejected, because it is below the conventionally accepted significance level of 0.05. Therefore, two variables are dependent with respect to each other. The direct relationship proves the evidence of adverse selection

	Value	df	Asymp. Sig.
Pearson Chi-Square	49.977	1	.001
Continuity Correction	48.126	1	.001

According to the Significance level of chi-square tests, the null hypothesis of statistical independence is rejected, because it is below the conventionally accepted significance level of 0.05. Therefore, two variables are dependent with respect to each other. The result of chi-square test corresponds to the variables having an association or relationship where the rate of this relationship is not specified.

Under the null hypothesis of symmetric information, CLM and ADD should be uncorrelated. Here the result shows positive correlation. It would be done with computing Phi correlation coefficient.

Phi correlation coefficient is usually applied to measuring the degree of relationship between

two binary variables. It can show the strength of the relationship between variables. The result of Phi correlation coefficient is shown Table 8.

Table 8: phi correlation coefficient is usually applied to measuring the degree of relationship between two binary variables. It can show the strength of the relationship between variables. The positive value of Phi (0.345) rejects the null hypothesis of symmetric information and supports the hypothesis of adverse selection in health insurance market. According to the value of Phi correlation coefficient, we conclude that adverse selection is observed in Iranian supplementary health insurance

		Value	Approx. Sig.
Nominal	Phi	0.345	.001
	Cramer's V	0.345	.001

The positive value of Phi (0.345) rejects the null hypothesis of symmetric information and supports the hypothesis of adverse selection in health insurance market. According to the value of Phi correlation coefficient, we conclude that adverse selection is observed in Iranian supplementary health insurance. In fact, most of the individuals who purchased supplementary health insurance are among relatively high risk individuals.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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