Journal of Applied Sciences

ISSN 1812-5654

science alert

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Journal of Applied Sciences 15 (3): 500-507, 2015
ISSN 1812-5654
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RESEARCH ARTICLE OPEN ACCESS

DOI: 10.3923/jas.2015.500.507

An Empirical Analysis of Relevance among Risk Factors, Selection of Insured Amount and Loss Ratio: A Case Study of Group Injury Insurance

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ARTICLE INFO
Article History:
Received: October 12, 2014
Accepted: December 16, 2014

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ABSTRACT
The purpose of this study is to examine whether high-risk groups tend to choose a higher insured amount and whether a higher insured amount leads to a higher loss ratio. Data of 2009 on group injury insurance from a property-liability company in Taiwan is analyzed by using a structural quotation model. Eight variables are used to describe the relationship between risk factors and the selection of the insured amount. The result indicates that both underwriting and rating have a significant positive impact on the selection of the insured amount. The analysis of the relationship between a high insured amount and a high loss ratio indicates that both the medical expense insured amount and the daily hospitalization indemnity have significant positive impact on the loss ratio. The results of this study can help underwriters establish a sound underwriting and rating system and also increase underwriting profits.

Key words: Group injury insurance, underwriting risk, adverse selection, advantage selection, ex-ante moral hazard, structural equation model, property-liability insurance

INTRODUCTION

The insurers' risk includes market risk, credit risk, business risk, underwriting risk, liquid risk and event risk (IAA., 2002). According to A.M. Best Company (1999), from 1969 to 1998, insurance companies registered insolvency in the United States in 683 events. Forty-two percent of these events were linked to insurance underwriting risks, suggesting that underwriting risk is the most significant risk contributing towards the failure of insurance companies. In the case of the loss rate of group injury insurance, the property-liability insurance and life insurance industries are significantly different. From 2005 to 2011, the average loss rate of group injury insurance in Taiwan, i.e., the property-liability insurance industry was 65% which was 20% higher than that of the life insurance industry (45%). The following question needs to be addressed here: After the property-liability insurance industry began participating in the accident insurance market, did business quality control (underwriting) take a back seat in order to win market share and facilitate business growth?

Arrow (1963) proposed the first asymmetric information theory. Rothschild and Stiglitz (1976) and Shavell (1979) applied this theory to their studies on insurance and suggested that asymmetric information in the insurance market will result in adverse selection and moral hazard. Wang (2004) indicated that the insurance market could use experience rating, co-insurance and deductibles to reduce losses caused by adverse selection and moral hazard. Wang *et al.* (2008) observed that asymmetric information ceases to exist in a well-developed insurance market, owing to a powerful underwriting system. Akerlof (1970) first proposed the market for "lemons". Pauly (1974) suggested that if insurers could identify the risk of risk characteristics by the insured, these risks could be reflected in insurance cost to restrict the coverage of the insured so as to control adverse selection. On the contrary, De Meza and Webb (2001) proposed advantageous selection. Given that a risk-averse person can purchase insurance and then carefully consider the risk factors, accident probability is lower and insurers can avail of extra underwriting profits. Dorfman (1998) suggested that the purpose of underwriting is to match the actual loss of

insurance companies with the expected loss and avoid the adverse selection of risk. According to Shavell (1979) and Arrow (1963), moral hazard is divided into ex ante moral hazard and ex post moral hazard. Ex-ante moral hazard refers to a situation where the insured neglect to take precautions to prevent loss. Ex-post moral hazard refers to the occurrence or expansion of claims after purchase insurance. Rejda (2005) argued that moral hazard detection is a significant component of underwriting work. Using basic statistics, Yang (2004) explored the adverse selection and moral hazard of labor with occupational injury insurance in Taiwan and realized that labor experience adverse selection when taking out insurance and moral hazard while applying for payment.

Webb *et al.* (1997) stated that during an insurance operation, insurance actuaries look for loss-contributing characteristics within the risk and rate the premium for a policy. Malecki and Underwriters (1986) mentioned that under the policy condition, actuaries supply the assumption of rating to underwriters. Underwriters formulate underwriting guidelines and implement it. The underwriting guidelines comprise the core variables used in determining the acceptability, classification and rating according to the risk factors. Luthardt and Wiening (2006) defined underwriting as the selection of the insured, the setting of coverage, the decision of the conditions of the insured and the examination and decision-making of business. In comparison to other kinds of life insurance products, the assessment of accident insurance is simpler and includes the following characteristics: (1) In accident insurance, the premium is calculated according to the danger levels of various types of occupation and other factors are not taken into account. Therefore, in insurance assessments, supplementary factors tend to be included in the insurance criteria and (2) Injury insurance is cheap and the insured amount is high; therefore, it tends to cause moral hazard. In comparison to individual accident insurance, the underwriting process for group injury insurance differs in a number of ways: (1) Decision-making is based on group characteristics and neglects the individuals' characteristics and (2) Of the total number of people in a group, 75% are required to purchase insurance and therefore, adverse selection and ex-ante moral hazard is rare. The premiums for group injury insurance are based on a freely negotiated rate between the insurer and the insured. As a result of market competition, pure insurance premiums are usually insufficient. In addition, the insured amount is usually increased as the insured becomes stronger. Therefore, the loss amount increases and the overall loss rate decreases.

Figure 1 shows the operational processes of group injury insurance which include (1) Collecting information from the applicants: salespeople collect information related to the business from groups (such as industry, number of employees, gender ratio of employees, employees' type of work). Recently, Taiwan has begun to value the confidentiality of personal information and therefore, it has become more difficult to collect data. This difficulty influences the precise decision-making of business selection. (2) Underwriting process i (according to group characteristics): Underwriters measure and evaluate the overall risk of the groups according to underwriting guidelines set by the company and the underwriters' experience. (3) Rating and decision-making on insurance conditions: After the measurement and evaluation of the risk of the groups, the risks are committed to the expected conditions of the groups and decisions are made to accept or reject a risk. Premiums are calculated accordingly. (4) Underwriting process ii: (according to individual characteristics): Underwriters set the insurance conditions (including limitations) in the computer system. After the underwriter inputs the personal information of the insured, the system will flag and exclude group members who are not qualified according to the conditions set by the underwriters. (5) Risk change (participation and withdrawal of group members): Group members participate in or withdraw from group insurance. Since individual characteristics are different, the group risk will change with changes in the group members. (6) Renewal operations: Since the risk of group injury insurance is dynamic, the risk of continuous coverage is different from the risk of the previous period. Underwriters will maintain or adjust the original insurance conditions by risk change and loss experience which is known as renewal operation, (1), (2) and (3) are static operation procedures and

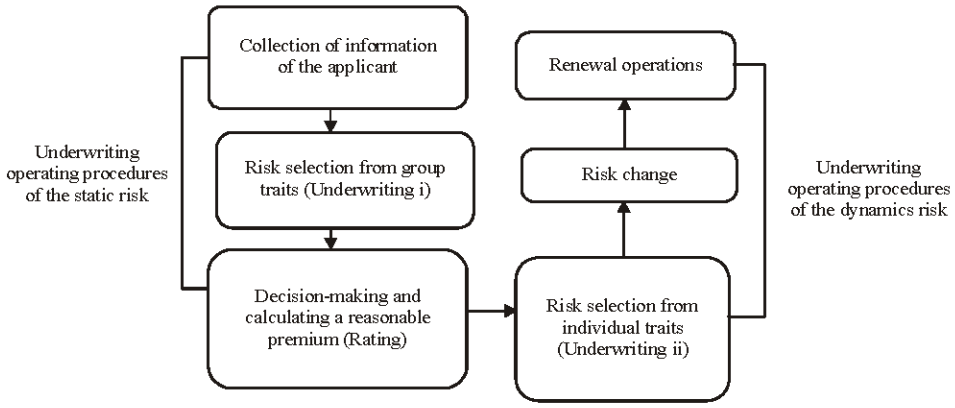

Fig. 1: Operational processes of group injury insurance

(4), (5) and (6) are dynamic operation procedures. This study deals only with the static process, assuming that the conditions for the dynamic process remain unchanged. In studies on the process of underwriting, Lee and Ting (2004) evaluated the underwriting system of automobile insurance using the Logit model and the GANN model and demonstrated that the evaluation performance of these two models was at least 80%. In a study on rate factors, Chou *et al.* (2010) used logistic regression to examine the business of personal accident insurance in a property-liability insurance company and demonstrated that age, place of accident, occupation and place significantly influence the loss ratio. Regarding the group insurance of a life insurance company, ERLINK\Chen *et al.* (2008) used logistic regression to establish the discriminant claim model and explored the claim factors using regression analysis. They found that the precision of the discriminate reimbursement rate as constructed by logistic regression was 81.7%. Based on the validation result of the regression analysis model, the employee insurance rate, medical insurance rate and region influence the claim ratio. Lee *et al.* (2013) used ordered logistic regression and to test the relevance of the insured amount and loss. They found that an insured amount is, indeed, related losses but further evidence on a positive or negative relationship between an insured amount and loss was not found. This study tested two hypotheses.

The purpose of this study is as follows. Li and Liu (2004) mentioned that asymmetric information-related research has mainly focused on automobile insurance and various kinds of life insurance. The asymmetry of information in the study of life insurance, health and annuity insurance is the main topic. Only a few researchers such as Chou *et al.* (2010) and Chen *et al.* (2008) used injury insurance as a research subject. This study is a pioneer for injury insurance in the field to verify the existence of adverse selection, advantage selection and ex-ante moral hazard, Wang (2004) and Wang *et al.* (2008) proposed that the experience rating and underwriting system reduce the impact of adverse selection and moral hazard. Prior studies for the above hypothesis are verified separately. This study used the structural equation model as the research method. Its purpose is to link the above two assumptions and to investigate Wang *et al.* (2008) and Malecki and Underwriters (1986) of the proposed underwriting and rate making core variables.

MATERIALS AND METHODS

Data and variables: The research data consists of group insurance policies and claims of a property-liability insurance company in Taiwan in 2009, from several regions across Taiwan. There were number 2,363 valid samples for 2009. The underwriting factors included the average age of group members, proportion of high-risk age group members and proportion of female group members. The rate factors included the average coefficient of occupational risk in the group, the proportion of high-risk occupations and the number of members in the group. Business factors included channels and agents' returns.

In addition to these variables, the study included variables to describe the behavior of subscribing insurance. These in turn include the insured amount for death and dismemberment (AD and D), insured amount for medical expense (MR) and the insured amount for Daily Hospitalization Indemnity (DHI). Loss ratio is the loss amount/premium for the amount of loss per unit of premium. It represents the relationship between the loss amount and the premium. If the loss ratio >100%, it indicates that the loss amount is greater than the premium, namely, that the insurance company underwriting the group is losing money. Conversely, if the loss ratio <100%, the insurance company underwriting the group is profitable, notwithstanding other factors.

Operational definitions of variables are shown in Table 1.

Explanatory variables: Risk factors are divided into three types; these are underwriting factors, rate factors and business factors.

Underwriting factors: Underwriters assessing the group have to consider these factors. Regarding the average age of the group members, older people react to accidents more slowly and the probability of accidents increases because of the existence of chronic diseases. Medical expenditures for older people are higher, because they recover more slowly after an accident. According to statistics published by the Department of Health in Taiwan, the ranking (from highest to lowest) of the ratio of death per number of people was as follows: The

Table 1: Operational definitions of variables

Risk factors and X_i	Variable	Operational definition
Explanatory variables		
underwriting		
X_1	Average age	0-25, $X_1 = 1$; 26-35, $X_1 = 2$; 36-45,
Factor		$X_1 = 3$; 46-55, $X_1 = 4$; 55~, $X_1 = 5$
X_2	High-age ratio	0, $X_2 = 1$; 0~10%, $X_2 = 2$; 10~20%, $X_2 = 3$; 20~30%, $X_2 = 4$; 30%~, $X_2 = 5$
X_3	Female ratio	0, $X_3 = 5$; 0~20%, $X_3 = 4$; 20~40%, $X_3 = 3$; 40~60%, $X_3 = 2$; 60%~, $X_3 = 1$
Rate factor		
X_4	Average occupation	0~1.25, $X_4 = 1$; 1.25~1.5, $X_4 = 2$; 1.5~2.25, $X_4 = 3$; 2.25~3.5, $X_4 = 4$; 3.5~, $X_4 = 5$
X_5	High-occupation ratio	0, $X_5 = 1$; 0~10%, $X_5 = 2$; 10~20%, $X_5 = 3$; 20~30%, $X_5 = 4$; 30%~, $X_5 = 5$
X_6	Group No.	5~10, $X_6 = 5$; 10~50, $X_6 = 4$, 50~100, $X_6 = 3$, 100~500, $X_6 = 2$; 500~, $X_6 = 1$
Business		
X_7	Place	Non-Agent, $X_7 = 0$; Agent, $X_7 = 1$.
Factor		
X_8	Commission	0%, $X_8 = 5$; 0~10%, $X_8 = 4$; 10~20%, $X_8 = 3$; 20~25%, $X_8 = 2$; 25%~, $X_8 = 1$
Explained variable		
AD and D (Y_1)		0~1,000,000, $Y_1 = 1$; 1,000,000~3,000,000, $Y_1 = 2$; 3,000,000~, $Y_1 = 3$
MR (Y_2)		0, $y_2 = 1$; 1~20,000, $Y_2 = 2$; 20,000~20,000, $Y_2 = 3$
DHI (Y_3)		0, $y_1 = 1$; 1~1,000, $y_3 = 2$; 1,000~, $y_3 = 3$
Loss ratio (Y)		0, Y=1; 0~100%, $Y_{19} = 2$; 100%~, $Y_{19} = 3$

ADD: Death and dismemberment insured amount, MR: Medical expense insured amount, DHI: Daily hospitalization indemnity insured amount

elderly, prime of life, youth, early youth and child. To determine the demand of insurance and the operating characteristics of group members, the year of the establishment of the company is also important, (1) Group members average age and (2) Proportion of high-risk age (older than 65): In underwriters experiences, people over the age of 65 belong to the high-risk age group. The insurer will normally limit the insured amount for this group or even decline to take on the risk for this age group. Regarding the proportion of female group members, according to statistics of the Department of Health in Taiwan, the rate of accidental deaths is 2.6 times higher for males than for females. If the group has a higher proportion of females, this suggests lower risk.

Rate factors: Premiums for injury insurance are classified by occupation and are based on the ranking of said classification. Group injury insurance should not only be concerned with the type of occupation but should also include the number of insured in the group. Besides the type of occupation and the number of insured, underwriters use other attributes of the group as criteria for decision-making. An occupation categories coefficient was used as the calculation base for accident insurance premiums. There were six categories: the first class category's coefficient is 1, the second class category's coefficient is 1.25, the third class category's coefficient is 1.5, the fourth class category's coefficient is 2.25, the fifth class category's coefficient is 3.5 and the sixth class category's coefficient is 4.5. Group insurance premiums use the average coefficient of occupation as the basis for calculation. (1) The average categories coefficient: An average of all members of the group, because the group has people working in different categories. The fact that the group consists of different categories, makes the administrative operations to calculate the right premium more complicated which is why the average coefficient of categories is used in the calculation and (2) The percentage of high-risk categories, accounted for: Five or six of the occupational categories correspond to an underwriter's concept of high-risk categories. Underwriters generally have some control over the amount of insurance coverage they take on or can even decline business. Group number: Premiums for small groups are higher than for big groups. This is because risk for large groups behaves according to the law of large number. If a large group's premiums are high, they have strong bargaining power in the interbank auctions. On the other hand, if premiums for a large group are too low, business could become a loss for the insurer.

Business factors: Regarding the place of underwriting a contract, where in comparison to direct salespeople, agents do not have direct and first-hand data regarding the motivation and risk of the insured. Therefore, there could be errors in the decision-making during insurance assessments. The variable for place was described as non-agent and agent. Regarding the agents' returns, the insurance assessors decide the degree of commission according to the quality of business and the insurance payment. The purpose is to collect high quality and mass business through commissions, in order to increase the homogeneity of the insurance operation. As to the decision-making of the insurance assessors, businesses with lower risk or sufficient premium rates will yield a higher commission, while businesses with lower risk or lower insurance payments yield a lower commission rate. However, the commission rate can be increased, because of channel pressure and for businesses with mass cash flow. Salespeople with a high commission should have business of high quality. In other words, there is a negative relationship between commission rate and business risk.

Explained variables: The insured amount should be appropriate. With a low insured amount for life insurance, employees will lack a guarantee, while too high coverage will cause moral hazard. The setting of group insurance coverage is not based on the group members' decisions; instead, it relies on the employees' salary, position, working years or fixed amounts. There should be no adverse selection or moral hazard. However, since there can be errors in the setting of group insurance coverage, that are caused by external factors, an examination is necessary. For the insured, those with higher risk will select higher insured amounts. However, underwriters hope that people with higher risk will select a lower insured amount. The balance of the two parties' interest will be the insured amount. Although the severity of death and dismemberment is high, the loss frequency is low. The severity of medical insurance loss is low and the loss frequency is much higher than for death and dismemberment. Therefore, the insured will lower the amount of death and dismemberment insurance coverage or increase the amount of medical insurance coverage. Underwriters will adopt a percentage of the medical insured amount in the death and dismemberment insured amount in order to determine the adverse selection of the insured when taking out insurance.

Descriptive statistics of variables are shown in Table 2 and the marginal percentages of the explained variables are shown in Table 3.

Research model

Hypothesis:

H1: High-risk consumers tend to choose a higher insured amount

H2: A higher insured amount leads to a higher loss ratio

H-1 is positive as it indicates the presence of adverse selection and advantage selection for negative, H-2 as a positive means the presence of ex post moral hazard. If H-2 is not validated, it means the presence of ex ante moral hazard or other factors. In insurance management, ex post moral hazard can be improved through underwriting technology; however, ex-ante moral hazard is more difficult to improve through underwriting technology (Fig. 2).

Table 4 shows the summary of hypotheses for this study. H-1.1, H-1.2 and H-1.3 are meant to verify the

Table 2: Descriptive statistics of variables

Variables	Factors	N	Minimum	Maximum	Mean	SD
Explained						
Y	Loss ratio	2363	1	3	1.32	0.59
y1	Average AD and D	2363	1	3	2.02	0.25
y2	Average MR	2363	1	3	1.85	0.56
y3	Average DHI	2363	1	3	2.01	0.62
Explanatory						
Underwriting factor						
X1	Average age	2363	1	5	2.78	0.81
X2	High-age ratio	2363	1	5	2.24	1.54
X3	Female ratio	2363	1	5	3.01	1.30
Rate factor						
X4	Average occupation	2363	1	5	1.96	1.01
X5	High-occupation ratio	2363	1	5	1.23	0.88
X6	Group number	2363	1	5	4.25	0.84
Business factor						
X7	Place	2363	0	1	0.52	0.50
X8	Commission	2363	1	5	2.83	1.46

Table 3: Marginal percentage of the explained variables

Variables	N	MP
AD and D (y_1)		
0~1,000,000	57	2.41
1,000,001~3,000,000	2210	93.53
3,000,001~	96	4.06
Total	2363	100.00
MR (y_2)		
0	586	24.80
1~20,000	1555	65.81
20,001~	222	9.39
Total	2363	100.00
DHI (y_3)		
0	446	18.87
1~1,000	1446	61.19
1,001~	471	19.93
Total	2363	100.00
Loss ratio (Y)		
0%	1771	74.95
0~100%	436	18.45
100%~	156	6.60
Total	2363	100.00

Table 4: Table of hypotheses

Risk factor and No.	H1-alternative hypothesis
Underwriting factor	
H-1.1	Underwriting factor has a positive correlated with AD and D
H-1.2	Underwriting factor has a positive correlated with MR
H-1.3	Underwriting factor has a positive correlated with DHI
Rate factor	
H-1.4	Rate factor has a positive correlated with AD and D
H-1.5	Rate factor has a positive correlated with MR
H-1.6	Rate factor has a positive correlated with DHI
Business factor	
H-1.7	Business factor has a positive correlated with AD and D
H-1.8	Business factor has a positive correlated with MR
H-1.9	Business factor has a positive correlated with DHI
Insured amount →loss ratio	
H-2.1	AD and D has a positive correlated with loss ratio
H-2.1	MR has a positive correlated with loss ratio
H-2.3	DHI has a positive correlated with loss ratio

relationship between underwriting factors and the insured amount. H-1.4, H-1.5 and H-1.6 are to verify the relationship between rate factors and the insured amount. H-1.7, H-1.8 and H-1.9 are to verify the relationship between business factors

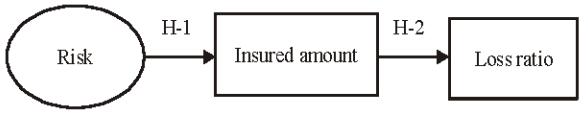

Fig. 2: Variables and hypotheses

and the insured amount. H-2.1, H-2.2 and H-2.3 are used to test the relationship between the insured amount and the loss ratio.

Structural equation model: This model was employed to verify assumptions about the relationship between latent variables and observed variables.

Endogenous variables:

$$x = \Lambda_x \xi + \delta$$

Exogenous variables:

$$y = \Lambda_y \eta + \varepsilon$$

The relationship between latent variables:

$$\eta = \beta\eta + \Gamma\xi + \zeta$$

RESULTS

Table 5 shows Goodness of fit. Absolutely fit index, although is x^2/df greater than 5, the number of samples in a lot of cases and this is only a reference index. GFI, AGFI, RMR and RMSE are within the recommended values, so absolutely fit with a moderately acceptable model. As regards incremental fit aspects, NFI, CFI and IFI, although not all are greater than 0.9, these are close enough to 0.9 to be a reluctantly accepted model of fit. Parsimony fit index, PNFI and PGFI are within the recommended value. Overall, the model used in this study is acceptable with moderation.

Table 5: Goodness of fit

Evaluation indicators and index	Suggested value	Model fit index
Absolutely fit index		
χ^2/df	1~5	15.330
GFI	≥0.90	0.957
AGFI	≥0.90	0.918
RMR	≤0.08	0.074
RMSE	≤0.08	0.078
Incremental fit index		
NFI	≥0.90	0.872
CFI	≥0.90	0.879
IFI	≥0.90	0.879
Parsimony fit index		
PNFI	≥0.50	0.542
PGFI	≥0.50	0.546

Table 6: Result of the hypotheses

Risk factor and H	Path	Estimate (Standardized)	Statistical significance	Result
Underwriting factor				
H-1.1	Underwriting→AD and D	0.395	****	✓
H-1.2	Underwriting→MR	-0.713	****	
H-1.3	Underwriting→DHI	-0.657	****	
Rate factor				
H-1.4	Rate→AD&D	-0.228	****	
H-1.5	Rate→MR	0.196	**	✓
H-1.6	Rate→DHI	0.350	****	✓
Business factor				
H-1.7	Business→AD and D	-0.045		
H-1.8	Business→MR	-0.048		
H-1.9	Business→DHI	-0.019		
Insured Amount→loss ratio				
H-2.1	AD and D→loss ratio	-0.081	****	
H-2.1	MR→loss ratio	0.204	****	✓
H-2.3	DHI→loss ratio	0.168	****	✓

✓: Accept relative hypothesis, ****: p-value<0.001, **: p-value<0.005, Assuming the relationship is positive

Table 6 shows the result of testing the hypotheses.

Figure 3 shows the correlation among explanatory variables, latent variables and explained variables.

Table 6 and Fig. 3 show that the underwriting factors are in compliance with statistical significant resistance. AD and D is a positive relationship which shows there is adverse selection; MR and DHI show a negative relationship, meaning that advantage selection is present. Of the sub-factors of underwriting variables, average age and female ratios showed a positive relationship, whereas high-age ratio is inversely related. The rate factors are in compliance with significant statistics for a negative relationship with AD and D, showing an advantage selection phenomenon; MR and DHI show a positive relationship, presenting an adverse selection phenomenon. In the sub-factors of rates variables, average occupation and high-occupation ratio are inversely related, whereas group number has a positive relationship. The business factors have no statistically significant relationship to the insured amount, meaning that the business factors do not cause the adverse selection or advantage selection phenomenon.

The relationship between the insured amount and the loss ratio is in compliance with statistical significant resistance: AD and D and the loss ratio show a negative relationship, meaning that not accepting a higher insured amount will lead

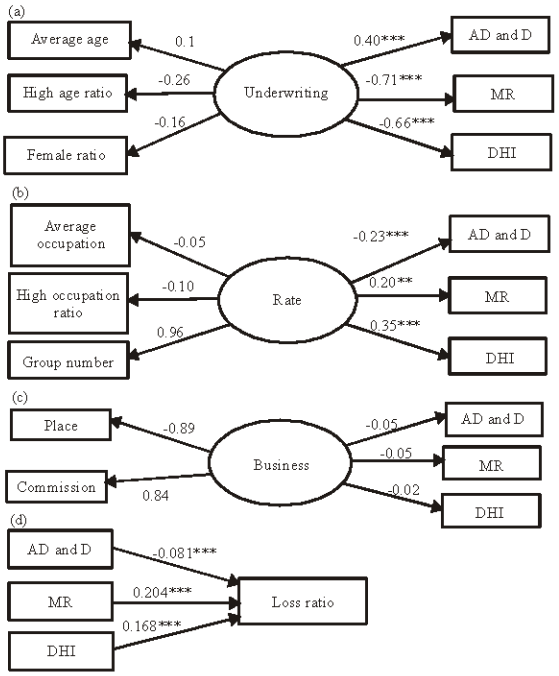

Fig. 3(a-d): Correlation among explanatory variables, risk factors and insured amount, (a) Underwritting factors, (b) Rate factor, (c) Business factor and (d) Insured amount→loss ratio

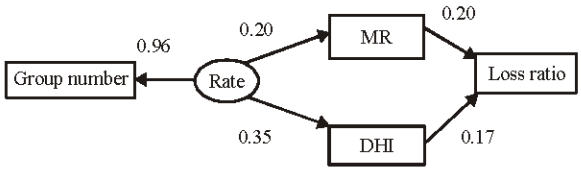

Fig. 4: Correlation among rate, insured amount and loss ratio

to a higher loss ratio. MR, DHI and loss ratio show a positive relationship, verifying that a higher insured amount leads to higher loss rates.

The original hypotheses, H-1 and H-2 were verified; statistical significance is shown as part of Fig. 4. The phenomenon of adverse selection is present and group number is the observed variable of the rate factors that leads to a higher loss ratio.

DISCUSSION

The results of the verification are discussed as follows. This study presents the phenomenon of adverse selection as mentioned by Akerlof (1970), namely, the relationship between underwriting factors and AD and D, rate factors and MR and rate factors and DHI. The results are similar to those mentioned by Yang (2004), who stated the existence of adverse selection in occupation injury insurance in the conclusion. Contrary to this is the advantage selection phenomenon, namely the relationship between underwriting factors and MR, rate factors and DHI and rate factors and AD and D as stated by De Meza and Webb (2001). This phenomenon indicates that underwriters implement the underwriting process (i), for the control of AD and D is invalid and did not meet Wang (2004) and Dorfman (1998) proposal that the underwriting system can reduce adverse selection effectively. In addition, the rating is invalid for MR and DHI control and does not meet Wang *et al.* (2008) proposal that a raised experience rating is effective in reducing the effects of adverse selection. With respect to place, there were no statistically significant data to verify the existence of adverse selection or advantage selection, contrary to Chou *et al.* (2010) proposal that place affects loss ratio inconsistent. For the relationship between insured amount and loss ratio. Prior research of Lee *et al.* (2013) proposed that an insured amount influences loss ratio but cannot confirm its positive or negative influence. This study further proposed that MR and DHI have positive relationships with loss ratio, suggesting the existence of the ex-ante moral hazard as stated by Shavell (1979). The AD and D presents a significant negative relationship with loss ratio. It illustrate the underwriters as AD and D insured amount is large so take more attention for this. The MR and DHI insured amount is not large so neglect attention to this. In contrast, in the above validation results for adverse selection and ex-ante moral hazard, the underwriting guidelines assume that the adverse selection and moral hazard phenomena are rare for group insurance. For the relationship between the variables and risk factors, underwriting factors and AD and D present the phenomenon of adverse selection and average age showing a positive relationship with the underwriting factors. Chou *et al.* (2010) similarly state that age will affect the loss ratio. Female ratio and underwriting factors have a positive relationship. Chou *et al.* (2010) did not find gender to be an influencing factor with loss ratio. Group number has a positive relationship with rate factors; this is similar to the findings of Chen *et al.* (2008) who stated that the employee rate influences the claim ratio. Chen *et al.* (2008) and Chou *et al.* (2010) only explore the relationship of variables and loss ratio and do not add the adverse selection factors as mediator variables, research methods for logistical regression. This study explores the selection of the insured amount to investigate the adverse selection and advantage selection phenomenon. As methods using structural equitation model link with H-1, H-2. This phenomenon explains that the group number has a significant impact on the rating. It not only has a positive relationship with the selection of MR and DHI insured amount but also shows a positive relationship with the loss ratio. This phenomenon is explained in large groups with greater bargaining power, underwriters would compromise on some insurance condition.

CONCLUSION

As Pauly (1974) proposed, insurance companies must understand the risk characteristics of the insured and take effective measures to control adverse selection by considering variables such as underwriting factors, rate factors and business factors. The average age and female ratio must also be included in the core variable factors when making underwriting decisions. In addition, group number affects adverse selection but also adversely affects the loss ratio. When calculating the premium, it is therefore necessary to consider a reasonable relation of risks and premium. These findings can assist the company used in the case study to establish a sound underwriting system for its injury insurance underwriting department. This system can promote effective operations, reduce losses and increase underwriting profits.

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