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EFFICIENCY PERFORMANCE OF JAPANESE NON-LIFE INSURERS AND THEIR PORTFOLIO OF INSURANCE POLICIES

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Abstract

This study tests how the selection of the insurance underwriting portfolio affects the cost efficiency of non-life insurers in different market environments. Our investigation spans the 1970-2005 period, covers ten major non-life insurers, and compares pre- and post-deregulation periods. Since portfolio considerations are essential for non-life insurers in making managerial decisions, this study attempts to clarify the relationship between insurer efficiency performance and their business portfolio. We employ an ordered probability model where the dependent variable is the ranking number of insurer efficiency derived from a fixed-effect model. Our results reveal that the efficiency of insurers deteriorates as they decrease their diversification. This indicates that non-life insurers can successfully improve their efficiency by diversifying their insurance policy portfolio. The contribution of market share expansion to efficiency performance differs among the various lines of insurance and regulatory environments. Insurers with higher shares in the automobile insurance market tend to be more efficient than those with lower shares. In contrast, increasing the market share in fire insurance may deteriorate insurer efficiency in the competitive marketplace after deregulation. Market share expansion of personal accident insurance contributes to efficiency only in the post-deregulation period.

Keywords: Japanese non-life insurers, efficiency performance, insurance policy portfolio, ordered probability model

I. *Introduction*

The purpose of this study is to examine the relationship between non-life insurers' cost efficiency and their selection of business portfolio at various stages of market environments by

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using an ordered probability model.

A number of previous works on the Japanese non-life insurance market study the efficiency and productivity of insurers by using panel data. Many of these focus on the organizational and ownership structures of insurers. However, there have been an insufficient number of works investigating insurer efficiency from the viewpoint of portfolio selection of insurance lines, despite the fact that portfolio considerations are important for non-life insurers in making their marketing and underwriting decisions.

In addition, this study spans the 36-year period and covers various stages of market development. Therefore, we attempt to conduct comparative analyses of the pre- and post-deregulation years by separating the data into these two time periods. The results of the analyses suggest how non-life insurers should make decisions when selecting their business portfolios in different environments such as in a growing, heavily regulated market, or in a mature, competitive market.

Moreover, this study is unique in its methodology since it employs an ordered probability model. We first measure the cost inefficiency of insurers based on a fixed-effect model and then convert the results into ranking data. We use the ranking number as the dependent variable and investigate the relationship between efficiency ranking and portfolio selection based on an ordered probability model. Using ranking data can eliminate the inappropriateness of adopting conditioned inefficiency values.

II. *Background*

Description of the Japanese Non-Life Insurance Market

The basic regulatory framework over the Japanese non-life insurance industry had been in place for more than 50 years, limiting excessive competition and preserving its earning stability under the former Insurance Business Law. The statutory rating organization system had mandated insurers writing major lines of non-life insurance to use premium rates calculated by rating organizations since 1948, in order to ensure policyholders' benefits by maintaining insurers' solvency. Moreover, the government virtually limited the number of insurers in the market for the purpose of avoiding excessive competition among them. Obtaining an operating licence generally took two years due to the complicated requirements and procedures. Moreover, non-life insurers were prohibited from selling life insurance, and vice-versa. Holding firms were banned from owning both life and non-life insurance subsidiaries. The strict regulations guaranteed greater but less cyclical underwriting income for non-life insurers.

Following the enforcement of the new Insurance Business Law in 1996, regulatory reforms were steadily implemented in the non-life insurance sector, and they replaced the traditional situation in which each insurer sold similar products at the same price. The brokerage system was introduced in April 1996, and mutual entry of life and non-life insurers through subsidiaries was allowed in October of the same year. In September 1997, insurers were allowed to market automobile insurance policies with differentiated premium rates, and some of them simultaneously started to utilize the direct-response scheme to distribute such risk-differentiated products. The obligation for member insurers to use the premium rates calculated by the rating organizations was abolished in July 1997, which further enhanced flexibility in the price and coverage of insurance products. Some insurers including foreign-based companies and new entrants have actively utilized the direct-response model by employing mailing, telephone, and Internet systems to sell risk-differentiated insurance policies that target certain groups of customers, e.g., those categorized into a certain age, region, or gender bracket. Meanwhile, traditional domestic insurers have generally maintained relationships with insurance agencies and have not actively taken the direct-response approach even after deregulation. Intense competition replaced a situation in which each insurer sold similar products at the same price, and it forced market players to develop expertise in ratemaking, underwriting, and product innovation.

Licensing procedures were also simplified, which increased the number of competitors after 1998. Banks also started to enter the insurance market beyond their firewall in October 2000. Although the number of players increased shortly after deregulation, many non-life insurers sequentially announced consolidations after 2001, which resulted in a decrease in the number of players.

Literature Review

A number of previous studies assess the efficiency performance of non-life insurers in the Japanese market. Lai and Limpaphayom (2003) examine the impact of organization structures, keiretsu firms, and stock and mutual insurers on the efficiency of Japanese non-life insurers and find that each structure has its unique comparative advantages.[1] Jeng and Lai (2005) also investigate the differences in efficiency of different organizational forms, keiretsu insurers, and independent firms.[2] They use the non-parametric frontier method and data for the period 1985-1994, and find that keiretsu firms appear to be more cost efficient than independent firms. These works focus on the organizational and ownership structures of insurers.

There are not many works on Japanese non-life insurers' efficiency or productivity from the perspective of selection of portfolios of insurance lines. Fukuyama and Weber (2001) examine Japanese non-life insurers in terms of technical efficiency and productivity changes during the period 1983-1994.[3] They focus on scale and scope economies based on non-parametric techniques and find that the main source of growth was technological advancement in the years of expansion; moreover, insurers were experiencing improved productivity and technological progress even in the recessionary period. Hirano and Inoue (2004) conduct an efficiency analysis of non-life insurers using data from 1980 to 1990.[4] They employ an error-components model and find that the effects of economies of scope are statistically significant between the third sector, including personal accident insurance, and other lines of insurance, including automobile and fire insurances. The above-mentioned studies are important for analysing the impact of the efficiency of insurers' business portfolios in the pre-deregulation period.

As the first decade has passed since deregulation in 1996, several works have conducted comparative analyses on the efficiency performance of Japanese non-life insurers covering both the pre- and post-deregulation eras. Yanase et al. (2007) examines the impacts of market

[1] Lai, Limpaphayom, and Jeng (2003), pp. 735-757.
[2] Jeng and Lai (2005), pp. 105-158.
[3] Fukuyama and Weber (2001), pp. 129-146.
[4] Hirano and Inoue (2004), pp. 501-530.

deregulation on non-life insurers' efficiency using a non-parametric frontier approach.[5] They use sample data from the period 1989-2005, and find that the rush for consolidation after 2000 had a positive effect on the efficiency and productivity of the industry.

Other studies investigate non-life insurers' efficiency from the perspective of their business portfolios, Miyashita (2005)[6] and Miyashita and Yoneyama (2007)[7] focus on voluntary automobile insurance (hereafter referred to as "automobile insurance") with the largest premium volume among non-life insurance lines and find that the shift to automobile insurance significantly contributes to cost efficiency. They employ an ordered probability model to assess how the explanatory variables related to the automobile insurance impact on the efficiency of non-life insurers. Suzawa and Miyashita (2007) follow the approach of Miyashita and Yoneyama (2007) but expand their study to other major lines of non-life insurance and investigate the profit performance of insurers using panel data from 1996 to 2000.[8] They observe that the higher the ratio of earned premium in compulsory automobile liability insurance (hereafter referred to as "CALI") and automobile and personal accident insurances, the greater the insurer's profitability.

Following Miyashita (2005), Miyashita and Yoneyama (2007), and Suzawa and Miyashita (2007), we construct panel data of ten major non-life insurers' business portfolios by lines of insurance including CALI, automobile insurance, fire insurance, and personal accident insurance from 1970 to 2005. Using the panel data, we assess the relationship between insurers' cost efficiency and their business portfolios by using an ordered probability model.

III. *Data and Methodology*

Variables

We conduct two patterns of estimates based on the different explanatory variables of insurers' cost efficiency. For the first analysis, we choose the composition ratios of net premium income of four major lines of insurance, and for the second, market shares of individual insurers in the four lines of insurance as described below.

Explanatory Variables for Analysis 1:

1. Composition ratio of CALI (CR-CALI) $= \mathrm{PW}_{CALI} / \sum_{i=1}^{n} \mathrm{PW}i$

2. Composition ratio of automobile insurance (CR-Auto) $= \mathrm{PW}_{Auto} / \sum_{i=1}^{n} \mathrm{PW}i$

3. Composition ratio of fire insurance (CR-Fire) $= \mathrm{PW}_{Fire} / \sum_{i=1}^{n} \mathrm{PW}i$

4. Composition ratio of personal accident insurance (CR-PA) $= \mathrm{PW}_{PA} / \sum_{i=1}^{n} \mathrm{PW}i$

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[5] Yanase et al. (2007).

[6] Miyashita (2005), pp. 99-112.

[7] Miyashita and Yoneyama (2007), pp. 1-41.

[8] Suzawa and Miyashita (2007), pp. 101-119.

5. Price of automobile insurance (P-Auto) $= PW_{Auto}$ / Number of policies
6. Domestic contracted interest rate

The composition ratio of each line of insurance is calculated as the net premium (PW) in each line divided by the total premium across all lines of individual insurers.[9] The price of automobile insurance is calculated as the net premium of automobile insurance divided by the number of policies written in this line. We choose it as an explanatory variable, since deregulation intensified price-product competition in the automobile insurance market. In the explanatory variables, we also include the domestic contracted interest rate to measure the effects of the interest rate level on insurers' cost inefficiency.[10] We also attempt to add other explanatory variables, including total premiums income, total assets, and surplus, but we obtain no significant results.[11] Since the impacts of these variables on insurer efficiency are too excessive to investigate the impalpable distinctions among business portfolios, we decide to exclude them from the analyses.

Explanatory Variables for Analysis 2:

1. Market share of CALI (MS-CALI) $= PW_{CALI} / \sum_{l=1}^{n} PWl$
2. Market share of automobile insurance (MS-Auto) $= PW_{Auto} / \sum_{l=1}^{n} PWl$
3. Market share of fire insurance (MS-Fire) $= PW_{Fire} / \sum_{l=1}^{n} PWl$
4. Market share of personal accident insurance (MS-PA) $= PW_{PA} / \sum_{l=1}^{n} PWl$
5. Price of automobile insurance (P-Auto) $= PW_{Auto}$ / Number of policies
6. Domestic contracted interest rate

The market share of each line of insurance is calculated based on the net premiums income of individual insurers in each line of business divided by the market total.

Our data sample covers ten major non-life insurers operating in the Japanese market including Tokio Marine & Nichido Fire Insurance, Sompo Japan Insurance, Mitsui Sumitomo Insurance, Nipponkoa Insurance, Nissay Dowa General Insurance, Aioi Insurance, Nisshin Fire & Marine Insurance, Fuji Fire & Marine Insurance, Kyoei Fire & Marine Insurance, and Asahi Fire & Marine Insurance. We compile panel data based on the underwriting and financial data of these insurers for the fiscal period 1970-2005. Due to significant market consolidations after 2001, many non-life insurers merged into single entities. Their past figures are added up

[9] All insurance-related data are collected from the annual issues of *Statistics of Japanese Non-Life Insurance* over the 1970-2005 period published by the Insurance Research Institute. The savings portion of the premiums of savings-type fire insurance policies is excluded from the net premiums income of fire insurance in order to eradicate overvaluation. For the same purpose, net premiums of automobile and personal accident insurances include the premiums of non-savings-type policies only.

[10] Domestic contracted interest rates are based on the annual issues of the *Japan Statistical Yearbook* of the subject period compiled by the Statistics Bureau, Ministry of Internal Affairs and Communications.

[11] Multicollinearity was closely checked by examining the correlation coefficient matrix. We added these important variables one by one and tried many combinations of these variables. However, the estimates were not significant statistically, i.e., the t-values were small.

according to their entities at the time of April 2008 and are regarded as single insurers.[12]

Research Methodology

We conduct our analysis in two steps. First, we measure the cost inefficiency of insurers based on a fixed-effect model. We convert the results into efficiency rankings. Second, using these rankings, we analyze the relationship between insurer efficiency performance and the selection of business portfolios. We use an ordered probability model for the analysis (LIMDEP/NLOGIT software).

Step 1: Measurement of Cost Inefficiency. In order to measure insurer cost inefficiency, we choose total assets (K), number of employees (L), and insurance agency (E) as the factors of production input and surplus (Y) as the variable indicating production output. The cost of total assets (PK), cost of employees (PL), and cost of insurance agency (PE) are obtained by the following calculations:

$$\begin{aligned} &PK=(K^{*}\ \text{Domestic Contracted Interest Rate}+\text{Non-Personal Expenses})/K \\ &PL=\text{Personal Expenses}/L \\ &PE=\text{Agency Commissions}/\text{Premiums Earned} \end{aligned} \tag{1}$$

We then construct the fixed-effect model based on the factors of production input and output chosen above. The model takes the form of a translog model.

$$\begin{aligned} \ln(C/p_E)_{it}=\;&\beta_0+\Sigma\mu_r D_r+\Sigma\theta_s T_s+\beta_K\ln(p_K/p_E)_{it}+\beta_L\ln(p_L/p_E)_{it}+\beta_Y\ln Y_{it} \\ &+\beta_{yy}(1/2)\ln^2 Y_{it}+\gamma_{yK}\ln Y\ln(p_K/p_E)_{it}+\gamma_{yL}\ln Y\ln(p_L/p_E)_{it} \\ &+\delta_{KK}(1/2)\ln^2(p_K/p_E)_{it}+\delta_{KL}\ln(p_K/p_E)\ln(p_L/p_E)_{it}+\delta_{LL}(1/2)\ln^2(p_L/p_E)_{it}+\varepsilon_{Cit} \\ S_{Kit}=\;&\beta_K+\delta_{KK}\ln(p_K/p_E)_{it}+\delta_{KL}\ln(p_L/p_E)_{it}+\gamma_{yK}\ln Y_{it}+\varepsilon_{Kit} \\ S_{Lit}=\;&\beta_L+\delta_{KL}\ln(p_K/p_E)_{it}+\delta_{LL}\ln(p_L/p_E)_{it}+\gamma_{yL}\ln Y_{it}+\varepsilon_{Lit} \\ &i=1,\dots,10 \quad t=1,\dots,36 \end{aligned} \tag{2}$$

where i denotes the insurer, and t, the year. C and Y indicate the total cost and the surplus, respectively. S_K and S_L denote the cost shares of PK and PL, respectively. The model is based on the seemingly unrelated regression (SUR) model and follows the maximum likelihood procedure. The share equation of S_E, i.e., the cost share of PE, is cut out by dividing PK and PL by PE since the total value of the three cost shares equals 1. D is a dummy variable measuring cost inefficiency by insurer, and T is a dummy variable measuring inefficiency by year. The consistency of the estimate can be derived only when the inefficiency and explanatory variables are mutually independent. However, as Yoneyama and Miyashita (1999) find, technical inefficiency is correlated with explanatory variables for life insurers.[13] Considering

[12] Aioi Insurance was formed by the merger of Dai-Tokyo Fire & Marine and Chiyoda Fire & Marine in April 2001. Nipponkoa Insurance was formed after the merger of Nippon Fire & Marine and Koa Fire & Marine in April 2001. Taiyo Fire & Marine joined this company in April 2002. Nissay Dowa General Insurance was formed by the merger of Dowa Fire & Marine and Nissay General Insurance in April 2001. Mitsui Sumitomo Insurance was created by the merger of Mitsui Marine & Fire and Sumitomo Marine & Fire in October 2001. Sompo Japan Insurance was formed in July 2002 after the merger of Yasuda Fire & Marine and Nissan Fire & Marine, and subsequently, the company acquired Taisei Fire & Marine in December of the same year. Antecedent to this, Yasuda had merged with Daiichi Property & Casualty in April of the same year. Tokio Marine & Nichido Fire was formed after the merger of Tokio Marine & Fire and Nichido Fire & Marine in October 2004.

[13] Yoneyama and Miyashita (1999) choose technical inefficiency as the independent variable and find it to be

the possibility of a similar tendency for non-life insurers, we construct a fixed-effect model representing cost inefficiency by these two dummy variables. From these dummy variables, D and T, inefficiency values of 10 and 36 are respectively derived. In order to determine the inefficiency values of ten insurers for 36 years, i.e., 360 values, we add up the values from these two variables for all 360 combinations of insurers and years. The smaller the value derived from a fixed-effect model, the greater the cost efficiency achieved by the insurer. We cannot, however, properly measure inefficiency on the basis of the value directly, since the size of insurers varies greatly. In order to control such differences in size and to scale down the number, we calibrate the cost inefficiency values by dividing them by $C/(PE*10^8)$.

Step 2: Ranking of Cost Inefficiency. The calibrations to derive 360 inefficiency values lead to inappropriateness in using the inefficiency values directly for the quantitative analyses. We thus convert these values into ranking data by eliminating the decimals of the cost inefficiency values. Using ranking data instead of directly using the inefficiency values creates the possibility of employing an ordered probability model. After deriving the ranking values based on a fixed-effect model, we find that the rank of Asahi Fire & Marine is too low to properly implement the estimation. We thus exclude this insurer when running an ordered probability model. The ranking extends from 0 to 8; 0 indicates the lowest inefficiency, i.e., the highest efficiency, and 8 implies the highest inefficiency, i.e., the lowest efficiency.

The ordered probability model is further divided into two sub-models: the ordered logit model based on logistic distribution and the ordered probit model based on normal distribution. As Greene (1997) expounds, there are no distinctive differences between the outcomes derived from these two models unless we deal with the edges of the distributions.[14] The model is as follows:

$$\begin{aligned} Y^*_{it} &= \beta' x_{it} + u_{it} \\ Y_{it} &= 0 \quad \text{if} \quad Y^*_{it} \leq \mu_0 \\ &\quad 1 \quad \text{if} \quad \mu_0 < Y^*_{it} \leq \mu_1 \\ &\quad 2 \quad \text{if} \quad \mu_1 < Y^*_{it} \leq \mu_2 \\ &\quad \ldots \\ &\quad J \quad \text{if} \quad \mu_{J-1} < Y^*_{it}, \ i=1,2,\ldots,n \end{aligned} \tag{3}$$

where Y^*_{it} denotes a dependent variable that is not observed and Y_{it} denotes an observed variable. $\beta'=(\beta_1, \beta_2, \beta_3,..., \beta_K)$ is an unknown parameter vector, x_i is a vector of the explanatory variable, and u_{it} is an error term: $E(u_{it})=0$ and $E(u^2_{it})=\sigma^2$.[15]

The estimation is made based on the maximum likelihood procedure. Probability values input into the log likelihood function are as follows:

$$\begin{aligned} \text{Prob}\ (Y_{it}=0) &= \Phi(-\beta' x_{it}) \\ \text{Prob}\ (Y_{it}=1) &= \Phi(\mu_1-\beta' x_{it}) - \Phi(-\beta' x_{it}) \\ \text{Prob}\ (Y_{it}=2) &= \Phi(\mu_2-\beta' x_{it}) - \Phi(\mu_1-\beta' x_{it}) \end{aligned}$$

correlated to explanatory variables.

14 Greene (1997), p. 875.

15 When the distribution of the error term is logistic, the model is an ordered logit model, and if its distribution is normal, the model is an ordered probit model.

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$$\text{Prob}\ (Y_{it}=J)=1-\Phi(\mu_{J-1}-\beta' x_{it}) \tag{4}$$

where Φ denotes the cumulative distribution function.

In order for all probability values to be positive, the following restriction is placed.

$$0<\mu_1<\mu_2<\ldots<\mu_{J-1} \tag{5}$$

The algorithm to derive the maximum likelihood estimator is Davidon/Fletcher/Powell (DFP). The initial value is given by the least-squares method or the generalized least-squares method, depending on the form of the data.

The effects of the change of explanatory variables on probability after estimation are then measured by the marginal effects that are represented as follows:

$$\partial \text{Prob}\ (Y_{it}=j)/\partial \mathbf{x}_{it}=[f(\mu_{j-1}-\beta' x_{it})-f(\mu_j-\beta' x_{it})]\ \beta \tag{6}$$

where $f(\mu_{j-1}-\beta' x_{it})$ or $f(\mu_j-\beta' x_{it})$ denotes the standard normal density function or standard logistic density function.[16]

Between the ordered logit model and ordered probit model discussed earlier, we choose the latter presuming normal distribution. Regarding Y_{it} in Formula (3) as ranking variables, μ_0 is set to zero, and the model is transformed as follows:

$$\begin{aligned} Y_{it}=0 &\quad \text{if} \quad Y^*_{it}\leq 0 \\ 1 &\quad \text{if} \quad 0<Y^*_{it}\leq \mu_1 \\ 2 &\quad \text{if} \quad \mu_1<Y^*_{it}\leq \mu_2 \\ \ldots & \\ 8 &\quad \text{if} \quad \mu_7<Y^*_{it} \end{aligned} \tag{7}$$

The ranking extends from 0 to 8, as discussed earlier, and the lower the ranking, the more cost efficient the insurer. Threshold parameters to be estimated are from μ_1 to μ_7. The estimation begins with the least-squares method, and the estimated value is obtained and input into the maximum likelihood estimation method.

As discussed earlier, the explanatory variables that we choose are the composition ratios of four major lines of insurance, market shares of individual insurers in the four lines of business, price of automobile insurance, and domestic contracted interest rate. We alter the variables other than the interest rate to smaller values by dividing them by 10^8 since the values of the variables are too large compared to the others including the interest rate and the ranking to employ the maximum likelihood estimation method in the normal fashion.

IV. *Results*

Analysis 1: Efficiency and Composition Ratio

We conduct two forms of analyses discussed in the previous section: Analysis 1 of the composition ratios of four lines of insurance and Analysis 2 of the market shares of individual

[16] As observed in Formula (6), the marginal effect depends on the value of the parameter vector. Thus, it is not necessarily the case that the marginal effect definitely represents a probability change.

TABLE 1. OUTPUTS OF ANALYSIS 1 FROM THE DATA FOR THE PERIOD 1970-2005

Summary

Variable	CR*-CALI	CR-Auto	CR-Fire	CR-PA**	P-Auto***	Interest
Relation to Efficiency****	(−)	(−)	(−)	(−)	(+)	

Outputs

Variable	Coefficient	Standard Error	t-Value	P-Value	Mean
Constant	−5.07146203	1.66862284	−3.039	.0024	
CR-CALI	5.43063464	1.67348363	3.245	.0012	.20214811
CR-Auto	9.16563791	1.52357263	6.016	.0000	.39064768
CR-Fire	16.70832890	2.28299555	7.319	.0000	.19536813
CR-PA	22.30156460	5.61133610	3.974	.0001	.06207168
P-Auto	−.05361191	.00922966	−5.809	.0000	55.95965630
Interest	−1.55231947	4.63911945	−.335	.7379	.05423472

Threshold Parameters for Index

Variable	Coefficient	Standard Error	t-Value	P-Value
μ_1	1.06894038	.07530163	14.195	.0000
μ_2	1.56625534	.07501991	20.878	.0000
μ_3	1.87707606	.07699686	24.379	.0000
μ_4	2.16843752	.08135896	26.653	.0000
μ_5	2.51057175	.09133532	27.487	.0000
μ_6	3.22333796	.13283269	24.266	.0000
μ_7	4.47022308	.37487856	11.924	.0000

Summary of Marginal Effects for the Ordered Probability Model (Probit)

Variable	Y=00	Y=01	Y=02	Y=03	Y=04	Y=05	Y=06	Y=07	Y=08
CR-CALI	−1.0913	−1.0640	.1514	.3152	.3711	.4342	.6197	.2544	.0094
CR-Auto	−1.8418	−1.7957	.2555	.5319	.6263	.7328	1.0459	.4294	.0158
CR-Fire	−3.3574	−3.2735	.4658	.9696	1.1417	1.3358	1.9065	.7827	.0289
CR-PA	−4.4814	−4.3693	.6217	1.2942	1.5238	1.7829	2.5448	1.0447	.0385
P-Auto	.0108	.0105	−.0015	−.0031	−.0037	−.0043	−.0061	−.0025	−.0001
Interest	.3119	.3041	−.0433	−.0901	−.1061	−.1241	−.1771	−.0727	−.0027

Note: * CR denotes the composition ratio of each line of insurance.
** PA denotes personal accident insurance.
*** P-Auto denotes the price of automobile insurance, i.e.., automobile insurance premium per contract.
**** A negative sign denotes the existence of a negative relationship between the efficiency and the variables.

insurers in each line of business.

First, we obtain the outputs from Analysis 1 shown in Table 1 for the entire 36-year period.

A positive value of the coefficients of the explanatory variables indicates a positive relationship between the variables and the inefficiency ranking. An increase in the ranking number implies deterioration of efficiency. Thus, if the coefficient of a certain variable has a positive value, insurer efficiency decreases as the variable increases, and vice-versa.

From the outputs tabled above, we mainly find the following:

1. We observe a significant negative relationship between the composition ratios of four lines of insurance and insurer efficiency.
2. Higher prices for automobile insurance tend to increase efficiency.

As discussed in Formula (6) in the previous section, the marginal effect indicates the effect of the change of explanatory variables on the probability after the estimation, as shown in Table 1 above. Negative values are observed in ranks 0 and 1 for the four lines of insurance, which implies that the probability of being ranked 0 or 1 declines when the composition ratio of any of the four lines of business is higher. Moreover, the positive values observed for higher-ranking numbers imply that the probability of being ranked at such numbers increases when an insurer has a larger composition ratio of each line of insurance. The negative values observed in rank 2 and the higher-ranking numbers for the price of automobile insurance indicate that the probability of being ranked at such numbers declines as the price of automobile insurance increases. These observations of marginal effects are in good accord with results (1) and (2).

Result (1) suggests that the efficiency of insurers tends to deteriorate as they increase the composition ratio of any line of business. The tendency is more apparent for automobile and fire insurances with higher t-values. From a long-term viewpoint, non-life insurers should underwrite a well-diversified portfolio of business and should not focus on certain lines in order to improve or maintain their efficiency.

The second result may be largely caused by the impact of the regulated era where non-life insurers were mandated to use premium rates calculated by rating organizations. The virtual unified price system eliminated competition among insurers who were able to maintain satisfactory levels of underwriting results. Even if the premium rates were expanded, insurers enjoyed the benefits of them without being concerned about a decrease in demand.

The regulatory environment changed in stages in the late 1990s, and the obligation for insurers to use unified premium rates was completely eliminated in July 1998 for all lines of non-life insurance with the exception of CALI and earthquake insurance.[17] Thus, we conduct a comparative analysis of the pre- and post-deregulation periods to clarify how selection of business portfolio impacts insurer efficiency under a variety of market environments.

Based on the data of the pre-deregulation 26-year period, we obtain the outputs presented in Table 2 below.

On the basis of the panel data for this time period, we obtained the following result:

1. A higher composition ratio of any of the four lines of insurance tends to negatively contribute to insurer efficiency, with the highest significance being for automobile insurance.

The result is similar to those derived for the 36-year period. In the regulated market, non-life insurers were able to effectively increase their efficiency by holding a diversified portfolio of businesses. The extensive regulation created the possibility of diversifying their business

[17] CALI and earthquake insurance are operated under the scheme of standard full rates where all insurers use the same tariff rates due to the social purpose of these insurances; relief for the victims of automobile accidents and earthquakes is provided under the Automobile Liability Security Law of 1955 and the Law Concerning Earthquake Insurance of 1966.

TABLE 2. OUTPUTS OF ANALYSIS 1 OF THE DATA FOR THE PERIOD 1970-1995

Summary

Variable	CR-CALI	CR-Auto	CR-Fire	CR-PA	P-Auto	Interest
Relation to Efficiency	(−)	(−)	(−)	(−)		

Outputs

Variable	Coefficient	Standard Error	t-Value	P-Value	Mean
Constant	−4.42200872	1.88824294	−2.342	.0192	
CR-CALI	4.89599950	1.85463146	2.640	.0083	.22245155
CR-Auto	5.43372795	1.64629853	3.301	.0010	.35371511
CR-Fire	6.88778698	2.34076390	2.943	.0033	.21266558
CR-PA	14.87811820	6.36644629	2.337	.0194	.05581339
P-Auto	−.00822630	.01065972	−.772	.4403	50.30265330
Interest	3.70152717	6.82312801	.542	.5875	.06688192

Threshold Parameters for Index

Variable	Coefficient	Standard Error	t-Value	P-Value
μ_1	.87008199	.07088190	12.275	.0000
μ_2	1.35732331	.07971919	17.026	.0000
μ_3	1.63847482	.08793274	18.633	.0000
μ_4	1.71205939	.09056145	18.905	.0000
μ_5	1.86196470	.09690705	19.214	.0000
μ_6	2.35924900	.12925634	18.252	.0000
μ_7	3.45693581	.34615560	9.987	.0000

Summary of Marginal Effects for the Ordered Probability Model (Probit)

Variable	Y=00	Y=01	Y=02	Y=03	Y=04	Y=05	Y=06	Y=07	Y=08
CR-CALI	−1.5093	−.4214	.3385	.3135	.0870	.1765	.5073	.4621	.0459
CR-Auto	−1.6751	−.4677	.3757	.3479	.0965	.1958	.5631	.5129	.0509
CR-Fire	−2.1234	−.5929	.4762	.4410	.1224	.2482	.7137	.6501	.0646
CR-PA	−4.5866	−1.2807	1.0287	.9526	.2643	.5362	1.5417	1.4042	.1395
P-Auto	.0025	.0007	−.0006	−.0005	−.0001	−.0003	−.0009	−.0008	−.0001
Interest	−1.1411	−.3186	.2559	.2370	.0658	.1334	.3836	.3494	.0347

without substantial effort—not only for larger insurers, including the former Tokio Marine & Fire and former Yasuda Fire & Marine, but also for relatively smaller insurers such as Fuji Fire & Marine, Nissay Dowa General, Kyoei Fire & Marine, and Nisshin Fire & Marine. Protected by the regulation, these insurers were assumed to hold diversified insurance portfolios despite their relatively smaller size. The values of marginal effects also support the observation.

From the data of the post-deregulation period of 1996-2005, the following outputs are derived.

From Table 3, we find the following:

1. In this time period, a negative relationship exists between the composition ratios of CALI and fire insurance and the efficiency performance of insurers with higher significance and negative marginal effects at rank 0.
2. A positive value is observed for the coefficient of the price of automobile insurance,

TABLE 3. OUTPUTS OF ANALYSIS 1 FROM THE DATA FOR THE PERIOD 1996-2005

Summary

Variable	CR-CALI	CR-Auto	CR-Fire	CR-PA	P-Auto	Interest
Relation to Efficiency	(−)		(−)		(−)	(−)

Outputs

Variable	Coefficient	Standard Error	t-Value	P-Value	Mean
Constant	−17.38441660	5.66996028	−3.066	.0022	
CR-CALI	31.50997970	8.65495832	3.641	.0003	.13782835
CR-Auto	.68012955	5.04281690	.135	.8927	.47179435
CR-Fire	22.83750210	7.01758605	3.254	.0011	.17453550
CR-PA	7.88225831	12.03096620	.655	.5124	.07953389
P-Auto	.09176722	.02798253	3.279	.0010	68.43936560
Interest	83.88881590	50.01488370	1.677	.0935	.02135200

Threshold Parameters for Index

Variable	Coefficient	Standard Error	t-Value	P-Value
μ_1	1.26556606	.17026744	7.433	.0000
μ_2	2.05403100	.22333609	9.197	.0000
μ_3	2.84697046	.38701123	7.356	.0000

Summary of Marginal Effects for the Ordered Probability Model (Probit)

Variable	Y=00	Y=01	Y=02	Y=03	Y=04
CR-CALI	−12.5625	7.1738	3.9736	1.2181	.1970
CR-Auto	−.2712	.1548	.0858	.0263	.0043
CR-Fire	−9.1049	5.1994	2.8799	.8828	.1428
CR-PA	−3.1425	1.7945	.9940	.3047	.0493
P-Auto	−.0366	.0209	.0116	.0035	.0006
Interest	−33.4451	19.0988	10.5788	3.2429	.5245

indicating a negative relationship between the variable and efficiency performance.

3. A rise in interest rates may adversely affect insurer efficiency.

The first observation is almost consistent with the previous results, indicating that non-life insurers can successfully improve their efficiency by well diversifying their portfolio of insurance lines, and the higher significance for CALI and fire insurance implies that the efficiency of insurers deteriorates when actively investing in these lines of insurance after deregulation.

CALI has been operated on the basis of a “no-loss, no-profit” rule under the Automobile Liability Security Law of 1955. Even after deregulation, due to the social purpose of this insurance comprising relief for victims of automobile accidents and development of automobile transportation, the standard full rates including not only pure premiums but also expense loadings are calculated by the rating organization. The premium rates are set to the lowest level, which allows all insurers to healthily underwrite CALI businesses, but it does not allow them to earn any profit. The result clarifies the fact that insurers have not been able to achieve efficiency by expanding the composition ratio of this line of business, and the social objective of the CALI scheme has been properly accomplished especially in the post-deregulation period. This tendency may become more prominent after the abolition of government reinsurance support in 2002.

Fire insurance is one of the lines where price competition has been very fierce after deregulation. Different from automobile insurance, exposure units of fire insurance are relatively large due to the nature of this line of insurance, especially for commercial properties. In addition, each exposure unit is less independent since fire insurance policies generally cover natural catastrophe losses. Active underwriting in this line of insurance under competitive pressure may expose insurers to higher parameter uncertainty, which results in them having less capacity to earn surplus. In addition, after the 1990s, the industry has repeatedly suffered from enormous losses caused by natural catastrophes, and this unfavorable environment may also exaggerate this tendency.

As mentioned in the second observation, the positive sign of the coefficient of automobile insurance price is noteworthy. In addition, the marginal effect for this variable of rank 0 is negative, and the probability of being ranked at 0 thus decreases as the price of automobile insurance increases. In a competitive market environment, the increase in the price of automobile insurance can impair efficiency performance, although it contributed to insurer efficiency in the pre-deregulation period. Since the new Insurance Business Law was enforced in April 1996, the statutory rating organization system has been reformed in stages. Risk-differentiated premium rates of automobile insurance filed by individual insurers began to be approved in September 1997. The obligation for insurers to use premium rates calculated by rating organizations was completely abolished in July 1998. Thereafter, insurers could use premium rates based on their own data and ratemaking methods by receiving prior approval from the regulatory authority. These regulatory changes resulted in increased flexibility of price and coverage especially for automobile insurance.[18] In such a competitive marketplace, the more efficiently an insurer operates, the more flexibly it can set prices for its products. Thus, insurers with better efficiency performance are able to rein in prices to a greater extent than those with poorer efficiency.

The third observation of the negative contribution of the interest rate level to insurer efficiency can be construed in relation to the ratemaking structure. If the actual interest rate is lower than the expected rate incorporated in the premium rates, insurers can eventually earn interest. As discussed above, in a deregulated marketplace, insurers can flexibly set the price of their insurance product. In order for insurers to make their own premium level competitive, they need to make an accurate estimate of the interest rate, which is an important component of the insurance premium.[19] Thus, insurers are more strongly influenced by the interest rate level after deregulation than in the pre-deregulation period where they were mandated to use the unified premium rates.

[18] Mizushima (2002), pp. 152-153, describes the competitive situation after deregulation; some foreign-based insurers began to sell risk-differentiated automobile insurance through direct-response schemes ahead of others in 1998, followed by new entrants who introduced similar types of products, while some domestic insurers played against them by introducing no-fault-type coverage attached to their automobile insurance policies.

[19] This issue is pointed out by Miyashita and Yoneyama (2007), p. 82. According to their discussion, insurers are adversely influenced by the decrease in interest rates since their overall operations heavily rely on investment results, which is different from general business entities.

TABLE 4. OUTPUTS OF ANALYSIS 2 FROM THE DATA FOR THE PERIOD 1970-2005

Summary

Variable	MS*-CALI	MS-Auto	MS-Fire	MS-PA	P-Auto	Interest
Relation to Efficiency	(−)	(+)	(+)	(−)	(+)	(+)

Outputs

Variable	Coefficient	Standard Error	t-Value	P-Value	Mean
Constant	12.82542510	.57072675	22.472	.0000	
MS-CALI	7.52782158	6.20697153	1.213	.2252	.10900903
MS-Auto	−36.02646130	8.40400504	−4.287	.0000	.11031300
MS-Fire	−29.37036800	4.52182643	−6.495	.0000	.10541613
MS-PA	19.13794840	2.99978219	6.380	.0000	.10626707
P-Auto	−.09195126	.00682234	−13.478	.0000	55.95965630
Interest	−10.64369720	4.13964124	−2.571	.0101	.05423472

Threshold Parameters for Index

Variable	Coefficient	Standard Error	t-Value	P-Value
μ_1	2.65939919	.14501756	18.338	.0000
μ_2	4.10058925	.12526755	32.735	.0000
μ_3	4.96878282	.11422636	43.499	.0000
μ_4	5.64844429	.11365276	49.699	.0000
μ_5	6.28756415	.12193679	51.564	.0000
μ_6	7.31780189	.16652827	43.943	.0000
μ_7	9.01197789	.50030473	18.013	.0000

Summary of Marginal Effects for the Ordered Probability Model (Probit)

Variable	Y=00	Y=01	Y=02	Y=03	Y=04	Y=05	Y=06	Y=07	Y=08
MS-CALI	−.0466	−2.8800	1.4892	1.0937	.2774	.0570	.0091	.0002	.0000
MS-Auto	.2229	13.7832	−7.1271	−5.2342	−1.3277	−.2729	−.0435	−.0008	.0000
MS-Fire	.1817	11.2367	−5.8103	−4.2671	−1.0824	−.2225	−.0354	−.0006	.0000
MS-PA	−.1184	−7.3219	3.7860	2.7805	.7053	.1450	.0231	.0004	.0000
P-Auto	.0006	.0352	−.0182	−.0134	−.0034	−.0007	−.0001	.0000	.0000
Interest	.0659	4.0721	−2.1056	−1.5464	−.3923	−.0806	−.0128	−.0002	.0000

Note: * MS denotes the market share of each insurer in each line of insurance.

Analysis 2: Efficiency and Market Share

We then conduct Analysis 2 based on the market shares of individual insurers in the four lines of insurance. The outputs from the data of the entire 36-year period are presented in Table 4.

In contrast with the outputs of Analysis 1, we observe some negative values for the coefficients of explanatory variables. This implies the existence of a negative relationship between these variables and the ranking number of insurer efficiency; the efficiency increases as the values of the variables increase. The outputs mainly reveal the following:

1. The higher the market shares of automobile and fire insurances, the higher the efficiency performance of insurers. The positive values of marginal effects at ranks 0 and 1 for these

lines are very consistent with the result.

2. A negative relationship exists between insurer efficiency and the market shares of CALI and personal accident insurance, especially for the latter with higher significance. These observations are accorded negative values at ranks 0 and 1 for these lines of insurance.

3. A higher price of automobile insurance tends to increase the efficiency supported by positive marginal effects at ranks 0 and 1.

4. A rise in the interest rate level may positively contribute to efficiency.

Result (1) indicates that the efficiency performance of insurers improves in the long term as they expand their shares in the automobile and fire insurance markets. This may be strongly influenced by the pre-deregulation period where insurers enjoyed relatively favorable underwriting results supported by price-product regulation. Moreover, the Japanese non-life insurance market experienced rapid growth in these lines of business in the early years of the subject period.[20] Being backed by the so-called convoy system combined with market growth, the greater the market share insurers aggressively captured, the higher the efficiency they achieved without being exposed to any serious growth risks.

The negative contribution of CALI to efficiency in the second observation is attributable to the feature of this line of insurance discussed in Analysis 1. The consistent policy of no-loss, no-profit for CALI throughout the subject period has not allowed insurers to achieve efficiency by expanding their market shares in this line of business. With regard to personal accident insurance, when underwriting this line of insurance, insurers generally utilized a different distribution channel from other business lines. While personal automobile and fire insurances were traditionally distributed through insurance agencies, personal accident insurance was often sold via the direct-writing scheme. Thus, insurers were required to invest in personnel development in order to newly launch this line of business, instead of merely utilizing existing channels. In actuality, only a few niche players who are not the subject of our analysis actively underwrote in this line of business in the early years of the said period.[21] Since it is difficult for economies of scale to function effectively in the personal accident insurance market, active investment in this line may impair efficiency performance.

The third observation that a higher price of automobile insurance appears to increase insurer efficiency can be explained along with the context of Analysis 1. This result also appears to be greatly impacted by the pre-deregulation era where all insurers used the same premium rates for this line of business. Even in a phase of premium increase, insurers were able to enjoy better underwriting results without suffering adverse effects including decreased demand.

In contrast to Analysis 1, there is a significant positive relationship between the interest rate and efficiency performance, as we observe in result (4). This is also supported by the positive marginal effects at ranks 0 and 1. Although, under a competitive environment, the interest rate level negatively contributes to efficiency performance, as discussed earlier, this paradoxical result appears to be caused by the stronger impact of the uncompetitive, early years of the subject period. The era from the 1970s to the mid '80s witnessed the latter half of the economic growth period, and the period from the late 1980s to the early '90s witnessed the

[20] In addition, insurers did not experience devastating or catastrophic losses caused by typhoons and major earthquakes in the 1970s or '80s. This also helped insurers to safely expand their market share.

[21] JI Accident & Fire Insurance and American Home Assurance are examples of this type of insurer.

Table 5. Outputs of Analysis 2 from the Data for the Period 1970-1995

Summary

Variable	MS-CALI	MS-Auto	MS-Fire	MS-PA	P-Auto	Interest
Relation to Efficiency	(−)	(+)	(+)			

Outputs

Variable	Coefficient	Standard Error	t-Value	P-Value	Mean
Constant	1.92087089	.69626399	2.759	.0058	
MS-CALI	13.34976240	6.07018394	2.199	.0279	.09883108
MS-Auto	−16.37989080	8.28194121	−1.978	.0480	.10000000
MS-Fire	−11.09500390	4.48348579	−2.475	.0133	.09609062
MS-PA	2.64663712	2.97010245	.891	.3729	.09824099
P-Auto	.00058540	.00667994	.088	.9302	50.30265330
Interest	1.44753939	6.34573743	.228	.8196	.06688192

Threshold Parameters for Index

Variable	Coefficient	Standard Error	t-Value	P-Value
μ_1	1.11810067	.08385830	13.333	.0000
μ_2	1.72993891	.09000581	19.220	.0000
μ_3	2.08329939	.09886208	21.073	.0000
μ_4	2.18000122	.10204766	21.363	.0000
μ_5	2.37567701	.10959613	21.677	.0000
μ_6	2.97379391	.14467277	20.555	.0000
μ_7	4.11215561	.34197623	12.025	.0000

Summary of Marginal Effects for the Ordered Probability Model (Probit)

Variable	Y=00	Y=01	Y=02	Y=03	Y=04	Y=05	Y=06	Y=07	Y=08
MS-CALI	−3.4804	−1.7443	1.3808	1.1292	.2996	.5627	1.2030	.6166	.0329
MS-Auto	4.2704	2.1403	−1.6942	−1.3855	−.3676	−.6904	−1.4761	−.7566	−.0403
MS-Fire	2.8926	1.4497	−1.1476	−.9384	−.2490	−.4676	−.9998	−.5125	−.0273
MS-PA	−.6900	−.3458	.2738	.2239	.0594	.1115	.2385	.1222	.0065
P-Auto	−.0002	−.0001	.0001	.0000	.0000	.0000	.0001	.0000	.0000
Interest	−.3774	−.1891	.1497	.1224	.0325	.0610	.1304	.0669	.0036

bubble economy boom. The investment environment generally favored insurers who were able to earn investment incomes since the interest rates increased throughout this period.

We then conduct further analysis that separates the data into pre- and post-deregulation periods in order to clarify the differences and similarities between the two time periods. The results derived from the data of the pre-deregulation 26-year period are tabled above.

Based on these outputs, the following observations are made:

1. Market expansion in the automobile and fire insurance lines positively contributes to insurer efficiency, which is supported by the positive marginal effects at ranks 0 and 1 in these lines.
2. Having a higher market share in the CALI business tends to decrease efficiency performance.

These observations are expounded in the same scenario discussed in the analysis of the

TABLE 6. OUTPUTS OF ANALYSIS 2 FROM THE DATA FOR THE PERIOD 1996-2005

Summary

Variable	MS-CALI	MS-Auto	MS-Fire	MS-PA	P-Auto	Interest
Relation to Efficiency	(−)	(+)	(−)	(+)	(−)	

Outputs

Variable	Coefficient	Standard Error	t-Value	P-Value	Mean
Constant	−6.28909224	1.55915968	−4.034	.0001	
MS-CALI	49.19354670	18.50846320	2.658	.0079	.09854484
MS-Auto	−59.17033670	23.45462010	−2.523	.0116	.10000000
MS-Fire	22.56385430	11.33409670	1.991	.0465	.09536496
MS-PA	−19.09984570	9.13920288	−2.090	.0366	.09181071
P-Auto	.09792845	.02348182	4.170	.0000	68.43936560
Interest	12.05986140	38.90000360	.310	.7565	.02135200

Threshold Parameters for Index

Variable	Coefficient	Standard Error	t-Value	P-Value
μ_1	1.18286728	.16435652	7.197	.0000
μ_2	2.00870859	.22869640	8.783	.0000
μ_3	2.85507255	.40053269	7.128	.0000

Summary of Marginal Effects for the Ordered Probability Model (Probit)

Variable	Y=00	Y=01	Y=02	Y=03	Y=04
MS-CALI	−19.6254	9.8810	7.1367	2.2748	.3328
MS-Auto	23.6055	−11.8849	−8.5841	−2.7362	−.4003
MS-Fire	−9.0017	4.5322	3.2734	1.0434	.1526
MS-PA	7.6197	−3.8364	−2.7709	−.8832	−.1292
P-Auto	−.0391	.0197	.0142	.0045	.0007
Interest	−4.8112	2.4223	1.7496	.5577	.0816

entire 36-year period. Under the rigid regulatory framework that continued until the mid 1990s, larger market shares in automobile and fire insurance positively contributed to improving the efficiency performance of insurers. The market growth and findable underwriting results in these lines of business appear to reinforce this tendency.

In contrast, insurers did not improve their efficiency performance by expanding their market share in CALI, since this line of insurance is operated under the no-loss, no-profit rule.

Neither did expansion of the personal accident insurance business contribute to efficiency. As discussed earlier, bearing of extra cost was necessary for insurers to remain active in this line of insurance, eventually impairing their efficiency performance.

From the data of the post-deregulation period of 1996-2005, we obtain the outputs shown in Table 6.

Based on these outputs, we find the following:

1. The efficiency performance of insurers tends to improve as they expand their market shares in the automobile insurance business.
2. Expansion in the fire insurance market appears to negatively contribute to efficiency.

3. As insurers expand their market shares in the CALI business, their efficiency performance tends to decline.
4. A positive relationship is observed between the market shares of personal accident insurance and efficiency performance.
5. The price of automobile insurance negatively contributes to efficiency.

With regard to result (1), the sign of the coefficient of automobile insurance continues to be negative, and the marginal effect at rank 0 is still positive—both indicating that expansion in this line of insurance can still contribute to improving efficiency performance even after deregulation. The tendency is explicable through two factors: an intrinsic characteristic of automobile insurance and the competitive environment of this insurance after deregulation. With regard to the first factor, an automobile insurance portfolio held by an insurer generally consists of a number of exposure units that are relatively smaller and more independent compared with those of other lines including fire insurance. Moreover, the larger the number of exposure units is, the more efficiently and accurately insurers estimate their future claims.[22] This nature of automobile insurance appears to allow insurers with larger market shares to improve their efficiency performance. With regard to the second factor, the automobile insurance market witnessed marked competition after deregulation. Deregulation resulted in price-product competition and changes in the distribution systems, forcing insurers to change their operations including ratemaking, distribution, products, and service developments. Some insurers are focusing on pricing by introducing risk-differentiated premium rates or the direct-response system, and others are adopting product and service differentiation strategies.[23] The expansion of an insurer's market share in this time period implies that the insurer, backed by its better efficiency performance, has successfully outpaced the competition.

In contrast, the sign of the coefficient of fire insurance changes to positive as we observe in result (2). This implies that insurers with larger shares in the fire insurance market tend to have poorer efficiency performance. This is supported by the negative value of the marginal effect at rank 0 and can be expounded in a context similar to that discussed in the results of Analysis 1. Fierce price competition after deregulation combined with larger, less independent exposure units appears to deteriorate the efficiency of insurers who their expand market shares in this line of insurance.

The third observation is supported by the negative marginal effects at rank 0 and the positive values at the higher-ranking numbers. This is explained by the fact that the no-loss, no-profit scheme of CALI continues to exist after deregulation.

Moreover, it is noteworthy that the coefficient of personal accident insurance becomes negative and the marginal effect at rank 0 gives a positive value after deregulation. As we observe in result (4), when an insurer expands its market share in this line, its efficiency performance tends to improve. This drastic change appears to be caused by the development of market environments in this sector. Consumers' awareness of the aging society and the role of third-sector insurance is forcing up demand and market growth for this line of insurance. In

[22] This is explained by Harrington and Niehaus (2004), pp. 57-60, based on the concept of pooling arrangements. According to their discussion, when losses are independent, pooling arrangements have two effects on the probability distribution of cost: standard deviation of the average loss is reduced, and the distribution of the average loss moves closer to the normal distribution.

[23] Mizushima (2002), pp. 152-153.

addition, the remarkable development of information technology coincided with deregulation and resolved, at least partly, the earlier problem of distribution channels. By utilizing the direct-response scheme via the Internet, insurers can effectively enter the market without newly constructing costly distribution channels that were necessary in the past.

Regarding result (5), we observe the positive sign of the coefficient of the automobile insurance price after deregulation, similarly to Analysis 1. This is explained in the same manner. Insurers with better efficiency performance can effectively retain the price of their products at a competitive level in a liberalized market, and thus, the price of automobile insurance negatively contributes to efficiency in this time period.

V. *Summary and Conclusions*

This paper investigates the relationship between non-life insurers' selection of the underwriting portfolio of insurance lines and their efficiency performance based on a 36-year period including various stages of market development. We utilize an ordered probability model and choose the ranking number of efficiency as the independent variable. As explanatory variables, we use the composition ratios of four major lines of insurance (CALI, automobile, fire, and personal accident insurances); the market shares of individual insurers in these lines; the price of automobile insurance; and the interest rate.

From the results of the analysis focusing on the composition ratios of the four lines of insurance of individual insurers, we observed a negative relationship between the composition ratio of each line of insurance and its efficiency throughout the subject period. This tendency is also observed even when we separate the data into pre- and post-deregulation periods. These findings imply that non-life insurers can successfully enhance their efficiency performance by diversifying their portfolios of insurance lines well, whereas a specializing strategy may undermine their performance not only in heavily regulated environments but also in competitive marketplaces.

The analysis based on market shares of individual insurers in the four lines of insurance, however, provides us with intricate results. Share expansion in the automobile insurance market consistently contributes to the efficiency performance of insurers over the subject period, being favored by relatively small, mutually independent exposure units of this line of insurance. Moreover, an increase in the share in the fire insurance market deteriorates efficiency in deregulated markets, possibly exposing insurers to a higher parameter uncertainty, even though it strengthened their efficiency in the regulated era. A higher market share of personal accident insurance tends to improve insurer efficiency after deregulation in line with innovation of distribution channels, while it tends to have impaired efficiency before deregulation. These findings suggest that investing in the automobile insurance business consistently contributes to insurers' efficiency in growing, regulated markets and in mature, competitive markets. In contrast, effects of share expansion in the fire and personal accident insurance markets on efficiency performance vary depending on the circumstances. Thus, when considering investments in these lines of insurance, insurers should examine a variety of factors including regulatory environments, trends of underwriting results, and utilizable distribution channels. Expansion of the CALI business does not contribute to improving efficiency performance throughout the subject period, which implies that the no-loss, no-profit scheme has been functioning properly for this society-oriented mandatory insurance.

This study covers ten major Japanese non-life insurers. Despite possessing a wide variety of characteristics, including size, management policy, organizational structure, and underwriting structure, all of them are domestic insurers with a long operating history from the pre-World War II era. There are also other types of players in the Japanese non-life insurance market, such as foreign-based companies with a relatively shorter operating history in this market, niche underwriters specializing in certain lines of business or in certain regions, life insurers' subsidiaries having entered after deregulation, and new entrants from other industry segments. Are our findings in this study authentic considering such great diversity in the types of insurers? Widening the scope of the subject insurers may provide different results, and it would represent a rich resource for future research.

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