Asymmetric Information Problems in Taiwan's Automobile Insurance Market: The Effect of Policy Design on Loss Characteristics

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Abstract

This article investigates asymmetric information problems for the automobile insurance market in Taiwan. Using panel data for the comprehensive automobile insurance coverage from 1995 to 1999, this article analyzes how types of coverage, deductible amounts, and experience ratings have affected the adverse selection and moral hazard problems in Taiwan's automobile insurance market. The empirical results provide partial evidence to demonstrate that the loss frequency and loss ratio were reduced by the addition of self-selection mechanisms in policies with different levels of coverage. In addition, the deductible amounts, experience ratings, and better control of underwriting and claims processing were shown possibly to have decreased potential losses from adverse selection and moral hazard problems.

Introduction

Asymmetric information has been one of the major topics in insurance research since Rothschild and Stiglitz (1976) and Shavell (1979) pioneered the development of the theoretical framework of moral hazard and adverse selection for insurance. Their work inspired a number of other researchers in the area of insurance theory over the past two decades—e.g., Miyazaki, 1977; Wilson, 1977; Radner, 1981; Holmstrom, 1982; Dionne, 1983; Rubinstein and Yarri, 1983; Crocker and Snow, 1986; Cooper and Hayes, 1987; Arnott and Stiglitz, 1988; Hellwig, 1988; Hosios and Peters, 1989; Hoy, 1989; Mookerjee and Png, 1989; Abreu, Pearce, and Stacchetti, 1990. The theoretical literature has identified many insightful concepts (such as incomplete coverage, commitment, renegotiation, and self-selection mechanisms) for understanding asymmetric information in the insurance market. Moreover, several more recent papers (including Dahlby, 1983; Dionne and Doherty, 1994; Puelz and Snow, 1994; and Chiappori and Salanie, 1997)

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have used data from automobile insurance to conduct further empirical tests to investigate whether asymmetric information problems exist in each insurance market.

On the other hand, adverse selection and moral hazard problems are also well recognized by insurers in real practice. In addition, insurance companies have developed many provisions—such as deductibles, co-insurance, and experience ratings—to reduce possible losses caused by adverse selection and moral hazard problems. For example, insurers may design different types of insurance coverages and deductible amounts with different costs to sort out the varying risk levels of the insured. Insurers have also used experience ratings in automobile insurance and workers compensation to control potential problems of asymmetric information.

In Taiwan, it has been widely believed that comprehensive automobile insurance coverage has long suffered from very severe asymmetric information problems. Insurance companies in Taiwan have developed several methods to overcome these problems. To explore these problems with empirical evidence, I have collected panel data for automobile insurance from 1995 to 1999 to account for how different types of coverage, deductible amounts, and experience rating systems affect adverse selection and moral hazard problems. In addition, I also address how automobile insurers in Taiwan have developed a self-selection mechanism for comprehensive coverage to deal with asymmetric information problems.

The empirical evidence provided in this aricle confirms that there may exist asymmetric information problems in comprehensive automobile insurance coverage in Taiwan. Moreover, the empirical results provide partial evidence to demonstrate that loss frequencies and loss ratios were reduced by self-selection mechanisms included in the contracts with different levels/costs of coverage. In addition, the deductible amounts and experience rating systems were found to decrease possible losses from moral hazard and adverse selection problems.

The next section of this article reviews automobile insurance and comprehensive coverage in Taiwan. The third section introduces the empirical data and methodology. The fourth section provides empirical results to investigate both asymmetric information problems and the self-selection mechanism in comprehensive automobile insurance coverage in Taiwan. The article ends with the Conclusion.

AUTOMOBILE INSURANCE IN TAIWAN

In Taiwan, automobile insurance represents more than 50 percent of the property-liability insurance premium volume in most insurance companies, and has occupied the largest market share of the property-liability insurance market. In 1999 there were approximately 4.5 million cars for which automobile insurance was purchased from the 25 insurance companies selling automobile insurance in Taiwan. In that same year, the total annual premium for automobile insurance was approximately 41 billion NT dollars (US $1.2 billion), and the total incurred loss for automobile insurance was approximately 24 billion NT dollars (US $0.7 billion). Three major types of automobile insurance have been observed in the market: (1) compulsory liability, (2) supplementary liability, and (3) comprehensive coverage for damage.

Compulsory automobile liability insurance covers only liability for bodily injuries—including death and medical expenditures. In 1999 the total premium for compulsory

liability insurance was approximately 21 billion NT dollars (US $0.6 billion); and the total incurred loss was approximately 11 billion NT dollars (US $0.3 billion). Both the coverage and rating are fully regulated. Moreover, liability for bodily injuries sustained in an automobile accident is mandated as strict liability under compulsory liability insurance. The coverage includes a 1.4 million NT dollar (US $42,000) death benefit and up to 20,000 NT dollars (US $6,000) for medical expenses. The insurance premium is, on average, about 4,000 NT dollars (US $120) per person.

There is no coverage for uninsured motorists; and the issue of hit-and-run drivers is handled by a special fund. In other words, any person injured by an uninsured or hit-and-run driver is compensated through a special fund that is financed through a tax on the premium for compulsory liability insurance. Since liability for bodily injuries is covered as a strict liability under the compulsory liability insurance, there is no first-party no-fault coverage in the market.

On the other hand, supplementary liability insurance provides liability coverage for both property damage and bodily injury and is purchased voluntarily. The levels of liability for property damage and bodily injuries above the limit for compulsory automobile liability insurance are on an at-fault basis. In 1999 the total premium for supplementary liability insurance was approximately 10 billion NT dollars (US $0.3 billion); and the total incurred loss was approximately 6 billion NT dollars (US $0.2 billion).

Comprehensive coverage, which is also purchased voluntarily, provides coverage for property damage to a driver's automobile. In 1999 the total premium for comprehensive coverage insurance was about 11 billion NT dollars (US $0.3 billion); and the total incurred loss was about 7 billion NT dollars (US $0.2 billion).

Automobile drivers can choose from three types of comprehensive coverage: type A covers all risks;[1] type B covers selected risks;[2] and type C covers only damage in a collision involving two or more vehicles.[3] Prior to 1995 insurance companies in Taiwan sold only type A coverage. In 1995, type B coverage was designed to reduce the moral hazard problems that existed under type A coverage; therefore, it excludes some losses where it is hard to verify the cause or source. Finally, type C coverage was introduced into the market in 1999 in response to the continuous escalation in the loss ratio for both type A and type B.

Two types of asymmetric information—the insured's moral hazard and the supplier's moral hazard—are both observed in the market for comprehensive insurance coverage, especially for type A. Since type A covers all risks, the insured has a strong incentive to file as many claims as possible, whether or not his/her car actually sustained damage. In

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[1] Type A coverage covers all kinds of collision and noncollision losses, which may be caused by missiles or falling objects, fire, explosion, windstorm, intentional body damage, malicious mischief, and any unidentified reasons other than the exclusions in the policy.

[2] Type B coverage also covers collision and noncollision losses. However, the noncollision losses caused by intentional body damage, malicious mischief, and the unidentified reasons covered under type A are specifically excluded from type B.

[3] Collision losses caused by hitting other objects—such as a telephone pole, a tree, or a building—and noncollision losses that used to be covered under types A and B are specifically excluded from type C.

this case, the insured usually asks the repair shop or garage to provide more services than necessary in order to claim greater compensation.[4] For example, the insured may ask to have the entire car re-polished for only a small scratch. On the other hand, the repair shop (i.e., the supplier) also has an incentive to augment the work to increase its revenue and profit.[5] Ironically, insurance companies usually have to tolerate this type of corruption between the insured and the supplier simply to avoid losing business, since repair shops owned by car dealerships are the major distribution channels for automobile insurance in Taiwan. In addition, car dealers have the incentive to promote more expensive coverage since they are rewarded by a commission that is a fixed percentage of the insurance premium. Thus, both the loss frequency and loss ratio under the comprehensive coverage have been extremely high and continue to increase, as does the insurance premium.

Table 1 reports the loss frequency, loss severity, and loss ratio[6] before the type B coverage was introduced into the market.[7] The data calculated in all these tables include only automobile insurance for noncommercial sedans. It should be noted that the premium rate[8] for type A coverage was increased in July 1990 in order to match the escalating loss ratio resulting from the adverse selection and moral hazard problems. In addition, the adjustment rate for experience rating (the so-called loss ratio plus/minus system) for type A coverage was first implemented in March 1994. From Table 1 we observe that the loss frequency and loss ratio decreased materially in 1991, which was the first year after the type A premium was increased. However, the loss frequency and loss ratio gradually returned to their original levels; and the loss ratio actually exceeded its original level in 1993.

Because of the significant annual increase in the loss ratio, in 1995 insurers developed type B coverage—the self-selection mechanism—to sort out different risk levels among consumers. As mentioned earlier, type B coverage excludes some losses, such as intentional body damage, malicious mischief, and losses caused by unidentified reasons. These losses were identified as the main reasons for the increase in the loss ratio for type A coverage. Tables 2 and 3 depict the loss frequency, loss severity, and loss ratio from 1995 to 1999 for type A and type B, respectively. From these tables we find that loss frequency and loss ratio were generally lower for type B than for type A.[9] It is worth noting that the adjustment rate for experience rating was further increased for both types A

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[4] The arguments may not be restricted only to no deductible policies. The possibility for this kind of insured's moral hazard is greater for the type A policy than the type B policy because the type A policy covers damages from unidentified reasons. Thus, the insured can use this rationale to file more claims as long as the compensation is higher than the deductible amount.

[5] The main distribution intermediaries of automobile insurance in Taiwan are the direct writers and car dealers. Car dealers account for more than 40 percent of the automobile insurance policies distributed in Taiwan. Therefore, repair shops owned by car dealers have very strong bargaining power in claim settlements. In some cases, insurance companies may even pay claims under certain amounts without any inspection.

[6] Loss frequency is defined as the total number of incurred loss policies divided by the total number of policies earned. Loss severity is defined as the total amount of incurred loss divided by the total number of incurred losses. Loss ratio is defined as the total amount of incurred loss divided by the total amount of premiums earned.

[7] See Table A4 in the Appendix for further details.

[8] The automobile insurance premium in Taiwan is subject to a prior approval system.

[9] The calculated t test results of the cross-sectional data will be discussed in the next section.

TABLE 1

Loss Frequency, Loss Severity, and Loss Ratio for Comprehensive Automobile Insurance Coverage From 1986 to 1994

Year	Loss Frequency (%)	Loss Severity (NT$)	Loss Ratio (%)
1986	184.38	4,759	73.58
1987	184.25	5,827	82.98
1988	191.70	7,282	97.51
1989	176.52	8,991	100.03
1990[a]	160.95	10,504	104.26
1990/1-6	163.73	10,495	106.70
1990/7-12	122.07	10,665	73.38
1991	135.67	10,877	81.98
1992	142.89	11,704	88.57
1993	144.30	14,426	101.62
1994	151.42	18,197	119.03

[a]The premium rate for type A coverage was increased in July 1990. To provide more detailed information, the semi-annual numbers were also reported for 1990.

TABLE 2

Loss Frequency, Loss Severity, and Loss Ratio for Comprehensive Coverage of Type A Auto Insurance From 1995 to 1999

Year	Loss Frequency (%)	Loss Severity (NT$)	Loss Ratio (%)
1995	150.98	20,417	116.13
1996	148.90	20,371	98.76
1996/1-6	152.04	20,273	101.19
1996/7-12	57.49[a]	27,871[a]	42.18[a]
1997	75.09	28,624	54.82
1998	85.25	31,616	68.58
1999	86.42	32,906	73.18

[a]The premium rate for type A coverage was increased in July 1996. To provide more detailed information, the semi-annual numbers were also reported for 1996.

and B coverage in July 1995. In addition, the premium rates for both type A and type B were increased in July 1996.[10] As in Table 1, we find that loss frequency and loss ratio decreased in the first year after the premium was raised but gradually increased each year afterwards.

However, because of the significant annual increase in loss ratios, type C coverage was finally introduced in 1999, providing another self-selection mechanism to reduce further

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[10] There was a greater increase in the premium rate for the type A policy than for the type B policy.

TABLE 3

Loss Frequency, Loss Severity, and Loss Ratio for Comprehensive Coverage of Type B Auto Insurance From 1995 to 1999

Year	Loss Frequency (%)	Loss Severity (NT$)	Loss Ratio (%)
1995	50.96	30,119	61.43
1996	37.42	28,908	43.55
1996/1-6	56.65[a]	22,335[a]	53.52[a]
1996/7-12	24.14	39,565	37.20
1997	30.81	33,459	41.24
1998	43.05	29,989	52.94
1999	52.08	26,537	57.59

[a]The premium rate for type A coverage was increased in July 1996. To provide more detailed information, the semi-annual numbers were also reported for 1996.

TABLE 4

Loss Frequency, Loss Severity, and Loss Ratio for Comprehensive Coverage of Types A, B, and C Auto Insurance in 1999

Year	Loss Frequency (%)	Loss Severity (NT$)	Loss Ratio (%)
1999			
Type A	86.42	32,906	73.18
Type B	52.08	26,537	57.59
Type C	22.01	28,643	46.71

the adverse selection and moral hazard problems. The collision loss caused by hitting other objects rather than other vehicles is especially excluded from type C. These losses were identified as the main reasons for the increase in the loss ratio for both type A and type B. Table 4 shows the loss frequency, loss severity, and loss ratio in 1999 for type A, type B, and type C, respectively. As we found earlier, in the comparison between types A and B, we observe that loss frequency and loss ratio were generally lower for type C than for types A and B.[11] The empirical results seem to suggest that both type B and type C coverage created the self-selection mechanism to attract lower-risk consumers. However, the effect caused by the type C coverage should be considered more tentatively, since the data were collected for only a one-year period following the introduction of the type C coverage.

EMPIRICAL DATA AND METHODOLOGY

To analyze empirically the asymmetric information problems in Taiwan's automobile insurance market, we collected panel data to account for how different types of coverage, deductible amounts, and experience rating systems affect adverse selection and moral hazard problems. The data utilized in this article are from *Annual Statistics for Automobile*

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[11] The calculated *t* test results of the cross-sectional data will be discussed in the next section.

Insurance, prepared by the Insurance Institute of the Republic of China, and were collected from 1986 to 1999, the latest year for which the data were available.

First, *t* tests were conducted to examine the differences in loss frequency, loss severity, and loss ratio between the different types of coverage for the aggregate data. In addition, the paired *t* test by separating two groups with its loss ratio was also performed to capture more detailed information. We ranked all the companies by their loss ratios and designated the first half as the higher loss ratio group and second half as the lower loss ratio group. The higher loss ratio group represented the poorer control group in underwriting and claims processing, whereas the lower loss ratio group represented the better control group. In calculating the *t* ratio, the sampling unit is the company, and the number of companies is 25. In addition, the standard deviations were calculated by measuring the deviations from the mathematical mean, and there was no difference weighted by the size of the company. To investigate rigorously the asymmetric information problems for the automobile insurance market in Taiwan, OLS regression models were also utilized to provide more insightful analysis. It is noted that, for both *t* tests and OLS regressions, only the data period from 1995 to 1999 was used to perform the analysis. The regression models were constructed as follows:

$$y_{it} = \beta_0 + \sum_{j=1}^{n} \beta_j x_{jit} + u_{it}, \tag{1}$$

where y_{it} is the loss severity (LS), the loss frequency (LF), or the loss ratio (LR) of firm i in year t,[12] x_{jit} is a vector of explanatory variables, u_{it} is the random disturbance, and β_j are parameters to be estimated.

In our estimation we include four groups of variables to control the firm effect, year effect, self-selection effect (type of coverage), and deductible effect. These variables are described in detail as follows:[13]

1. Firm effect: 24 dummies to indicate insurance companies.

2. Year dummy:[14] dummies to indicate the year from 1995 to 1999. The base is 1995, the first year type B coverage was issued.

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[12] The loss ratio could be approximated by the product of loss severity, loss frequency, and the ratio of number of policies earned to the amount of premiums earned. If loss frequency, loss severity, and premium per policy have a linear specification, then the loss ratio also could have a linear specification.

[13] The premium rate is also an important variable in this analysis. However, the premium rate for auto insurance in Taiwan is highly regulated and subject to a prior approval system. Therefore, we do not include pure premium as a dependent variable since the pure premium is the same among the companies.

[14] We assume a constant-purchasing-power value in our data period. The year dummy may not be a substitute for correcting severity to a constant-purchasing-power value of the NT$. Therefore, the loss severity equation usually needs to be controlled by a variable such as a GDP deflator. However, this adjustment should not be an issue, since our data period for the regression covers only 4 years.

3. Type of coverage: dummy to indicate type A or type B coverage.[15] It equals 1 if the coverage is type B.

4. Deductible effect: the weighted average of the deductible level (WADL). It is measured by the average deductible level weighted by the percentage of the written premium of the corresponding deductible level to the total written premium of the firm.

5. Interaction term: the interaction terms between policy type and year are added to the regression to further identify which years capture the difference between types A and B.

The summary of basic statistics for the numerical variables used in the analysis is illustrated in Table 5.

EMPIRICAL RESULTS

Tables 6, 7, 8, 9, 10, and 11 report the results of the t test for the differences between type A and type B, type B and type C, and type A and type C, respectively.

In general, the t test results confirm that there were significant differences for both loss frequency and loss ratio between type A and type B, type B and type C, and type A and type C coverages. In the comparison between types A and B, we observe that loss frequency and loss ratio were significantly lower for type B than for type A at the one percent level from 1995 to 1999. However, the t ratios did not have consistent results for loss severity. It is worth noting that, compared to the lower loss ratio group, the difference in loss ratio between types B and A was found to be less significant or even not significant for the higher loss ratio group. This implies that the moral hazard problem seems to be more severe for the poor control group in underwriting and claims processing. Thus, better control of underwriting and claims processing seems to have possibly decreased the potential losses from moral hazard problems.

Moreover, for the comparison between type C and type A or type B, we also find that loss frequency and loss ratio were significantly lower for type C than for type A or type B at the one percent level. The empirical results seem to imply that both type B and type C coverage could create self-selection mechanisms to attract lower-risk consumers. As found in the previous comparison between type A and type B, the difference in loss ratio between type C and types A or B were found to be not significant for the higher loss ratio group. This also implies that the moral hazard problem seems to be more severe for the poor control group in underwriting and claims processing.

Furthermore, Tables 12, 13, and 14 report the OLS regression results for loss severity, loss frequency, and loss ratio, respectively, from 1995 to 1999.

In summary, the regression results suggest that type B coverage has a significantly lower loss frequency and loss ratio than type A. The regression results as well as the t ratios provide partial evidence[16] to demonstrate that type B coverage may create the

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[15] The latest available data can provide only one year of data for type C coverage. Therefore, type C coverage is not included as a dummy in the regression model.

[16] Because of a lack of individual level data, we are unable to test whether self-selection is working because of risk aversion or other reasons.

TABLE 5
The Summary Statistics for the Numerical Variables ($N = 300$)

Variable	Mean	Std. Dev.	Minimum	Maximum
LS	28263.91	10567.86	0	76876.00
LF	44.8695813	44.2435802	0	185.7100000
LR	41.7311720	38.1148006	0	172.3900000
Firm1	0.0400000	0.1962866	0	1.0000000
Firm2	0.0400000	0.1962866	0	1.0000000
Firm3	0.0400000	0.1962866	0	1.0000000
Firm4	0.0400000	0.1962866	0	1.0000000
Firm5	0.0400000	0.1962866	0	1.0000000
Firm6	0.0400000	0.1962866	0	1.0000000
Firm7	0.0400000	0.1962866	0	1.0000000
Firm8	0.0400000	0.1962866	0	1.0000000
Firm9	0.0400000	0.1962866	0	1.0000000
Firm10	0.0400000	0.1962866	0	1.0000000
Firm11	0.0400000	0.1962866	0	1.0000000
Firm12	0.0400000	0.1962866	0	1.0000000
Frim13	0.0400000	0.1962866	0	1.0000000
Firm14	0.0400000	0.1962866	0	1.0000000
Firm15	0.0400000	0.1962866	0	1.0000000
Firm16	0.0400000	0.1962866	0	1.0000000
Firm17	0.0400000	0.1962866	0	1.0000000
Firm18	0.0400000	0.1962866	0	1.0000000
Firm19	0.0400000	0.1962866	0	1.0000000
Firm20	0.0400000	0.1962866	0	1.0000000
Firm21	0.0400000	0.1962866	0	1.0000000
Firm22	0.0400000	0.1962866	0	1.0000000
Firm23	0.0400000	0.1962866	0	1.0000000
Firm24	0.0400000	0.1962866	0	1.0000000
Year95	0.1666667	0.3733007	0	1.0000000
Year96A	0.1666667	0.3733007	0	1.0000000
Year96B	0.1666667	0.3733007	0	1.0000000
Year97	0.1666667	0.3733007	0	1.0000000
Year99	0.1666667	0.3733007	0	1.0000000
WADL	2814.77	1638.45	0	9907.63

self-selection mechanism to attract lower-risk consumers. Therefore, our empirical evidence implies that the adverse selection and moral hazard problems seem to have been reduced by the introduction of type B coverage.

TABLE 6

t Tests for Loss Severity, Loss Frequency, and Loss Ratio for Aggregate Data Between Type A and Type B (A-B[a])

Year	*t* Ratio for Loss Severity	*t* Ratio for Loss Frequency	*t* Ratio for Loss Ratio
1995	−1.85*	10.83***	4.40***
1996/1-6	−0.49	5.30***	3.72***
1996/7-12	−2.62***	6.25***	0.95
1997	−2.74***	9.16***	2.95***
1998	0.49	7.14***	3.37***
1999	1.72*	3.79***	3.18**

[a]When calculating the *t* ratios for loss severity, loss frequency, and loss ratio, the base is type B.
*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

TABLE 7

t Tests for Loss Severity, Loss Frequency, and Loss Ratio for the Companies With Lower Loss Ratios Between Type A and Type B (A-B[a])

Year	*t* Ratio for Loss Severity	*t* Ratio for Loss Frequency	*t* Ratio for Loss Ratio
1995	0.09	7.52***	9.91***
1996/1-6	−0.47	7.62***	6.02***
1996/7-12	−1.35	5.83***	1.5
1997	−3.59***	9.81***	3.30***
1998	−0.05	6.49***	4.64***
1999	2.66**	4.31***	4.18***

[a]When calculating the *t* ratios for loss severity, loss frequency, and loss ratio, the base is type B.
*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

From the estimators of year dummies in Tables 13 and 14, we find that loss frequency and loss ratio were significantly lower in 1996. This finding implies that changes in the deductible amount and adjustment rate for experience ratings may have played important roles in reducing loss frequency and loss ratio. Table A1 in the Appendix shows the changes in both the amount and design of the deductible from 1986 to 1999. After July 1996, the lowest deductible amount was increased from 2,000 NT dollars per claim to 8,000 NT dollars per claim—or 3,000 NT dollars for the first claim, 5,000 NT dollars for the second claim, and 7,000 NT dollars for the third or later claim.[17] The loss frequency, loss severity, and loss ratio for the most public type of deductible levels from 1995 to 1999 for type A and type B are shown in Tables A2 and A3, respectively, in the Appendix. Moreover, the highest deductible amount was also raised from 10,000 NT dollars to 100,000 NT dollars;[18] and more types of deductibles were offered by

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[17] This type of deductible was the most popular for type A and type B coverage after July 1996.

[18] A deductible of 100,000 NT dollars is about 20 percent of the market value for a typical new sedan.

TABLE 8

t Tests for Loss Severity, Loss Frequency, and Loss Ratio for the Companies With Higher Loss Ratio Between Type A and Type B (A-B[a])

Year	*t* Ratio for Loss Severity	*t* Ratio for Loss Frequency	*t* Ratio for Loss Ratio
1995	−2.53*	18.65***	0.2
1996/1-6	−0.55	3.45***	1.69
1996/7-12	−2.83**	17.48***	0.37
1997	−1.99*	17.85***	2.57**
1998	0.77	5.93***	2.56**
1999	2.23**	2.32**	0.78

[a]When calculating the *t* ratios for loss severity, loss frequency, and loss ratio, the base is type B.
*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

TABLE 9

t Tests for Loss Severity, Loss Frequency, and Loss Ratio for Aggregate Data in 1999

Comparison	*t* Ratio for Loss Severity	*t* Ratio for Loss Frequency	*t* Ratio for Loss Ratio
Types A and C[a]	1.91*	7.24***	3.30***
Types B and C[a]	0.71	6.76***	2.41**

[a]When calculating the *t* ratio for loss severity, loss frequency, and loss ratio, the base is type C.
*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

TABLE 10

t Tests for Loss Severity, Loss Frequency, and Loss Ratio in 1999 for Companies With a Lower Loss Ratio

Comparison	*t* Ratio for Loss Severity	*t* Ratio for Loss Frequency	*t* Ratio for Loss Ratio
Types A and C[a]	2.32**	7.27***	3.79***
Types B and C[a]	−0.32	7.56***	2.64**

[a]When calculating the *t* ratio for loss severity, loss frequency, and loss ratio, the base is type C.
*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

TABLE 11

t Tests for Loss Severity, Loss Frequency, and Loss Ratio in 1999 for Companies With a Higher Loss Ratio

Comparison	*t* Ratio for Loss Severity	*t* Ratio for Loss Frequency	*t* Ratio for Loss Ratio
Types A and C[a]	−0.22	5.37***	1.19
Types B and C[a]	−1.34	4.55***	0.77

[a]When calculating the *t* ratio for loss severity, loss frequency, and loss ratio, the base is type C.
*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

TABLE 12
Regression Analysis for Loss Severity

Dependent Variable	Coefficient	t Ratio	p Value
Constant	17115*	1.85	0.067
Type B	11243***	3.61	0.000
Year96A	−927	−0.33	0.744
Year96B	368	0.10	0.922
Year97	10193***	2.74	0.007
Year98	13240***	3.43	0.001
Year99	13573***	3.71	0.000
WADL	−0.83	−0.77	0.444
Firm1	3956	0.45	0.655
Firm2	3223	0.38	0.701
Firm3	7065	0.86	0.392
Firm4	7216	0.83	0.408
Firm5	4421	0.51	0.610
Firm6	−3695	−0.43	0.670
Firm7	5555	0.63	0.528
Firm8	3471	0.41	0.684
Firm9	1296	0.15	0.882
Firm10	7072	0.83	0.409
Firm11	2843	0.33	0.745
Firm12	4499	0.52	0.606
Frim13	4301	0.49	0.626
Firm14	17116**	2.15	0.033
Firm15	314	0.04	0.971
Firm16	3907	0.43	0.667
Firm17	4565	0.43	0.671
Firm18	6428	0.80	0.425
Firm19	11142	1.33	0.184
Firm20	3205	0.36	0.718
Firm21	−9461	−0.97	0.333
Firm22	14596	1.63	0.106
Firm23	16383	1.35	0.177
Firm24	−8566	−0.71	0.477
TypeB*96A	−1132	−0.27	0.787
TypeB*96B	−2048	−0.49	0.628
TypeB*97	−4951	−1.19	0.235
TypeB*98	−12593***	−3.08	0.002
TypeB*99	−15358***	−3.80	0.000
$R^2 = 46.8\%$	$F = 4.59$		p Value $= 0.000$

*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

TABLE 13
Regression Analysis for Loss Frequency

Dependent Variable	Coefficient	t Ratio	p Value
Constant	83.35***	6.83	0.000
Type B	−94.56***	−15.26	0.000
Year96A	−131.55***	−21.83	0.000
Year96B	−139.14***	−19.83	0.000
Year97	−69.19***	−10.03	0.000
Year98	−53.41***	−7.57	0.000
Year99	−63.26***	−9.55	0.000
WADL	0.003	1.54	0.124
Firm1	59.82***	4.99	0.000
Firm2	41.61***	3.62	0.000
Firm3	40.79***	3.59	0.000
Firm4	57.68***	4.87	0.000
Firm5	47.22***	4.01	0.000
Firm6	57.88***	4.92	0.000
Firm7	54.68***	4.58	0.000
Firm8	55.01***	4.72	0.000
Firm9	49.31***	4.15	0.000
Firm10	49.96***	4.30	0.000
Firm11	57.62***	4.86	0.000
Firm12	50.36***	4.25	0.000
Frim13	53.33***	4.46	0.000
Firm14	52.60***	4.74	0.000
Firm15	42.74***	3.62	0.000
Firm16	35.09***	2.71	0.007
Firm17	31.75*	1.86	0.064
Firm18	24.69**	2.25	0.026
Firm19	−15.30	−0.99	0.323
Firm20	52.34***	4.10	0.000
Firm21	49.17***	3.42	0.001
Firm22	41.51***	3.41	0.001
Firm23	−28.28*	−1.79	0.076
Firm24	19.45	1.16	0.248
TypeB*96A	90.17***	10.34	0.000
TypeB*96B	91.65***	10.49	0.000
TypeB*97	51.28***	6.03	0.000
TypeB*98	46.87***	5.55	0.000
TypeB*99	64.81***	7.87	0.000
$R^2 = 85.6\%$	$F = 32.26$		p Value $= 0.000$

*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

TABLE 14
Regression Analysis for Loss Ratio

Dependent Variable	Coefficient	t Ratio	p Value
Constant	63.65***	4.58	0.000
Type B	−55.19***	−7.83	0.000
Year96A	−105.92***	−15.45	0.000
Year96B	−112.34***	−14.07	0.000
Year97	−58.08***	−7.40	0.000
Year98	−42.96***	−5.36	0.000
Year99	−46.20***	−6.13	0.000
WADL	0.003	0.81	0.421
Firm1	50.06***	3.67	0.000
Firm2	34.30***	2.62	0.009
Firm3	33.97***	2.63	0.009
Firm4	46.25***	3.43	0.001
Firm5	41.41***	3.09	0.002
Firm6	36.24***	2.71	0.007
Firm7	50.45***	3.71	0.000
Firm8	42.40***	3.20	0.002
Firm9	36.09***	2.67	0.008
Firm10	39.49***	2.98	0.003
Firm11	44.50***	3.30	0.001
Firm12	42.64***	3.16	0.002
Frim13	50.77***	3.73	0.000
Firm14	50.09***	3.97	0.000
Firm15	32.41**	2.42	0.017
Firm16	26.52*	1.80	0.073
Firm17	24.23	1.25	0.214
Firm18	23.04*	1.84	0.067
Firm19	1.36	0.08	0.938
Firm20	41.24***	2.84	0.005
Firm21	29.73*	1.82	0.071
Firm22	41.84***	3.02	0.003
Firm23	−20.00	−1.11	0.268
Firm24	1.16	0.06	0.952
TypeB*96A	53.70***	5.41	0.000
TypeB*96B	53.33***	5.37	0.000
TypeB*97	40.32***	4.17	0.000
TypeB*98	34.64***	3.61	0.000
TypeB*99	41.35***	4.41	0.000
$R^2 = 74.8\%$	$F = 16.16$		p Value = 0.000

*,**,*** Significance at the 10%, 5%, and 1% level, respectively.

the insurers. Further, in 1995 the adjustment rate for experience ratings for both type A and type B was changed from 0.1 to 0.2. These empirical results seem to suggest that the deductible amounts and experience ratings could at least partially control the problems of asymmetric information. In addition, we also found that most of the firm dummies are also significant for loss frequency and loss ratio. Moreover, the interaction terms in both Tables 13 and 14 show that in all the sample years type B had a more positive impact on the reduction of loss frequency and loss ratio. That is to say, compared to type A in all the sample years, type B generally had less reduction in both loss frequency and loss ratio.

However, the estimators for the 1998 year dummy and interaction terms in Table 13, as well as the estimators for the 1997 and 1998 year dummies and interaction terms in Table 14, also show that the loss frequency and loss ratio of both type A and type B could continue to increase even after the higher deductibles and experience ratings were adopted. This may suggest that the effect of introducing higher deductibles and experience ratings to control the moral hazard problem could be temporary rather than permanent.

As mentioned earlier, type C coverage was finally introduced in 1999. From Tables 13 and 14, the estimator for the 1999 dummy shows that loss frequency and loss ratio were reduced significantly after the introduction of this coverage. This result seems to suggest that the introduction of type C coverage further reduced the adverse selection and moral hazard problems. However, it is too early to say whether asymmetric information problems are under control in Taiwan's automobile insurance market. Rather, it will be an on-going battle between our wisdom and weakness, since both the problems of and the cure for moral hazard come from us.

CONCLUSIONS

Using panel data of comprehensive automobile insurance coverage from 1995 to 1999 in Taiwan, this article has analyzed how different types of coverage, deductible amounts, and experience rating systems have affected the adverse selection and moral hazard problems in Taiwan's automobile insurance market. The empirical results provide partial evidence to demonstrate that loss frequency and loss ratio were reduced by issuing different types of coverage policies to create self-selection mechanisms and also by the introduction of the deductible. Moreover, the types of deductible amounts, experience rating systems, and better control of underwriting and claims processing were shown to have reduced possible losses caused by the moral hazard and adverse selection problems.

From Table A4, we find that the percentage of vehicles insured for comprehensive coverage declined from 27 percent in 1986 (or almost 30 percent in 1990) to about 8 percent in 1999. This decline poses an important question: What type of self-selection might be operating in this market? The selection of a different policy type may be due to the differences in the risk aversion attitudes of the people or the behavior changes that result from choosing different policies. However, due to a lack of suitable individual level data, we are unable to test in this paper whether self-selection is working on the basis of assessment of accident proneness, through differences in risk aversion, or through differences in the willingness to perpetrate fraud. This issue is very important in the asymmetric information literature and certainly deserves more investigation for future research.

APPENDIX

TABLE A1

The Change in the Amount and Types of Deductibles for Comprehensive Coverage From 1986 to 1999 (Unit: NT1,000)

| Year | Deductible Type | | |
	Policy Type A	Policy Type B	Policy Type C
1986	0, 1, 2, 3		
1987			
1988			
1989			
1990/1-6			
1990/7-12	0, 2, 3, 4, 5, 6, 8, 10		
1991			
1992			
1993			
1994			
1995		0, 2, 3, 5, 8, 10	
1996/1-6		0, 2, 3, 4, 5, 6, 8, 10	
1996/7-12	3/5/7, 5/8, 5/8/10, 8, 10, 15, 20, 30, 100	3/5/7, 5/8, 5/8/10, 8, 10, 15, 20, 30, 50, 100	
1997	3/5/7, 5/8, 5/8/10, 8, 10, 15, 20, 30, 40, 50, 100	3/5/7, 5/8, 5/8/10, 8, 10, 15, 20, 30, 40, 50, 100	
1998			
1999	0, 3/5/7, 5/8, 5/8/10, 8, 10, 15, 20, 30, 40, 50, 100	0, 3/5/7, 5/8, 5/8/10, 8, 10, 15, 20, 30, 40, 50, 100	0, 3/5/7

Note: (1) 3 or 5 represents the deductible amount as 3,000 or 5,000 NT dollars. (2) 3/5/7 represents the deductible amount as 3,000 NT dollars for the first claim, 5,000 NT dollars for the second claim, and 7,000 NT dollars for the third or later claim during the policy year.

TABLE A2

Loss Frequency, Loss Severity, and Loss Ratio for the Most Popular Type of Deductible for Comprehensive Coverage of Type A Insurance From 1995 to 1999

Year	Most Popular Type of Deductible[a]	WP%[b]	Loss Frequency (%)	Loss Severity (NT$)	Loss Ratio (%)
1995	0	77.9%	158.12	19,510	126.52
	5,000	12.0%	94.75	36,180	67.78
1996/1-6[c]	0	69.1%	173.69	19,143	117.26
	5,000	17.8%	74.45	31,353	55.47
1996/7-12	3/5/7	95.9%	58.51	27,568	42.63
1997	3/5/7	95.6%	76.55	28,353	55.43
1998	3/5/7	95.1%	86.25	31,321	68.84
1999	3/5/7	95.8%	83.89	32,782	71.15

[a]For the deductible type product, the loss severity is calculated by the incurred loss net of the amount of the deductible.
[b]WP% is the percentage of the written premium of the corresponding deductible level to the total written premium.
[c]To avoid loss, most insurers adjust their underwriting strategy by not selling a no deductible policy to the high-risk insured who has been identified through the underwriting process. Thus, the severity for 5,000 NT$ deductibles in this year is much higher than that for no deductibles.

TABLE A3

Loss Frequency, Loss Severity, and Loss Ratio for the Most Popular Type of Deductible for Comprehensive Coverage of Type B Insurance From 1995 to 1999

Year	Most Popular Type of Deductible[a]	WP%[b]	Loss Frequency (%)	Loss Severity (NT$)	Loss Ratio (%)
1995	0	90.9%	52.41	29,875	62.65
	5,000	4.1%	28.00	27,163	30.16
1996/1-6	0	84.3%	59.78	21,552	54.55
	5,000	7.5%	33.42	29,174	35.65
1996/7-12	3/5/7	95.0%	23.32	38,678	35.30
1997	3/5/7	94.5%	29.57	33,068	39.11
1998	3/5/7	94.0%	43.33	29,512	52.43
1999	3/5/7	74.3%	48.52	26,000	53.46
	0	19.5%	61.85	23,808	58.79

[a]For the deductible type product, the loss severity is calculated by the incurred loss net of the amount of the deductible.
[b]WP% is the percentage of the written premium of the corresponding deductible level to the total written premium.

TABLE A4

Overview of the Comprehensive Coverage of the Automobile Insurance Market for Non-Commercial Sedans From 1986 to 1999

Year	No. of Firms	No. of Cars	No. of Written Policies	No. of Policies Earned	Ratio of Insured	Total Written Premiums	Total Premiums Earned (NT$)	Loss Ratio (%)
1986	14	1,046,660	283,311	254,946	0.27	3,479,051,394	3,040,220,005	73.58
1987	14	1,734,000	358,113	318,328	0.21	4,833,446,550	4,118,270,101	82.98
1988	17	2,089,000	494,637	418,967	0.24	7,436,643,124	5,998,127,865	97.51
1989	17	2,524,000	636,765	571,862	0.25	10,375,870,371	9,072,912,549	100.03
1990	17	2,263,418	670,248	679,325	0.30	11,167,211,829	11,014,905,251	104.26
1991	17	2,541,364	631,297	514,723	0.25	11,460,585,016	9,264,327,499	81.98
1992	17	2,900,042	662,985	646,672	0.23	13,046,393,604	12,210,692,311	88.57
1993	18	3,238,756	679,003	668,882	0.21	14,435,569,856	13,702,443,224	101.62
1994	18	3,570,501	711,516	692,352	0.20	17,887,970,872	16,027,145,980	119.03
1995	19	3,874,203	691,845	720,958	0.18	19,689,937,147	19,135,586,510	116.09
1996	19	4,146,475	535,292	617,256	0.13	16,801,899,780	18,845,199,824	97.38
1997	20	4,411,911	396,505	331,674	0.09	12,828,930,553	10,890,950,465	50.18
1998	20	4,545,488	346,769	375,328	0.08	10,525,150,828	11,747,317,436	62.04
1999	22	4,509,430	372,871	347,436	0.08	10,294,974,121	10,143,519,202	65.62

Notes: (1) We assume that each policy covers exactly one car for one year for the calculation in this table since the laws in Taiwan do not allow issuing a multiple vehicle coverage policy. (2) The number of earned policies is calculated by using the half-year rule. For example, the number of earned policies in 1990 equals to the number of written policies from July to December in 1989 plus the number of written policies from January to June in 1990.

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