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Can Auto Liability Insurance Purchases Signal Risk Attitude?

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1. Introduction

In the last decade, extensive literature has been devoted to analyzing the asymmetric information problem raised by Rothschild and Stiglitz (1976) to test if there is a positive relation between insurance coverage and risk. Among the assumptions required under their framework, homogeneity in all dimensions is the fundamental one. However, risk aversion, although well acknowledged to be unobservable, is an important factor influencing the results of their model. For example, Smart (2000) and Snow (2009) provide theoretical proof to show that when risk aversion is taken into account, the traditional argument of the positive relation between risk and coverage might not exist. Therefore, the empirical models without a risk aversion factor are not robust.

In practice, the measurement of risk aversion, provided by Arrow (1970) and Pratt (1964), requires individual wealth data for calculation, but this information is sometimes difficult to obtain. In the empirical research associated with insurance markets, there are two common approaches to measure risk aversion. One is a risky behavior questionnaire. Using risky behavior as proxies of risk aversion, the relationships between risk aversion and risk occurrence or insurance coverage are tested. The other approach, as used by Dreze (1981), Cohen and Einav (2007), and Saito (2006), uses deductibles to make inferences about risk aversion. However, both approaches require sophisticated procedures or simplified assumptions.

In two seminal works, Puelz and Snow (1994) and Dionne et al. (2001) use liability insurance as a proxy variable of wealth, representing risk aversion to test asymmetric information. Since liability insurance is usually sold together with other automobile insurance as a bundle, the data is readily available and easily applied.

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While feasible, the hypothesis of whether automobile liability insurance purchases can signal risk attitude has not been formally tested. The purpose of this study is to examine if liability insurance contains information of risk aversion and if it is correlated with insurance risk. We focus on the relationship between comprehensive vehicle physical damage insurance (VDI) and voluntary third-party liability insurance (VLI) in the Taiwanese automobile insurance market.

2. Data and Empirical Approach

Our data from the Taiwan Insurance Institute is individual-level information that consists of VDI and VLI policies sold by all Taiwanese nonlife insurers in 2003. Our sample includes 212,481 VDI policies.

Table 1. Descriptive Statistics of Vehicle Claim Variables

	Vehicle coverage level		
Variable	High vehicle coverage	Low vehicle coverage	t-statistic for difference
With vehicle claim	0.54 (0.50)	0.48 (0.50)	21.65
Vehicle claim payment	15.14 (31.22)	13.86 (34.54)	6.91
Vehicle claim count	0.76 (0.86)	0.59 (0.70)	43.17
Observations	170,964 (80.46%)	41,517 (19.54%)	
	Liability insurance status		
Variable	With liability insurance policy	Without liability insurance policy	t-statistic for difference
With vehicle claim	0.53 (0.50)	0.51 (0.50)	4.16
Vehicle claim payment	14.85 (31.74)	15.58 (34.74)	–2.29
Vehicle claim count	0.73 (0.83)	0.71 (0.85)	1.51
Observations	201,644 (94.90%)	10,837 (5.10%)	
	Liability coverage level		
Variable	High liability coverage	Low liability coverage	t-statistic for difference
With vehicle claim	0.55 (0.50)	0.53 (0.50)	6.76
Vehicle claim payment	16.43 (37.39)	14.39 (29.83)	12.17
Vehicle claim count	0.74 (0.85)	0.72 (0.83)	5.39
Observations	46,278 (21.78%)	155,366 (77.05%)	

Notes: Standard deviations are in parentheses. The unit of vehicle claim payment is NTD 1,000.

Table 1 provides descriptive statistics. We focus on the correlations of both vehicle coverage and liability coverage on vehicle risk. For VDI policies, we define those with a deductible as low coverage and those without a deductible as high coverage. To correct for the problem of inconsistency in coverage and claims, we subtract the deductible from those claims without a deductible. Our sample shows that policyholders with high VDI have higher vehicle risk than those with low VDI, which is consistent with the positive coverage-risk correlation. For the risk aversion role of liability coverage, we also show vehicle risk differences between policyholders who purchase VLI policies and those who do not. Since the average VLI coverage per person is NTD 1.92 million, and around 32% of policies are concentrated around NTD 2 million (not shown), we define high liability coverage as a covered amount over NTD 2 million. Policyholders with high liability coverage have higher vehicle risk than those with low liability coverage. This is not consistent with the hypothesis that liability coverage is a proxy of risk aversion. However, these results are preliminary. Further study is needed to control for additional information associated with the characteristics of both policyholders and vehicles.

To investigate whether VLI coverage is an appropriate proxy of risk aversion for VDI, we employ the Heckman model to estimate the correlation between vehicle risk and liability coverage. There is potential endogeneity in purchasing both types of policies, and the Heckman model can correct the problem of selection bias. Therefore, we first specify a selection function for purchasing liability coverage status, estimating parameters by a probit model to compute the inverse Mills ratio for correcting endogeneity bias. The model can be written as:

$$\text{Prob}(\text{With liability coverage}_i = 1) = \Phi(Z_i\gamma)\,, \tag{1}$$

where "$\text{With liability coverage}_i$" is a binary variable that equals 1 if individual i purchases VDI with VLI and 0 otherwise, Z_i is a vector of control variables that includes demographic characteristics of the policyholder (age, gender, and marital status) and characteristics of the vehicle (car age, car model, and exhaust class), γ is a vector of parameters, and Φ is the standard normal cumulative distribution.

The inverse Mills ratio is included in the claim behavior model and the following equation is estimated:

$$\begin{aligned} Y_i = \delta_1 X_i + \delta_2 \text{High vehicle coverage}_i + \delta_3 \text{With liability coverage}_i \\ + \delta_4 \text{Liability amount}_i + \delta_5 \lambda_i + \varepsilon_i\,, \end{aligned} \tag{2}$$

where X_i is a vector of control variables, "$\text{High vehicle coverage}_i$" is a dummy variable that equals 1 if individual i purchases a VDI policy without deductible and 0 otherwise, "$\text{Liability amount}_i$" is the covered amount of VLI policy, λ_i is the inverse Mills ratio, and ε_i is an error term. We employ three response variables (Y_i): "With vehicle claim" (i.e., at least one claim is filed), "Vehicle claim payment," and "Vehicle claim count."

3. Empirical Results

Table 2 shows the estimated results of VDI and VLI on vehicle risk. Models 1 and 2 examine the coverage-risk correlation without including the inverse Mills ratio. To correct selection bias, Models 3–5 explore the suitability of VLI coverage as a measure of risk aversion. The significant coefficient of λ shows the presence of endogeneity bias for both types of policies.

Table 2. Estimated Results of Vehicle Coverage and Liability Coverage on Vehicle Risk

	Model 1	Model 2	Model 3	Model 4	Model 5
Panel A: Response variable is whether at least one vehicle physical damage claim is filed					
High vehicle coverage	0.095***	0.095***	0.095***	0.095***	0.095***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
With liability coverage		0.071***	–0.867***	–0.871***	–0.832***
		(0.013)	(0.214)	(0.214)	(0.215)
Liability amount				–0.002	–0.017**
				(0.003)	(0.006)
Liability amount ×High liability coverage					0.012***
					(0.005)
λ			0.438***	0.441***	0.433***
			(0.100)	(0.100)	(0.100)
Observations	212,481	212,481	212,481	212,481	212,481
Panel B: Response variable is vehicle claim payment					
High vehicle coverage	5.371***	5.372***	5.372**	5.315***	5.338***
	(0.333)	(0.333)	(0.333)	(0.333)	(0.333)
With liability coverage		0.926*	–18.296**	–17.366*	–15.185*
		(0.548)	(8.858)	(8.863)	(8.886)
Liability amount				0.369***	–0.435*
				(0.118)	(0.262)
Liability amount ×High liability coverage					0.643***
					(0.187)
λ			8.978**	8.212**	7.721*
			(4.130)	(4.138)	(4.140)
Observations	212,481	212,481	212,481	212,481	212,481
Panel C: Response variable is vehicle claim count					
High vehicle coverage	0.189***	0.189***	0.189***	0.190***	0.191***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
With liability coverage		0.060***	–0.711***	–0.727***	–0.677***
		(0.014)	(0.233)	(0.233)	(0.233)
Liability amount				–0.006**	–0.025***
				(0.003)	(0.007)
Liability amount ×High liability coverage					0.015***
					(0.005)
λ			0.361***	0.373***	0.362***
			(0.108)	(0.109)	(0.109)
Observations	212,481	212,481	212,481	212,481	212,481

Notes: Standard errors are in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The results are estimated by probit in Panel A and tobit in Panels B and C. The liability amount is in NTD 1 million.

Model 1 is one of the standard tests of asymmetric information on automobile insurance. We obtain consistent results—positive coverage-risk correlation—for three measures of vehicle risk conditional on all information used by insurers for risk classification, which displays the presence of asymmetric information. Reliable results are shown for other models when we correct for selection bias.

We investigate the effect of VLI coverage on vehicle risk by observing whether policyholders concurrently purchase VDI and VLI. In Panel A, Model 2 shows that policyholders with VLI coverage have higher vehicle risk without considering endogeneity bias; however, a negative correlation is shown in Model 3 when the endogeneity bias is corrected. Panels B and C have robust findings. This is consistent with the effect of risk aversion.

Model 4 in Panel A shows that policyholders who purchase more VLI coverage have a lower tendency to file a vehicle claim; however, this is not statistically significant. When vehicle risk is measured by claim count, the effect of the liability amount in Panel C is significantly negative. However, in Panel B, vehicle claim payment and the liability amount are significantly and positively correlated. These estimated results are mixed in Model 4. We therefore further identify whether the effect of the liability amount changes under different extents of liability coverage.

We separate samples into two groups based on VLI amount. The dummy variable, "High liability coverage," equals 1 if an individual purchases VLI with an amount greater than 2 million and 0 otherwise. Using the interaction term between "Liability amount" and "High liability coverage," Model 5 in Panel A shows a significantly negative correlation between the liability amount and the possibility of filing a vehicle claim when the liability amount is equal to or less than NTD 2 million. Due to the positive effect of the interaction term, the negative correlation is offset when the liability amount is greater than NTD 2 million.[1] However, we find a significantly negative correlation in Panel C for two extents of liability coverage.[2] Dependent on three risk measure variables, there are consistently negative correlations under low liability coverage. As policyholders purchase relatively low liability coverage, the covered liability amount seems to be appropriate to measure risk aversion in the Taiwanese automobile insurance market. Those policyholders who purchase high liability coverage have fewer small vehicle claims but higher claim payments. They might actually be high risk, and thus the risk aversion hypothesis cannot be applied.

4. Conclusions

Based on the empirical results, we find that the role of voluntary third-party liability insurance in automobile insurance can be presented in various dimensions. In terms of purchasing or not purchasing VLI, the former contains risk aversion information. However, when the amount of VLI is considered, a higher VLI amount may not be able to provide a positive signal of risk aversion.

Notes

1. The coefficient associated with "Liability amount" when the covered liability amount is greater than NTD 2 million is $-0.017 + 0.012 = -0.005$ with a standard error of 0.003.
2. The coefficient associated with "Liability amount" when the covered liability amount is greater than NTD 2 million is $-0.025 + 0.015 = -0.010$ with a standard error of 0.003.

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