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Who Obtains Greater Discounts on Automobile Insurance Premiums?

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Insurance purchasers obtain varied discounts for insurance. This paper examines what drives these differences, specifically whether the loss probability and the wealth of the insured affect the size of the premium discount in automobile insurance. To describe a bargain between a client and an insurer over premiums and coverage, we first develop a sequential insurance bargaining game where the client has an outside option to bargain with another insurer. We find that the equilibrium involves full coverage and, based on the results of comparative statics, we propose hypotheses regarding the effects of the loss probability and the wealth of the insured on the size of the premium discount. We then use a unique data set of 85,806 observations of Taiwanese automobile liability insurance for property damage to empirically test the predictions. After controlling for underwriting and macroeconomic variables, we find that both (1) the insured with a lower claim probability (as a proxy for the insured with a lower loss probability) and (2) the insured with a higher salvage value car (as a proxy for the wealthier insured) receive a greater premium discount. These results support our theoretical results.
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Introduction

Although the factors that determine automobile insurance premiums are thoroughly studied in the literature on automobile insurance pricing,[1] the reasons that buyers receive differential discounts of premiums[2] have received less attention. For example, it is general practice for insurance premiums paid by high-risk drivers to be higher. However, it is less obvious whether such drivers should receive a smaller discount. Note that previous studies on insurance pricing have focused on the final price that a policyholder pays. In this paper, we extend this line of the literature but investigate the premium discount.

The premium discount is commonly determined by bargaining. The economics literature has explored several factors that determine the outcome of bargaining, such as an individual's risk aversion,[3] bargaining power,[4] risk level and wealth. However, few papers provide empirical support for the effects of the above factors on premium discounts because of bargaining.

This paper focuses on investigating the effects of the loss probability and the wealth of an insured on the size of the premium discount.[5] Specifically, we examine whether the loss probability and the wealth of an insured are associated with the size of the premium discount. We first develop a sequential insurance bargaining game structured as in Rubinstein[6,7] to characterise the bargaining between a client and an insurer over premiums and coverage. To consider the competitiveness of the insurance market, the client in our insurance bargaining game has the option to bargain with another insurer if he/she rejects an insurer's offer, as in the game with an outside option of Osborne and Rubinstein,[8] Muthoo[9]

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[1] The literature has revealed that drivers' characteristics (such as age, gender and marital status), driving record, and territory are factors that commonly affect automobile insurance premiums (e.g. Chang and Fairley, 1979; Peck and Kuan, 1983; Dahlby and West, 1986; Kelly and Nielson, 2006).

[2] In this paper, a premium discount refers to the difference between the initial price that an insurer offers and the final price that a policyholder pays.

[3] For example, Kihlstrom and Roth (1982); Schlesinger (1984); Viaene *et al.* (2002); Volij and Winter (2002).

[4] For example, Yavas and Yang (1995); Arnold (1999); Harding *et al.* (2003); Casterella *et al.* (2004); Colwell and Munneke (2006); Quiggin and Chambers (2009).

[5] Although there may be proxies for the risk aversion and bargaining power of an insured to test their effects, adequate proxies for the two factors are not available in our data set. Although we have variables that may be related to the risk aversion and bargaining power of an insured, possibly confounding effects could not be isolated to obtain their pure effects. Thus, we employ variables such as *insurance* to indicate the purchase of more insurance to partially control for the effects of the risk aversion and bargaining power of an insured.

[6] Rubinstein (1982).

[7] Please also refer to Osborne and Rubinstein (1990) and White (2008).

[8] Osborne and Rubinstein (1990).

[9] Muthoo (1995).

and Gantner.[10] We find an equilibrium that includes full coverage, the same as the findings in the literature in the absence of an outside option.[11] From the results of comparative statics, we develop two hypotheses: (1) an insured with a higher loss probability is expected to receive less of a premium discount and (2) a wealthier insured is expected to receive a greater premium discount.

A unique data set based on Taiwanese automobile liability insurance for property damage (ALIPD) is used to examine the theoretical results. The data is hand-collected from a large insurance company and covers policies issued from 2005 to 2007. The special feature of the data set is that it contains both the premiums that the insurance company initially offered and the premiums that policyholders finally paid. We choose ALIPD for several reasons. First, no deductibles exist in automobile liability insurance[12] and we can therefore avoid the confounding effects resulting from different deductibles. Second, we specifically employ the data on ALIPD rather than on bodily injury, because coverage for bodily injury is much more complicated than for property damage.[13] We use relatively homogeneous data in our analysis. After further selection, the sample comprises 85,806 observations.

To compare the relative size of the premium discount received by different insureds, we use the premium discount ratio instead of the absolute amount of the premium discount. The premium discount ratio (DoP) is defined as follows:

$$DoP = 1 - \frac{P_f}{P_0}, \tag{1}$$

where P_f denotes the premium that a policyholder finally pays and P_0 denotes the premium that an insurance company initially offers.[14]

We employ the claim probability estimated by a standard probit regression as a measure of the insured's loss probability. Since we cannot directly observe the wealth of the insured from the data, the salvage value of the insured car is used as a proxy of the insured's wealth. Cars with higher salvage values are usually cars with higher selling prices, generally purchased by wealthier clients.

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[10] Gantner (2008).

[11] For example, Kihlstrom and Roth (1982); Huang *et al.* (2013).

[12] The regulators in Taiwan do not allow any deductibles in automobile liability insurance. We therefore have no intention of claiming that the lack of deductibles in automobile liability insurance supports our theoretical prediction that equilibrium involves full coverage.

[13] Coverage for bodily injury provides an indemnity per person or per accident, while coverage for property damage provides an indemnity only per accident.

[14] According to our consultation with an executive at the insurance company that provided our study data, the profit margin on the initial price offered by the insurer is equal for all policies within the same line. In other words, in our sample, the insurer does not strategically offer a greater premium discount for policies with higher profit margins. The size of the premium discount is determined by the bargain reached between the insurer and the insured.

Two steps are performed to test the hypotheses. We first estimate the insured's claim probability and then examine the hypotheses. We control whether the policy is a new policy or an existing policy that was renewed and factors such as the purchase of multiple types of insurance. We also control all underwriting variables such as gender, marital status, age, residential region, engine displacement, car age, whether the car is imported and claim records. In addition, the effect of recession on the premium discount ratio is further controlled, since macroeconomic factors could influence both the insured's willingness to buy insurance and an insurer's willingness to sell it.

Our theoretical results are supported by empirical evidence.[15] Insureds with higher claim probabilities are found to obtain significantly lower premium discount ratios, which supports the hypothesis regarding the loss probability. Furthermore, insureds with cars of higher salvage values are found to obtain significantly higher premium discount ratios, which is consistent with the hypothesis regarding the insured's wealth.

This paper serves as a complement to the literature on insurance bargaining. First, we provide a theoretical model for insurance bargaining with an outside option and find a full-coverage equilibrium, identical to the result in the absence of an outside option found by Kihlstrom and Roth[16] and Huang *et al.*[17] Second, on the basis of the theoretical model, we show the relations between the loss probability/wealth of the insured and the premium discount. Furthermore, we use the insurance data to empirically test our theoretical results and find supportive evidence.

The rest of the paper is organised as follows. The section "An insurance bargaining game and hypotheses" develops an insurance bargaining game and associated hypotheses. The section "Data and methodology" describes our data and methodology. The section "Empirical findings and robustness check" discusses the empirical findings and conducts a robustness check. Finally, the section "Conclusions" concludes the paper and the Appendices show the proofs.

An insurance bargaining game and hypotheses

An insurance bargaining game

To describe the bargaining between a client and an insurer over premiums and coverage, we develop a sequential insurance bargaining game, following Rubinstein.[6] Furthermore, considering the competitiveness of the insurance market, our bargaining game is structured as a game with an outside option, as in Osborne and Rubinstein,[8]Muthoo[9] and Gantner.[10] In other words, once the insurer's offer is

[15] Our results are generally robust when considering different measures of past claim records and policies with different coverage amounts.
[16] Kihlstrom and Roth (1982).
[17] Huang *et al.* (2013).

rejected, the client can either make an alternate offer to the insurer or bargain with another insurer. The settings are as follows.

Suppose that a risk-averse client with wealth ω_C and a utility function u has a potential loss L. The loss L occurs with probability π or does not occur with probability $1-\pi$ and can occur only once. The client would like to buy insurance to transfer his/her risk.

Suppose that there are two risk-neutral insurers in the market, Insurer A and Insurer B, both endowed with identical equity ω_I. On the other hand, the premiums and coverage offered by the two insurers, (P_A, Q_A) and (P_B, Q_B), respectively, are endogenously determined.

The client and the insurer (Insurer A or Insurer B) determine premiums and coverage through sequential bargaining. We assume that Insurer A makes the first move, that is, first makes an offer to the client. If the client rejects Insurer A's offer, the client can continue bargaining with Insurer A by making a counter-offer or find Insurer B to begin another bargaining game, where Insurer B has the first move. Once the client chooses to bargain with Insurer B, he/she can never go back to bargaining with Insurer A.[18] Furthermore, for simplicity, there is no time discounting on expected utility across periods.[19] All the information is objective and perfect. Figure 1 illustrates the insurance bargaining game.

In Period 1, Insurer A makes an offer to the client where the client pays premium P_{1A} for coverage Q_{1A}. If the client accepts Insurer A's offer, he/she receives expected utility $EU^C_{1A} = (1-\pi)u(\omega_C - P_{1A}) + \pi u(\omega_C - P_{1A} - L + Q_{1A})$ and Insurer A receives expected utility $EU^I_{1A} = \omega_I + P_{1A} - \pi Q_{1A}$. If the client rejects the offer, the state of nature is realised. The client is without insurance and the probability of the client incurring a loss is π and the probability of the client incurring no loss is $1-\pi$. If the loss occurs, Insurer A maintains the initial equity ω_I and the client suffers the loss and therefore receives utility $u(\omega_C - L)$. If the loss does not occur, the bargaining game proceeds to the next bargaining round, Period 2.

In Period 2, the client can continue bargaining with Insurer A by making a counter-offer of premium P_{2A} for coverage Q_{2A} or find Insurer B to start another bargaining game, where Insurer B offers coverage Q_{2B} for premium P_{2B}. Once the client chooses to bargain with Insurer B, he/she cannot return to bargain with Insurer A.

To sum up, the state of nature is immediately realised after any of the players either accepts or rejects an offer. For the bargaining round, which starts with the offer made by the insurer (Insurer A or Insurer B), if the client accepts the offer, the game is over after the state of nature is realised. Since an insurance contract is agreed upon, the expected utility of each player can be computed. The insurer (Insurer A or Insurer B)

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[18] We adopt this assumption because of Muthoo's (1995) finding, which shows that the equilibrium outcome in the sequential bargaining game does not depend on whether the client can return to the original bargaining table.

[19] We suppose that actions in the same bargaining round occur in the same period. Therefore, in this bargaining game, a period is also referred to as a bargaining round.

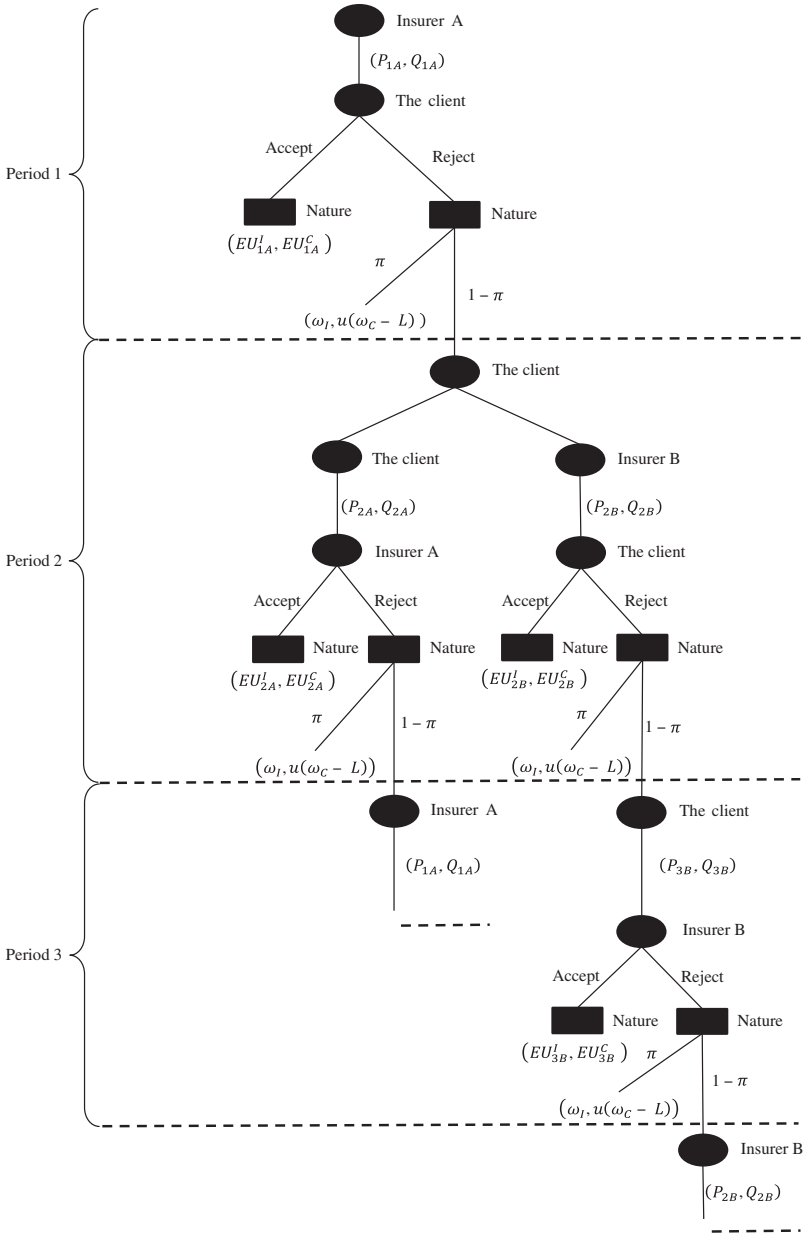

Figure 1. An insurance bargaining game.

receives expected utility $EU^I_{xy} = \omega_I + P_{xy} - \pi Q_{xy}$ and the client receives expected utility $EU^C_{xy} = (1-\pi)u(\omega_C - P_{xy}) + \pi u(\omega_C - P_{xy} - L + Q_{xy})$, where the subscript x denotes Period 1, Period 2 or Period 3 and the subscript y denotes Insurer A or Insurer B. If the client rejects the insurer's (Insurer A or Insurer B) offer, the game is over when the loss occurs and, since no insurance contract is agreed upon, the insurer (Insurer A or Insurer B) maintains the initial equity ω_I and the client receives $u(\omega_C - L)$. On the other hand, if the loss does not occur after the client rejects the offer, the game proceeds to the next period (the next bargaining round), where it is the client's turn to make an offer to the insurer. A similar sequence of play occurs in the bargaining round that starts with the offer made by the client. As long as a loss does not occur after an offer is rejected, the game is not over until there is an agreement between the insurer and the client.

Following Osborne and Rubinstein,[8] we obtain a unique subgame perfect equilibrium where the client accepts Insurer A's offer (P^*_{1A}, Q^*_{1A}) in Period 1, as follows.

Proposition 1: For an insurance bargaining game depicted in Figure 1, the client and Insurer A reach an agreement on (P^*_{1A}, Q^*_{1A}) in Period 1, as follows:

(1) *If* $P_{2A}(P_{1A}) \leqslant P_{2B}$, *where* $P_{2A} = \pi^2 L + (1-\pi)P_{1A}$, *then* $Q^*_{1A} = L$ *and* P^*_{1A} *satisfies* $u(\omega_C - P^*_{1A}) = \pi u(\omega_C - L) + (1-\pi)u(\omega_C - \pi^2 L - (1-\pi)P^*_{1A})$.

(2) *If* $P_{2A}(P_{1A}) > P_{2B}$, *where* $P_{2A} = \pi^2 L + (1-\pi)P_{1A}$, *then* $Q^*_{1A} = L$ *and* P^*_{1A} *satisfies* $u(\omega_C - P^*_{1A}) = \pi u(\omega_C - L) + (1-\pi)u(\omega_C - P_{2B})$ *in which* P_{2B} *satisfies* $u(\omega_C - P_{2B}) = \pi u(\omega_C - L) + (1-\pi)u(\omega_C - \pi^2 L - (1-\pi)P_{2B})$.

Proof Please see Appendix A.

In the insurance bargaining game, delaying the agreement exposes the client to the risk of the loss occurring when he/she has no insurance coverage. As a result, the risk-averse client has an incentive to reach an agreement with an insurer as soon as possible, which, along with the first offer made by Insurer A, explains the intuition of the equilibrium reached in Period 1.

Since Insurer A is assumed to be risk neutral, the equilibrium being at full coverage is not surprising. Proposition 1 shows that full coverage is the equilibrium, even when an outside option is considered. This finding complements the results in the absence of an outside option, as shown by Kihlstrom and Roth[16] and Huang *et al.*[17]

Regarding the premium in equilibrium, the condition that solves it depends on the relative size of the premium proposed by the client to Insurer A ($P_{2A}(P_{1A})$) and the premium proposed by Insurer B to the client (P_{2B}), because the equilibrium is solved by backward induction. If $P_{2A}(P_{1A}) \leqslant P_{2B}$, since the premium proposed by Insurer B is higher, the client will choose to continue bargaining with Insurer A after rejecting Insurer A's offer. Thus, as in finding (1) in Proposition 1, the condition solving the premium in equilibrium P_{1A} is irrelevant to P_{2B}. In other words, in this case, the premium in equilibrium is identical to that without an outside option.

On the contrary, if $P_{2A}(P_{1A}) > P_{2B}$, the condition that solves the premium in equilibrium P_{1A} depends on P_{2B}. Since the premium proposed by Insurer B is lower,

the client will choose to bargain with Insurer B after rejecting Insurer A's offer. Hence, in equilibrium, Insurer A has to offer P_{1A}^{*}, which makes the client's expected utility for the acceptance of Insurer A's offer, $u(\omega_C - P_{1A}^{*})$, indifferent to the expected utility for the rejection of Insurer A's offer, $\pi u(\omega_C - L)+(1-\pi)u(\omega_C - P_{2B})$, as shown in finding (2) in Proposition 1.

Under full coverage, we can obtain the comparative statics of the client's loss probability π and wealth ω_C for the premium in equilibrium P_{1A}^{*}. The following proposition shows the results.

Proposition 2:

(1) When the client has a higher loss probability, the premium in equilibrium is higher.
(2) When the client becomes wealthier, the premium in equilibrium is lower if and only if $u'(\omega_C - P_{1A}) \leqslant \pi u'(\omega_C - L)+(1-\pi)u'(\omega_C - P_{2A}(P_{1A}))$.

Proof Please see Appendix B.

When the client has a higher risk (higher loss probability), he/she is willing to pay a higher premium to transfer the risk, since he/she is more likely to face the worst situation, in which the loss occurs when there is no insurance coverage, after rejecting Insurer A's offer. On the other hand, Insurer A, who is risk neutral, knows the client's aversion to the higher loss probability and will accordingly propose a higher premium. Therefore, the client with a higher loss probability pays a higher premium, as shown by finding (1) in Proposition 2.

For comparative statics of the client's wealth for the premium in equilibrium, finding (2) in Proposition 2 shows that the wealthier client pays a lower premium if and only if the higher wealth results in an increase in expected utility from accepting Insurer A's offer that is smaller than the increase in expected utility from rejecting Insurer A's offer.

Further exploring the intuition of finding (2) in Proposition 2, we find that $P_{1A} - P_{2A}(P_{1A}) \leqslant \pi(L - P_{2A}(P_{1A}))$ implies that $u'(\omega_C - P_{1A}) \leqslant \pi u'(\omega_C - L)+(1-\pi)u'(\omega_C - P_{2A}(P_{1A}))$ for all $u'>0$, $u''<0$, and $u'''>0$. If we set $v = -u'<0$, then $u'(\omega_C - P_{1A}) \leqslant \pi u'(\omega_C - L)+(1-\pi)u'(\omega_C - P_{2A}(P_{1A}))$ could be rewritten as $v(\omega_C - P_{1A}) \geqslant \pi v(\omega_C - L)+(1-\pi)v(\omega_C - P_{2A}(P_{1A}))$.

To show that $P_{1A} - P_{2A}(P_{1A}) \leqslant \pi(L - P_{2A}(P_{1A}))$ implies that $v(\omega_C - P_{1A}) \geqslant \pi v(\omega_C - L)+(1-\pi)v(\omega_C - P_{2A}(P_{1A}))$ for all $v'>0$ and $v''<0$; suppose that there are two payoff distributions, $F(x)$ and $G(x)$, as follows. Under distribution F, one can obtain $\omega_C - P_{1A}$ with a probability of one. Under distribution G, one can obtain $\omega_C - L$ with a probability π and can obtain $\omega_C - P_{2A}(P_{1A})$ with a probability $1-\pi$. From Figure 2, we find that when $P_{1A} - P_{2A}(P_{1A}) \leqslant \pi(L - P_{2A}(P_{1A}))$, $F^{(2)}(x) \leqslant G^{(2)}(x)$ for all x, where $F^{(2)}(x) = \int_{\underline{x}}^{x} F(t)\,\mathrm{d}t$, $G^{(2)}(x) = \int_{\underline{x}}^{x} G(t)\,\mathrm{d}t$, and $\underline{x}$ is the lower bound of the payoff x.[20]

[20] Note that we show the case in which $P_{1A} - P_{2A}(P_{1A}) < \pi(L - P_{2A}(P_{1A}))$ but omit the case in which $P_{1A} - P_{2A}(P_{1A}) = \pi(L - P_{2A}(P_{1A}))$ in Figure 2. Our finding is robust to the case in which $P_{1A} - P_{2A}(P_{1A}) = \pi(L - P_{2A}(P_{1A}))$.

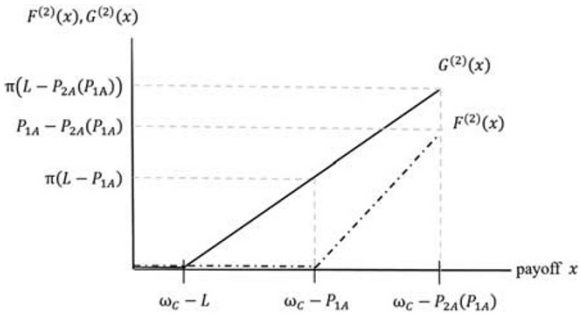

Figure 2. $F^{(2)}(x) \leqslant G^{(2)}(x)$ for all x if $P_{1A} - P_{2A}(P_{1A}) < \pi(L - P_{2A}(P_{1A}))$, where $F^{(2)}(x) = \int_{\underline{x}}^{x} F(t)\,\mathrm{d}t$, $G^{(2)}(x) = \int_{\underline{x}}^{x} G(t)\,\mathrm{d}t$, and $\underline{x}$ denotes the lower bound of x.

Thus, F second-order stochastically dominates G. Since $v = -u'$, $v' > 0$ and $v'' < 0$ are the same as $u'' < 0$ and $u''' > 0$. Accordingly, when $P_{1A} - P_{2A}(P_{1A}) \leqslant \pi(L - P_{2A}(P_{1A}))$, we have $u'(\omega_C - P_{1A}) \leqslant \pi u'(\omega_C - L) + (1-\pi)u'(\omega_C - P_{2A}(P_{1A}))$ for all $u' > 0$, $u'' < 0$, and $u''' > 0$.

Furthermore, we would like to demonstrate that the sufficient condition $P_{1A} - P_{2A}(P_{1A}) \leqslant \pi(L - P_{2A}(P_{1A}))$ could be observed in most practices. Assuming that $P_{1A} = (1+\lambda)\pi L$, where λ is the premium loading factor, the sufficient condition $P_{1A} - P_{2A}(P_{1A}) \leqslant \pi(L - P_{2A}(P_{1A}))$ can be written as $\lambda \leqslant ((1-\pi))/(1-(1-\pi)^2)$, since $P_{2A} = \pi^2 L + (1-\pi)P_{1A}$. We assert that the sufficient condition $\lambda \leqslant (1-\pi)/(1-(1-\pi)^2)$ holds for most cases in reality. Take an extreme case, where the loss probability π is 0.5, for example. λ should be equal to or less than 0.67. As the loss probability decreases, the threshold for λ increases, which means that the sufficient condition $\lambda \leqslant (1-\pi)/(1-(1-\pi)^2)$ is satisfied more easily. In most cases, the loss probability is rather low and usually, in pricing practice, the premium loading might not exceed 0.5.

We summarise the above discussions on the intuition of finding (2) in Proposition 2 as the following corollary:

Corollary 1: If $P_{1A} = (1+\lambda)\pi L$ and $\lambda \leqslant (1-\pi)/(1-(1-\pi)^2)$, then $u'(\omega_C - P_{1A}) \leqslant \pi u'(\omega_C - L) + (1-\pi)u'(\omega_C - P_{2A}(P_{1A}))$ for all $u' > 0$, $u'' < 0$, and $u''' > 0$.

Hypotheses

The hypothesis related to the effect of the insured's wealth on the premium discount ratio can be directly derived from finding (2) in Proposition 2. The initial premium offered by the insurer is often set by the actuarial department and is naturally believed to be uncorrelated to the insured's wealth. On the basis of finding (2) in Proposition 2, the final premium paid by the wealthier insured is lower. Accordingly, the premium discount ratio is expected to be higher for the wealthier insured.

On the other hand, according to finding (1) in Proposition 2, we could just claim that if we observe a lower premium discount ratio for the insured with a high loss

probability, then the result is that the final premium paid by the insured with a high loss probability is higher. In fact, we employ a sufficient condition of comparative statics for the loss probability in finding (1) of Proposition 2 as our empirical hypothesis. Note that the initial premiums set by the actuarial department should be higher for high loss probability insureds. If the final premiums the high loss probability insureds pay are lower, then the premium discount ratios they obtain would be higher, a hypothesis we intend to reject in our empirical testing. Accordingly, Hypothesis 1 (listed below) is a more restrictive sufficient condition for finding (1) in Proposition 2. It is reasonable to say that the inability to reject Hypothesis 1 leaves us with a conclusion consistent with finding (1) in Proposition 2.

We employ a probit regression model to estimate a claim probability for each insured and treat it as a proxy for the loss probability of the insured. Note that the probability of filing a claim may be lower than the probability of loss occurrence, since more sophisticated policyholders may not file a claim in certain cases (i.e. bear the expense out of their own pockets), knowing that filing claims can lead to an increased premium in the future.[21] To capture the effect of the insured's wealth on the premium discount ratio, we use the salvage value of the insured car as its proxy. Cars with higher salvage values are usually those with higher selling prices and are generally bought by the wealthier insured. Accordingly, the hypotheses are as follows.

Hypothesis 1: The insured with a higher claim probability receives a smaller premium discount ratio than the insured with a lower claim probability.

Hypothesis 2: [22] The insured who has a car with a higher salvage value receives a higher premium discount ratio than the insured who has a car with a lower salvage value.

Data and methodology

Data

This paper employs the data of ALIPD in Taiwan to test the hypotheses. ALIPD provides an insured with protection against damage caused by the vehicle to other people's property. The data was provided by a leading property and casualty insurance company in Taiwan and covers all policies from 2005 to 2007.

The information contained in the data is composed of four elements. The first concerns the characteristics of the insured: gender, marital status, age and living region. The second has to do with the characteristics of the insured car: its price,

[21] We are grateful to an anonymous referee for mentioning this point.
[22] We thank the anonymous referee very much for proposing this hypothesis regarding wealth.

the residual rate, engine displacement, whether the car is imported or domestic, and its age. The third element concerns the insurance contract, including the policy number, issue date, whether the insured has other types of insurance coverage besides ALIPD, the premiums initially offered by the insurance company, and the premiums finally paid by the policyholders. The last element is based on claim records. By connecting the 12-digit policy number with the claim data, we can verify the claim information for each policy. On the basis of this internal data, the salvage value of a car when it is insured can be calculated and the insured risk can be estimated. More importantly, we are thus able to calculate the premium discount ratio for each policy.

We conduct the following procedure to obtain the final sample. First, only policies issued by direct writers are included. Second, corporations are excluded from the insureds. Next, we select policies with an insurance coverage of NT$500,000[23] for the analysis. Finally, the claim data is extended to 2010 to ensure that each claim was completely settled, with no losses that had been reported but had not yet been settled. The final sample consists of 85,806 observations.

The sample produced above was considered adequate for accurate results. For one thing, policies issued by direct writers have the advantage of avoiding the confounding effects of different marketing channels on the premium discount ratios. Non-direct writers, such as auto dealer insurance agents, often mix the discount on auto sales with the discount on insurance premiums. Thus, focusing on policies issued by direct writers can alleviate this problem. In addition, selecting policies with a coverage of NT$500,000 generates the largest sample size. Doing so eliminates the possibility of the premium discount ratios varying with the coverage amount, since all the policies in the sample have the identical coverage amount.

Measurement of variables

To test the hypotheses, we first estimate the claim probability for each policy (the proxy of the loss probability of the insured) and then, by controlling for underwriting variables, we examine the effects of the estimated claim probability and the salvage value of the insured car (the proxy of the wealth of the insured) on the premium discount ratio. All the variables and their definitions are listed in Table 1.

An insured's loss probability can be measured in terms of a claim probability. In the first step, estimating risks, the dependent variable is *claim*, which is a dummy variable indicating whether the insured filed a claim during the policy year. As for the independent variables, a variable *car salvage value* used as a proxy for the wealth of

[23] We also select policies with a coverage of NT$200,000 for a robustness check. The results are shown in Panels A and B of Table 5.

Table 1 Definitions of variables

Variable	*Definition*	*Step 1*	*Step 2*
Dependent variable			
Claim	1 if the insured filed a claim during the policy year; 0 otherwise.	V	
Premium discount ratio	1-(premium that the policyholder finally pays/ premium that the insurance company initially offers).		V
Independent variable			
Estimated claim probability	Estimated claim probability obtained by Eq. (2).		V
Car salvage value (per $100,000)	The salvage value of a vehicle when it is insured = the price of the car×the residual rate.	V	V
New policy	1 if the insured does not have an existing policy with the insurance company when buying insurance.	V	V
Insurance	1 if the insured purchases any of the following types of insurance besides ALIPD: Type A/B auto comprehensive insurance, auto collision insurance, auto theft insurance and auto liability insurance for bodily injury; 0 otherwise	V	V
Male	1 if the insured is male; 0 otherwise.	V	V
Marriage	1 if the insured is married; 0 otherwise.	V	V
Insured age 30	1 if the insured is less than 30 years old; 0 otherwise.	V	V
Insured age 30_50	1 if the insured is between 30 and 50 years old; 0 otherwise.	V	V
Insured age 50_70	1 if the insured is between 50 and 70 years old; 0 otherwise.	V	V
(Insured who are more than 70 years old are the reference group.)			
North	1 if the insured lives in the northern part of Taiwan; 0 otherwise.		V
Midland	1 if the insured lives in the central part of Taiwan; 0 otherwise.		V
South	1 if the insured lives in the southern part of Taiwan; 0 otherwise.		V
(Insured living in the eastern part of Taiwan are the reference group.)			
City	1 if the insured lives in Taipei City, New Taipei City, Taichung City or Kaohsiung City; 0 otherwise.		V
Past claim coefficient	An interval variable takes a value between −3 and +15. For no claim in the past policy year, the insured has a *past claim coefficient* value of −1, which represents a 10 per cent reduction in premium. For each claim filed during the past 3 policy years, the insured faced a 30 per cent increase in premium, denoted by a *past claim coefficient* value of +3.	V	
Car age 1	1 if the insured vehicle is less than 1 year old; 0 otherwise.		V

Table 1: (*Continued*)

Variable	*Definition*	*Step 1*	*Step 2*
Car age 1_5	1 if the insured vehicle is between 1 and 5 years old; 0 otherwise.		V
(Insured vehicles that are older than 5 years are the reference group.)			
Displacement 1,800	1 if the displacement of the insured vehicle is less than 1,800 cc; 0 otherwise.	V	V
Displacement 1,800_2,400	1 if the displacement of the insured vehicle is between 1,800 cc and 2,400 cc; 0 otherwise.	V	V
Displacement 2,400_3,000	1 if the displacement of the insured vehicle is between 2,400 cc and 3,000 cc; 0 otherwise.	V	V
(Insured vehicles with displacement greater than 3,000 cc are the reference group.)			
Import	1 if the insured vehicle is imported; 0 otherwise.	V	V
Recession	1 if the monthly monitoring indicator compiled by the Council for Economic Planning and Development is yellow-blue or blue[a]; 0 otherwise.		V
Year 2005	1 if the policy was issued in 2005; 0 otherwise.	V	V
Year 2006	1 if the policy was issued in 2006; 0 otherwise.	V	V
(Policies issued in 2007 are the reference group.)			

[a]The monthly monitoring indicators yellow-blue and blue indicate a transitional economy and a sluggish economy, respectively.

the insured is computed by multiplying the price of the insured car by its residual rate. To control for the effect of whether the policy is new or a renewed, a dummy variable *new policy* that equals 1 for new policies is used. Throughout the paper, new policies refer to the insurance contracts of the insured who did not have a previous policy with the insurance company we examine.

In addition, the dummy variable *insurance* is used to denote multiple types of insurance coverage (more coverage). Because all the policies in the sample have the identical coverage amount, more coverage here means multiple types of coverage, defined as an insured with any of the following types of insurance in addition to ALIPD: Type A/B auto comprehensive insurance,[24] auto collision insurance, auto theft insurance and auto liability insurance for bodily injury. To consider the impact of claim records, we include the variable, *past claim coefficient*[25] which is an interval variable whose value reflects the premium discount allowed when there was no claim (denoted by a negative value) and the

[24] Type B auto comprehensive insurance provides indemnities for losses resulting from fire, floods, lightning, dropped objects and collision, whereas Type A auto comprehensive insurance not only includes the coverage of Type B insurance but also provides indemnities for intentional damage by a third party.

premium surcharge for any claims (denoted by a positive value) during the past three policy years under the bonus-malus system.[26] The insured with a higher *past claim coefficient* value indicates more claims filed during the past three policy years. We also include demographic variables and insured vehicle variables as independent variables. Furthermore, year dummy variables are included to control for year effects.

In the next step, testing the hypotheses, we define the dependent variable *premium discount ratio* as one minus the premium that the policyholder finally pays divided by the premium that the insurance company initially offers (as shown in Eq. (1) in Introduction). The main independent variables are the estimated claim probability obtained by the previous step and proxy for wealth, that is, the variable *car salvage value*. In addition to demographic variables, vehicle variables and year dummy variables, the business cycle variable *recession* is included to indicate whether a policy was issued when the economy was passing through a recession.

Models

A claim probability is first estimated for each policy. The relation between the variable *claim* and the independent variables is modelled by a probit regression, as follows:

$$Prob(C_i = 1|X_i) = \Phi(X_i'\beta), \tag{2}$$

where subscript i denotes the ith policy, C_i is a dummy variable indicating whether the insured filed a claim during the policy year, Φ is the cumulative distribution function of the standard normal distribution, X_i represents a vector of the independent variables related to pricing, and β is a vector of regression coefficients for X_i. The vector of estimated coefficients $\hat{\beta}$ obtained from Eq. (2) is used to compute the estimated claim probability of each policy.

Subsequently, we examine the relations between the loss probability/wealth of the insured and the premium discount ratios by using the following Tobit regression

[25] Our results generally hold when past claim records are represented by a dummy variable equal to 1 if the insured has past claim records.

[26] Under the bonus-malus system of Taiwanese ALIPD, *past claim coefficient* can take a value between −3 and +15. For example, an insured with no claim records during the past policy year has a *past claim coefficient* value of −1, which represents a 10 per cent reduction in premium. On the other hand, for each claim filed during the past 3 policy years, there is a 30 per cent increase in premium denoted by a *past claim coefficient* value of +3.

model[27]:

$$DoP_i = \begin{cases} DoP_i^* & \text{if } DoP_i^* > 0, \\ 0 & \text{if } DoP_i^* \leq 0, \end{cases} \tag{3}$$

$$DoP_i^* = Y_i\alpha + Z_i\gamma + e_i,$$

where subscript i denotes the ith policy; DoP_i is the premium discount ratio; DoP_i^* is a latent variable of the premium discount ratio; Y_i is a vector of the key independent variables, including the claim probability estimated by Eq. (2), $Prob(\hat{C}_i = 1 \mid X_i)$, and the proxy of wealth, *car salvage value;* Z_i is a vector of control variables; e_i is the random error term with a normal distribution with zero mean and variance σ^2; and α and γ are the vectors of the coefficients for Y_i and Z_i, respectively.

Empirical findings and robustness check

This section presents our empirical results (the section 'Empirical findings') and a robustness check (the section 'Robustness check'). We first show the characteristics of the sample. Subsequently, we show the results of estimating the claim probability and the analysis of the premium discount ratios. Furthermore, as a robustness check, we use the data on policies with a coverage of NT$200,000 to reexamine our hypotheses. All the results are displayed in Tables 2-5.

Empirical findings

The summary statistics of all the variables are shown in Table 2, which reports the characteristics of our sample.[28] In Table 2, for the sample with the coverage of NT $500,000, on average, 4 per cent of the insured filed a claim during the policy year. A policyholder in our sample can obtain a 13 per cent discount, on average, and a 35 per cent discount at most on the premium. Furthermore, we find that each insured car has a mean salvage value of NT$356,810 and a maximum salvage value of NT$6,645,200. Furthermore, Table 2 suggests that 14 per cent of the sample are new policies.

Next, we estimate the insured's claim probability. The results are shown in Panel A of Table 3. First, the insured with a car of high salvage value is shown to have a significantly higher claim probability. Second, the results for the variable *new policy* reveal that new policies have significantly higher claim probabilities than renewed policies. On the one

[27] A Tobit regression model is employed to examine the hypotheses because a certain percentage of policies have zero premium discount ratios.

[28] We also examine a whole sample containing policyholders with not only ALIPD but also other types of insurance coverage (auto comprehensive insurance, auto collision insurance, auto theft insurance or auto liability insurance for bodily injury). The summary statistics of the premium discount ratios in the whole sample are found to be almost the same as those in the ALIPD sample.

Table 2 Summary Statistics of Variables for Coverage of NT$500,000

Variable	*Mean*	*Std. deviation*	*Median*	*Min*	*Max*
Claim	0.0438	0.2045	0	0	1
Premium discount ratio	0.1303	0.0884	0.1499	0	0.3470
Estimated claim probability	0.0438	0.0201	0.0414	0.0126	0.2929
Car salvage value (per $100,000)	3.5681	3.4798	2.8566	0.0187	66.4520
New policy	0.1428	0.3499	0	0	1
Insurance	0.5536	0.4971	1	0	1
Male	0.4102	0.4919	0	0	1
Marriage	0.9215	0.2690	1	0	1
Insured age 30	0.0507	0.2194	0	0	1
Insured age 30_50	0.6675	0.4711	1	0	1
Insured age 50_70	0.2715	0.4447	0	0	1
North	0.4001	0.4899	0	0	1
Midland	0.2471	0.4313	0	0	1
South	0.3243	0.4681	0	0	1
City	0.5124	0.4998	0	0	1
Past claim coefficient	−2.2826	1.3002	−3	−3	15
Car age 1	0.0682	0.2521	0	0	1
Car age 1_5	0.4051	0.4909	0	0	1
Displacement 1,800	0.4699	0.4991	0	0	1
Displacement 1,800_2,400	0.4151	0.4927	0	0	1
Displacement 2,400_3,000	0.0807	0.2723	0	0	1
Import	0.3268	0.4690	0	0	1
Recession	0.8528	0.3543	1	0	1
Year 2005	0.2804	0.4492	0	0	1
Year 2006	0.3393	0.4735	0	0	1
Sample size			85,806		

hand, a new policy may mean that this is the first time the owner has bought a car and is unfamiliar with driving one, which leads to a higher claim probability. On the other hand, new policies can also mean that the insureds switched from another insurer. They could therefore have high loss probabilities. The insureds with higher loss probabilities are charged extra premiums if they renew their policies with their previous insurer. Therefore, they might switch to another insurer to obtain a better deal.

Third, the variable *insurance* is significantly positive, which means an insured with more coverage has a significantly higher claim probability. This result might be related to the positive relation between coverage and risk resulting from asymmetric information.[29] Furthermore, an insured with a higher *past claim coefficient* value is found to have a significantly higher claim probability, which is reasonable.

[29] For example, Rothschild and Stiglitz (1976); Puelz and Snow (1994); Finkelstein and Poterba (2004); Cohen (2005).

Table 3 Results of claim and premium discount ratios for coverage of NT$500,000

	Panel A		*Panel B*	
	Dependent variable Claim		*Dependent variable* Premium discount ratio	
	Coefficient	*P-value*	*Coefficient*	*P-value*
Intercept	−1.9830	0.0000***	0.0067	0.1649
Estimated claim probability			−0.1429	0.0000***
Car salvage value (per $100,000)	0.0104	0.0001***	0.0010	0.0000***
New policy	0.1219	0.0000***	0.0004	0.7576
Insurance	0.0869	0.0000***	0.1195	0.000***
Male	−0.0377	0.0190**	−0.0001	0.8400
Marriage	−0.0283	0.3292	−0.0028	0.0307**
Insured age 30	0.1442	0.1072	0.0174	0.0000***
Insured age 30_50	0.0716	0.3935	0.0177	0.0000***
Insured age 50_70	0.0684	0.4190	0.0105	0.0024***
North			0.0123	0.0000***
Midland			0.0090	0.0000***
South			0.0139	0.0000***
City			0.0208	0.0000***
Past claim coefficient	0.0637	0.0000***		
Car age 1			0.0138	0.0000***
Car age 1_5			−0.0022	0.0154**
Displacement 1,800	0.0580	0.2442	0.0197	0.0000***
Displacement 1,800_2,400	0.0688	0.1485	0.0156	0.0000***
Displacement 2,400_3,000	0.0595	0.2374	0.0052	0.0229**
Import	−0.0013	0.9437	0.0013	0.1108
Recession			−0.0028	0.0091***
Year 2005	0.3207	0.0000***	−0.0098	0.0000***
Year 2006	0.2870	0.0000***	−0.0038	0.0010***
Sample size			85,806	

The dependent variables are *claim* and *premium discount ratio* in Panels A and B, respectively. The superscripts *, ** and *** denote statistical significance at the 0.10, 0.05, 0.01 levels, respectively.

We now turn to the main empirical results, that is, whether a higher loss probability and greater wealth of the insured are associated with a higher premium discount ratio. The results are presented in Panel B of Table 3.

After controlling for underwriting and macroeconomic variables, we find evidence supporting the hypotheses. In particular, the coefficient of the estimated claim probability is significantly negative at the 0.01 level, which indicates that, on average, an insured with a higher claim probability receives a significantly smaller premium discount ratio, which is consistent with Hypothesis 1 and also provides evidence of the relation between the loss probability and the premium discount. On

Table 4 Summary statistics of variables for coverage of NT$200,000

Variable	*Mean*	*Std. deviation*	*Median*	*Min*	*Max*
Claim	0.0343	0.1821	0	0	1
Premium discount ratio	0.1227	0.0861	0.1497	0	0.3469
Estimated claim probability	0.0343	0.0151	0.0344	0.0096	0.2504
Car salvage value (per $100,000)	1.8202	1.8700	1.3015	0.2120	38.9300
New policy	0.0982	0.2975	0	0	1
Insurance	0.4363	0.4959	0	0	1
Male	0.4888	0.4999	0	0	1
Marriage	0.9011	0.2985	1	0	1
Insured age 30	0.0603	0.2380	0	0	1
Insured age 30_50	0.6696	0.4704	1	0	1
Insured age 50_70	0.2523	0.4343	0	0	1
North	0.4527	0.4978	0	0	1
Midland	0.2155	0.4112	0	0	1
South	0.2642	0.4409	0	0	1
City	0.4580	0.4982	0	0	1
Past claim coefficient	−2.3339	1.2700	−3	−3	14
Car age 1	0.0219	0.1463	0	0	1
Car age 1_5	0.2288	0.4201	0	0	1
Displacement 1,800	0.6452	0.4785	1	0	1
Displacement 1,800_2,400	0.3105	0.4627	0	0	1
Displacement 2,400_3,000	0.0358	0.1858	0	0	1
Import	0.2119	0.4087	0	0	1
Recession	0.8919	0.3105	1	0	1
Year 2005	0.3396	0.4736	0	0	1
Year 2006	0.3161	0.4650	0	0	1
Sample size			43,386		

the other hand, regarding the effect of the insured's wealth on the premium discount ratio, we find that, on average, an insured with a car of a higher salvage value obtains a significantly higher premium discount ratio, which supports Hypothesis 2.

Regarding the other variables, we find that policyholders of new policies obtain higher but not significant premium discount ratios than those of renewed policies. Our results seem to indicate that the effect of whether the policy is new or renewed on the premium discount might be channelled through the loss probability (claim probability) *per se*. New policyholders are shown to have higher loss probabilities, as demonstrated in Panel A of Table 3, and the premium discounts received by high loss probability types are smaller, as pointed out earlier. Hence, the influence of whether the policy is new or renewed on the premium discounts could be partially offset by the influence of the loss probability on the premium discount.

In addition, the estimated coefficient of the variable *insurance* is found to be significantly positive, which indicates that, on average, the insured buying more

Table 5 Results of claim and premium discount ratios for coverage of NT$200,000

	Panel A		*Panel B*	
	Dependent variable claim		*Dependent variable* premium discount ratio	
	Coefficient	*P-value*	*Coefficient*	*P-value*
Intercept	−1.9769	0.0000***	0.0331	0.0000***
Estimated claim probability			−0.1670	0.0057***
Car salvage value (per $100,000)	0.0100	0.1388	0.0019	0.0000***
New policy	0.0617	0.0983*	0.0029	0.1479
Insurance	0.0769	0.0017***	0.0947	0.0000***
Male	−0.0268	0.2643	−0.0083	0.0000***
Marriage	−0.0342	0.3969	−0.0080	0.0000***
Insured age 30	−0.0864	0.3827	−0.0078	0.0680*
Insured age 30_50	−0.1154	0.1940	−0.0034	0.3694
Insured age 50_70	−0.0627	0.4890	−0.0094	0.0151**
North			0.0212	0.0000***
Midland			0.0200	0.0000***
South			0.0311	0.0000***
City			0.0226	0.0000***
Past claim coefficient	0.0649	0.0000***		
Car age 1			0.0177	0.0000***
Car age 1_5			0.0048	0.0042***
Displacement 1,800	0.1262	0.3795	0.0279	0.0000***
Displacement 1,800_2,400	0.1887	0.1856	0.0253	0.0000***
Displacement 2,400_3,000	0.0952	0.5324	0.0244	0.0001***
Import	0.0053	0.8584	0.0002	0.8884
Recession			0.0017	0.3401
Year 2005	0.3237	0.0000***	−0.0235	0.0000***
Year 2006	0.3241	0.0000***	−0.0095	0.0000***
Sample size			43,386	

The dependent variables are *claim* and *premium discount ratio* in Panels A and B, respectively. The superscripts *, ** and *** denote statistical significance at the 0.10, 0.05, 0.01 levels, respectively.

insurance coverage receives a greater premium discount. One possible reason for this result is the so-called bundle effect. When policyholders buy multiple types of coverage from one insurer, which resembles buying an insurance coverage set, the insurer obtains more business and the premium discounts for all the coverage can be jointly determined by a bargain. Therefore, the insurer is willing to offer a greater premium discount to such policyholders.

Robustness check

In this section, as a robustness check, we employ the data of policies with a coverage of NT$200,000 to test our hypotheses. The results are shown in Tables 4 and 5.

We first look at the summary statistics of the sample with a coverage of NT $200,000 presented in Table 4. Almost all figures are lower, compared with those in

the sample with a coverage of NT$500,000. For example, fewer consumers buy a coverage of NT$200,000 (43,386 observations). The mean claim probability is 3 per cent, slightly lower than that of the sample with a coverage of NT$500,000. On average, each policyholder receives a smaller discount (12 per cent), but the maximum discount ratio is almost the same. For the salvage value of an insured car, both the mean and the maximum values are also lower (NT$182,020 and NT $3,893,000, respectively). Finally, we find that the proportion of new policies is much lower (10 per cent).

The results are generally robust to the different coverage amount. The signs and significance of the estimates of the claim probability (Panel A in Table 5) are consistent with those for the NT$500,000 coverage, except for the variable *car salvage value*, which becomes insignificant. For the main results shown in Panel B of Table 5, we find that the estimated coefficient of the claim probability is significantly negative, as predicted by Hypothesis 1. Furthermore, the estimated coefficient of the variable *car salvage value* is found to be significantly positive, which also supports Hypothesis 2. For the other variables, such as *insurance*, both the signs and significance are the same as for the coverage of NT$500,000.

It should be noted that better-educated policyholders can have superior negotiating skills, which can affect the size of the premium discount. However, because of the data limitations, the education level of the insured is not controlled for in our empirical studies. As known from the literature,[30] an individual's education level is somehow positively correlated to his/her wealth. Therefore, the estimator of the car salvage value (as a proxy for the wealth of the insured) could be at least partially confounded by the effect of education.[31] Further research to test the effect of education separately could be fruitful.

Conclusions

This paper examines whether the loss probability and the wealth of an insured are determinant factors of discounts on insurance premiums. We first develop a sequential insurance bargaining model with an outside option and formulate hypotheses based on the results of comparative statics. A unique data set of the Taiwanese ALIPD market is then used to test the hypotheses. We find significant evidence supporting our hypotheses that both the insureds with lower claim probabilities (as a proxy for low loss probability insureds) and the insureds whose cars have higher salvage values (as a proxy for wealthier insureds) obtain significantly greater premium discounts.

[30] For example, Hartog and Oosterbeek(1998); Mondragón-Vélez (2009); Diaz-Giménez *et al.* (2011).
[31] We thank the anonymous referee for pointing out the effect of education.

It should be noted that this paper provides a preliminary but not comprehensive study of the factors that determine the size of the premium discounts. Beyond the loss probability and the wealth of the insured, other factors, such as the risk aversion and bargaining power of the insured, could affect the premium discount. Future studies could be extended to empirically examine these effects.

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Appendix A

Proof of Proposition 1

Assume that all the second-order conditions (SOCs) hold. A unique subgame perfect equilibrium is obtained by backward induction as follows.

Part 1. Bargain between the client and Insurer B

In Period 3, the client makes an offer (P_{3B}, Q_{3B}) that maximises the expected utility from insurance but makes Insurer B indifferent to acceptance or rejection:

$$\max_{P_{3B},Q_{3B}} EU_{3B}^{C} = (1-\pi)u(\omega_C - P_{3B}) + \pi u(\omega_C - P_{3B} - L + Q_{3B}) \tag{A.1}$$

$$s.t. \quad P_{3B} = \pi Q_{3B} + (1-\pi)P_{2B} - \pi(1-\pi)Q_{2B}. \tag{A.2}$$

When $Q_{3B} = L$, we find that $(\partial EU_{3B}^{C}/\partial Q_{3B})\big|_{Q_{3B}=L} = 0$. Since the SOC holds, $Q_{3B} = L$ and $P_{3B} = \pi L + (1-\pi)P_{2B} - \pi(1-\pi)Q_{2B}$.

In Period 2, given the client's response in Period 3, Insurer B makes an offer (P_{2B}, Q_{2B}) that maximises his/her expected utility but makes the client indifferent to

acceptance or rejection:

$$\max_{P_{2B},Q_{2B}} EU_{2B}^{I} = \omega_I + P_{2B} - \pi Q_{2B} \tag{A.3}$$

$$\begin{aligned} s.t. \quad EU_{2B}^{C} =& (1-\pi)u(\omega_C - P_{2B}) + \pi u(\omega_C - P_{2B} - L + Q_{2B}) \\ =& \pi u(\omega_C - L) + (1-\pi)u(\omega_C - P_{3B}(P_{2B}, Q_{2B})). \end{aligned} \tag{A.4}$$

Assuming a Lagrange function $£ = \omega_I + P_{2B} - \pi Q_{2B} - \lambda[(1-\pi)u(\omega_C - P_{2B}) + \pi u(\omega_C - P_{2B} - L + Q_{2B}) - \pi u(\omega_C - L) - (1-\pi)u(\omega_C - P_{3B}(P_{2B}, Q_{2B}))]$ and rearranging $((\partial £)/(\partial P_{2B}))/((\partial £)/(\partial Q_{2B}))$ yields

$$\frac{-(1-\pi)u'(\omega_C - P_{2B}) - \pi u'(\omega_C - P_{2B} - L + Q_{2B}) + (1-\pi)^2 u'(\omega_C - P_{3B}(P_{2B}, Q_{2B}))}{-u'(\omega_C - P_{2B} - L + Q_{2B}) + (1-\pi)^2 u'(\omega_C - P_{3B}(P_{2B}, Q_{2B}))} = 1. \tag{A.5}$$

If $Q_{2B} = L$, then the left-hand side of Eq. (A.5) is one. Since the SOC holds, $Q_{2B} = L$.

Moreover, evaluating for $Q_{2B} = L$ yields $P_{3B} = \pi^2 L + (1-\pi)P_{2B}$ and P_{2B} which satisfies $u(\omega_C - P_{2B}) = \pi u(\omega_C - L) + (1-\pi)u(\omega_C - \pi^2 L - (1-\pi)P_{2B})$.

Part 2. Bargain between the client and Insurer A

In Period 2, the client makes an offer (P_{2A}, Q_{2A}) that maximises his/her expected utility from insurance but makes Insurer A indifferent to acceptance or rejection:

$$\max_{P_{2A},Q_{2A}} EU_{2A}^{C} = (1-\pi)u(\omega_C - P_{2A}) + \pi u(\omega_C - P_{2A} - L + Q_{2A}) \tag{A.6}$$

$$s.t. \quad P_{2A} = \pi Q_{2A} + (1-\pi)P_{1A} - \pi(1-\pi)Q_{1A}. \tag{A.7}$$

By an argument similar to that in Part 1, we find that $Q_{2A} = L$ and $P_{2A} = \pi L + (1-\pi)P_{1A} - \pi(1-\pi)Q_{1A}$.

In Period 1, given the client's response in Period 2, Insurer A proposes (P_{1A}, Q_{1A}), which maximises the expected utility from insurance but makes the client indifferent to acceptance or rejection:

$$\max_{P_{1A},Q_{1A}} EU_{1A}^{I} = \omega_I + P_{1A} - \pi Q_{1A} \tag{A.8}$$

$$\begin{aligned} s.t. \quad EU_{1A}^{C} =& (1-\pi)u(\omega_C - P_{1A}) + \pi u(\omega_C - P_{1A} - L + Q_{1A}) \\ =& \pi u(\omega_C - L) + (1-\pi)[\max(EU_{2A}^{C}, EU_{2B}^{C})]. \end{aligned} \tag{A.9}$$

From the above results, because $Q_{2A}=Q_{2B}=L$, $EU_{2A}^{C}=u(\omega_C-P_{2A}(P_{1A},Q_{1A})$ and $EU_{2B}^{C}=u(\omega_C-P_{2B})$, whether the client continues bargaining with Insurer A after rejecting the offer depends on the relative sizes of EU_{2A}^{C} and EU_{2B}^{C}.

If $EU_{2A}^{C}\geqslant EU_{2B}^{C}$, this implies that $P_{2A}(P_{1A},Q_{1A})\leqslant P_{2B}$ and the client chooses to continue bargaining with Insurer A. Thus, Constraint (A.9) becomes $EU_{1A}^{C}=(1-\pi)u(\omega_C-P_{1A})+\pi u(\omega_C-P_{1A}-L+Q_{1A})=\pi u(\omega_C-L)+(1-\pi)EU_{2A}^{C}$. By the same argument as in Part 1, we find that, in equilibrium, $Q_{1A}^{*}=L$ and P_{1A}^{*} should satisfy $u(\omega_C-P_{1A}^{*})=\pi u(\omega_C-L)+(1-\pi)u(\omega_C-\pi^2L-(1-\pi)P_{1A}^{*})$. On the other hand, if $EU_{2A}^{C}<EU_{2B}^{C}$, which means $P_{2A}(P_{1A},Q_{1A})>P_{2B}$, then the client chooses to find Insurer B to begin another bargain. Constraint (A.9) becomes $EU_{1A}^{C}=(1-\pi)u(\omega_C-P_{1A})+\pi u(\omega_C-P_{1A}-L+Q_{1A})=\pi u(\omega_C-L)+(1-\pi)EU_{2B}^{C}$ and, in equilibrium, $Q_{1A}^{*}=L$ and P_{1A}^{*} should satisfy $u(\omega_C-P_{1A}^{*})=\pi u(\omega_C-L)+(1-\pi)u(\omega_C-P_{2B}^{*})$, where P_{2B} satisfies $u(\omega_C-P_{2B})=\pi u(\omega_C-L)+(1-\pi)u(\omega_C-\pi^2L-(1-\pi)P_{2B})$. Q.E.D.

Appendix B

Proof of Proposition 2

In equilibrium, $Q_{1A}^{*}=L$ in all cases but P_{1A}^{*} satisfies different conditions under different relationships between $P_{2A}(P_{1A})$ and P_{2B}. In the following, we only show the comparative statics when $P_{2A}(P_{1A})\leqslant P_{2B}$. One can employ a similar argument to derive the results when $P_{2A}(P_{1A})>P_{2B}$.

Let $\Gamma=u(\omega_C-P_{1A})-\pi u(\omega_C-L)-(1-\pi)u(\omega_C-P_{2A}(P_{1A}))$, where $P_{2A}=\pi^2L+(1-\pi)P_{1A}$. We know that

$$\frac{\partial P_{1A}}{\partial \omega_C}=-\frac{\frac{\partial\Gamma}{\partial\omega_C}}{\frac{\partial\Gamma}{\partial P_{1A}}}$$
$$=-\frac{u'(\omega_C-P_{1A})-\pi u'(\omega_C-L)-(1-\pi)u'(\omega_C-P_{2A}(P_{1A}))}{-u'(\omega_C-P_{1A})+(1-\pi)^2u'(\omega_C-P_{2A}(P_{1A}))}.$$

Since a risk-neutral insurer will not offer an equilibrium premium lower than the actuarially fair price, $(P_{2A}(P_{1A}))/(L)-(P_{1A})/(L)=\pi[\pi-(P_{1A})/(L)]\leqslant 0$. Thus, $P_{2A}(P_{1A})\leqslant P_{1A}$, which implies that $(\partial\Gamma)/(\partial P_{1A})<0$ when $u''<0$. The sign of $(\partial P_{1A})/(\partial\omega_C)$ is determined by the sign of $(\partial\Gamma)/(\partial\omega_C)$. Therefore, $\partial P_{1A}^{*}/\partial\omega_C\leqslant 0$ if and only if $u'(\omega_C-P_{1A})\leqslant\pi u'(\omega_C-L)+(1-\pi)u'(\omega_C-P_{2A}(P_{1A}))$.

On the other hand, we know that

$$\frac{\partial P_{1A}}{\partial \pi}=-\frac{\frac{\partial\Gamma}{\partial\pi}}{\frac{\partial\Gamma}{\partial P_{1A}}}=-\frac{-u(\omega_C-L)+u(\omega_C-P_{2A}(P_{1A}))}{-u'(\omega_C-P_{1A})+(1-\pi)^2u'(\omega_C-P_{2A}(P_{1A}))}.$$

Because $L>P_{2A}(P_{1A})$, $(\partial\Gamma)/(\partial\pi)>0$. In addition, because $P_{2A}(P_{1A})\leqslant P_{1A}$, $(\partial\Gamma)/(\partial P_{1A})<0$. Consequently, $(\partial P_{1A})/(\partial\pi)>0$. Q.E.D.

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