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An Empirical Analysis of the Effects of Increasing Deductibles on Moral Hazard

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Abstract

Using information on timing and number of claims in a unique data set pertaining to comprehensive automobile insurance with the increasing deductible provision in Taiwan, the authors provide new evidence for moral hazard. Time-varying correlations between the choice of the insurance coverage and claim occurrence are significantly positive and exhibit a smirk pattern across policy months. This empirical finding supports the existence of asymmetric information. A subsample estimation depicts insured drivers' significant responses to increasing deductibles, which implies the existence of moral hazard. According to the probit regression results, the increasing deductible makes policyholders who have ever filed claims less likely to file additional claims later in the policy year. The empirical findings strongly support the notion that the increasing deductible provision helps control moral hazard.

Introduction

Rothschild and Stiglitz (1976) and Shavell (1979) pioneered work on adverse selection and moral hazard for insurance and inspired many theoretical studies[1] during the past three decades. The theoretical literature has identified many insightful mechanisms for understanding and controlling adverse selection and moral hazard in the insurance market, and more recent papers[2] have conducted empirical analyses

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[1] See, for example, Miyazaki (1977), Wilson (1977), Dionne (1983), Rubinstein and Yarri (1983), Crocker and Snow (1986), Cooper and Hayes (1987), Arnott and Stiglitz (1988), Hoy (1989), Ligon and Thistle (1996), and Doherty and Richter (2002).

[2] See, for example, Dahlby (1983), Browne (1992), Browne and Doerpinghaus (1993), Dionne and Doherty (1994), Puelz and Snow (1994), Butler (1996), Chiappori and Salanié (1997, 2000), Butler, Gardner, and Gardner (1998), Dionne and Gagne (2002), Finkelstein and Poterba (2004), Gray and Selden (2002), Villeneuve (2003), and Saito (2006).

to investigate whether adverse selection and moral hazard exist in the insurance market.

However, empirical evidence in the insurance literature has not yet provided a consensus regarding whether asymmetric information exists. Some research, such as that by Puelz and Snow (1994), Dionne and Gagne (2002), Fong (2002), and Finkelstein and Poterba (2004), finds evidence to support the existence of asymmetric information in the insurance market, whereas other research, such as Dionne, Gouriéroux, and Vanasse (2001), Cawley and Philipson (1999), and Chiappori and Salanié (2000), uncovers no such evidence.

To determine whether insurance markets have asymmetric information problems, most researchers test the correlation between the choice of insurance coverage and claim occurrence. Correlation tests were simultaneously suggested by Chiappori and Salanié (with a nonparametric approach, 2000) as well as Dionne, Gouriéroux, and Vanasse (with a parametric approach, 2001). The literature has been most interested in two types of asymmetric information: adverse selection and moral hazard. If the adverse selection problem exists in the insurance market as described by Rothschild and Stiglitz (1976), then the market could settle at a separating equilibrium in which the high risk purchase higher coverage whereas the low risk purchase lower coverage. Thus, the higher is the loss probability, the higher coverage the insured tend to buy. On the other hand, if the moral hazard problem does exist in the insurance market as shown by Shavell (1979), then the individual with higher coverage may have less incentive to avoid the occurrence of the risk. Therefore, the loss probability of the individual with higher coverage could be higher than that of the individual with lower coverage. Since both moral hazard and adverse selection predict the occurrence of the risk and the coverage of the insurance are positive correlated, a positive correlation implies adverse selection, moral hazard, or both.

Exploring the existence of asymmetric information in insurance markets is important, but it is at least as important to distinguish between adverse selection and moral hazard because the literature has developed alternative mechanisms to solve the adverse selection and moral hazard problems. In this regard, we note that Dionne and Gagne (2002) find that a replacement cost endorsement in an automobile insurance policy increases the probability of theft near the end of the protection. They interpret this result as an *ex post* moral hazard or opportunistic fraud after ruling out *ex ante* moral hazard and adverse selection. Finkelstein and Poterba (2004) use annuity data to distinguish moral hazard and adverse selection and argue that moral hazard is unlikely to play an important role in the annuity market. Their empirical evidence supports the presence of adverse selection. Chiappori and Salanié (2000) also suggest that dynamic data may help distinguish between moral hazard and adverse selection. In turn, Abbring, Chiappori, and Pinquet (2003) use dynamic data and employ experience ratings to test for the existence of moral hazard, but their empirical results do not support its existence.

This article uses a unique data set to reexamine whether asymmetric information exists in the automobile insurance market and further investigate whether moral hazard contributes to such asymmetric information. In Taiwan, the increasing deductible provision creates data on comprehensive automobile coverage insurance that provide an unusual opportunity to verify the existence of moral hazard empirically. According to the increasing deductible provision, each subsequent claim within a single policy period faces a higher deductible. Therefore, the incentive to be careful gets stronger later in the policy period for those who have filed any claims.

Li and Liu (2003) find that when multiple claims are possible in a policy period and moral hazard does not exist, a decreasing deductible constitutes the optimal contract. Li, Liu, and Yeh (2007) nevertheless show that an increasing deductible may become necessary in a real world with moral hazard. They also use comprehensive automobile coverage insurance in Taiwan and find that the deductible helps control moral hazard. However, their study focuses on the effect of a deductible rather than an increasing deductible. In contrast, we directly examine whether an increasing deductible provision can help control moral hazard.

We first try to confirm the existence of asymmetric information in the market by testing whether the conditional correlation between the choice of insurance coverage and the occurrence of claims is significantly positive. We adopt Chiappori and Salanié's (2000) methodology as a benchmark for comparison. Contrary to Chiappori and Salanié's findings, our results support asymmetric information in Taiwan's comprehensive automobile insurance market. In particular, we observe that the time-varying conditional correlations between the choice of insurance coverage and claim occurrence are significantly positive and exhibit a smirk pattern.[3]

We also go a step further to analyze the effects of an increasing deductible provision (i.e., the deductible automatically increases for each additional claim) on asymmetric information. If moral hazard exists, we expect that the conditional correlation between the choice of insurance coverage and claim occurrence declines as the number of claims increases. We therefore measure the conditional correlation between the choice of insurance coverage and claim occurrence for a sequence of progressively smaller subsamples with more claims and study the pattern in the resulting correlation estimates. The idea behind this approach is in essence similar to that proposed by Abbring, Chiappori, and Pinquet (2003), who use the experience rating system to separate adverse selection from moral hazard. Adverse selection is more tightly controlled in our analysis because we use data in one policy year, whereas Abbring, Chiappori, and Pinquet (2003) use data from adjacent years. Because the insured cannot change their type of the coverage within a policy year but can alter their behavior, increasing deductibles during a single policy year seem to be a more accurate design than experience rating across years to separate moral hazard from adverse selection.

Through subsample estimation, we find evidence in support of the insured drivers' responses to increasing deductibles, from which we infer the existence of moral hazard. It is important to understand that in each subsample, the insured do not switch their choice of coverage, which means we control for the possible effect of adverse selection. Thus, any reduction in the conditional correlation can be explained only by moral hazard due to the increasing deductible provision.

[3] In the graphs of the conditional correlations over different policy months, we observe that the conditional correlations remain at about the same level in the first three quarters and dramatically increase near the end of the policy year, just like a smirk pattern.

To investigate whether the increasing deductible provision helps control moral hazard further, we test whether policyholders with an increasing deductible (types A and B) who filed claims in prior months are less likely to file another claim in subsequent months of the policy year, by comparing them with policyholders who do not face a higher deductible later in the policy year (type C) who also filed claims. Thus, an increase in deductible may provide a stronger incentive for drivers to drive more carefully. In other words, drivers who filed claims should be less likely to file another claim later in the policy year. We therefore predict that type A and B policyholders should be less likely to file another claim later in the policy year than those of type C if they all have filed claims earlier; our empirical results support this prediction.

Our empirical analysis provides strong and robust evidence in support of the hypothesis that the increasing deductible provision helps control moral hazard. Because policyholders who filed claims in the early period of the policy year cannot change their type of policy after filing a claim, the impact of the increasing deductible, if any, can only be explained by moral hazard, not adverse selection. Furthermore, because the increasing deductible provision helps control the moral hazard problem, the same empirical evidence further supports our finding of moral hazard in the market.

AUTOMOBILE INSURANCE IN TAIWAN

Most previous studies use data from developed countries such as the United States, Canada, or France. Even though asymmetric information problems in the insurance market may exist, they gradually disappear in well-developed markets because insurance companies usually accumulate data and develop powerful underwriting systems to eliminate the asymmetric information problem. Therefore, if asymmetric information problems exist, they are more likely to be found in emerging markets such as Taiwan, for which we have a fairly good data set.

Approximately 5.6 million car owners purchase automobile insurance from 25 insurance companies in Taiwan, and automobile insurance accounted for about 45 percent of insurance premium volumes for property liability insurance companies in 2003. In that year, the annual premiums for automobile insurance were approximately \$1.6 billion, and the incurred loss was \$0.98 billion. Three types of automobile insurance appear in the market: compulsory liability, supplementary liability, and comprehensive coverage for damage. Unlike most research[4] that uses automobile liability insurance to study the asymmetric information issue, we use comprehensive coverage for damage here.

Comprehensive coverage, which is purchased voluntarily in Taiwan, provides coverage for property damage to the driver's automobile. In 2003, the total premiums for comprehensive coverage insurance were approximately \$0.37 billion, and incurred losses were about \$0.23 billion. Car owners can choose from among three types of

[4] See, for example, Dahlby (1983), D'Arcy and Doherty (1991), Dionne and Doherty (1994), Chiappori and Salanié (1996, 2000), among others.

comprehensive coverage: type A covers all risks,[5] type B covers selected risks,[6] and type C only covers damage in a collision involving two or more vehicles.[7] Only type A coverage was offered before 1995. To deal with the asymmetric information problem, insurance companies started in 1995 to offer type B coverage, which excludes losses whose causes are hard to determine. In response to the increasing loss ratios, type C coverage was introduced in 1999. These three types of comprehensive coverage in Taiwan provide a unique opportunity to study whether asymmetric information exists in the island's insurance market.

Consumers can choose different deductible levels for their comprehensive coverage. The most popular type of deductibles for A and B coverage is an increasing deductible system in which the deductible is, respectively, $85, $140, and $200 for the first, second, and third or more claims. The premiums for these increasing deductible systems account for almost 95 percent of total written premiums. Type C coverage does not have any deductible provision. The increasing deductible system makes it possible to use policy-monthly data and the number of the claims to distinguish adverse selection from moral hazard because the system helps control moral hazard but is much less likely to influence adverse selection. We provide more details about how we exploit this idea in the next section.

We compile data on comprehensive automobile coverage from one property/casualty insurance company that enjoys a large market share in Taiwan. To avoid inconsistencies in the data, we use data from the year 2000; recall that type C coverage was first introduced to the market in 1999. For each observed comprehensive policyholder, we have access to records for both coverage choice and whether any indemnity has been claimed in the previous or current year. The data set also includes information about gender, age, age of car, type of car, residence area, distribution channel, and so forth.

As suggested by Chiappori and Salanié (2000), we only use data pertaining to new cars, less than two years of age (i.e., car age equals one or two years). Claims are defined only for those with more than two cars involved. Because noncollision losses are covered under types A and B but excluded from type C, the number of claims is necessarily fewer in the case of type C. To address this asymmetry, we only use claim data that involve more than two cars. Moreover, we consider only new cars because new car drivers have the strongest incentive to purchase comprehensive coverage.

Other than the differences in the degree of coverage, type B is more similar in nature to type A than to type C because both types A and B allow no-collision clauses whereas type C does not. In addition, we obtain quite similar empirical results from

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

[6] 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.

[7] Collision losses resulting from hitting other objects, such as a telephone pole, a tree, or a building, as well as noncollision losses that are covered under types A and B, are specifically excluded from type C.

the two special cases: the one with type A versus type C and the other with type B versus type C. Therefore, we aggregate consumers of types A and B as a group. Basic statistics appear in Table 1. Finally, though our empirical analysis is based on claim time rather than accident time, the time difference between them is relatively small because insurance policies clearly state that the insured must file the claim no later than five days after an accident occurs.

METHODOLOGY

Our empirical analysis starts with the two testing procedures suggested by Chiappori and Salanié (2000), who consider the generalized correlation between error terms from two regression models: car owners' insurance coverage choices and the occurrence of claims. Let $i = 1, 2, \ldots, n$ denote consumers who have purchased a comprehensive coverage policy. We define individual i's choice of coverage y_{1i} as follows:

$$y_{1i} = \begin{cases} 1, & \text{if individual } i \text{ chooses high coverage (type A\&B);} \\ 0, & \text{if individual } i \text{ chooses low coverage (type C).} \end{cases}$$

Another binary variable specifies the occurrence of claims as follows:

$$y_{2i} = \begin{cases} 1, & \text{if individual } i \text{ has made at least one claim;} \\ 0, & \text{otherwise.} \end{cases}$$

We perform Chiappori and Salanié's (2000) test by first estimating two probit regression models:

$$y_{ki} = \begin{cases} 1, & \text{if } y_{ki}^* = \mathbf{x}_i'\beta_k + \varepsilon_{ki} \geq 0, \\ 0, & \text{otherwise,} \end{cases} \qquad k = 1, 2, \tag{1}$$

where vector $\mathbf{x}_i$ denotes the set of exogenous variables as shown in Table 1 that contains all the information about individual i available to the insurance company before it provides the policy to that person. In line with previous research, we assume that the disturbance terms ε_{1i} and ε_{2i} are standard normal random variables and focus on reduced-form specifications in which the variables in the $\mathbf{x}_i$ vector are the same for both the y_{1i} and y_{2i} equations. From the estimates of Equation (1), we can compute the so-called generalized residuals $\hat{\varepsilon}_{1i}$ and $\hat{\varepsilon}_{2i}$ proposed by Gourieroux, Renault, and Trognon (1987):

$$\hat{\varepsilon}_{ki} \equiv y_{ki} \cdot \frac{\phi(\mathbf{x}_i'\beta_k)}{\Phi(\mathbf{x}_i'\beta_k)} - (1 - y_{ki}) \cdot \frac{\phi(\mathbf{x}_i'\beta_k)}{1 - \Phi(\mathbf{x}_i'\beta_k)}, \qquad k = 1, 2, \tag{2}$$

where ϕ and Φ are, respectively, the density and the cumulative distribution function of the standard normal distribution. Under the null hypothesis of conditional

TABLE 1
Basic Statistics

	Car Age = 0		Car Age = 1	
Variable	Average	SD	Average	SD
Type A&B	0.765	0.424	0.545	0.498
Age	39.146	9.308	39.802	9.170
Female	0.703	0.457	0.690	0.462
Marital status	0.553	0.497	0.680	0.467
Dealer	0.613	0.487	0.237	0.425
Urban	0.500	0.500	0.532	0.499
Region: North	0.439	0.496	0.474	0.499
Region: South	0.303	0.460	0.262	0.440
Region: East	0.036	0.187	0.045	0.208
Domestic Brand	0.803	0.398	0.803	0.398
Foreign Brand 1	0.080	0.271	0.161	0.367
Foreign Brand 2	0.150	0.357	0.124	0.329
Foreign Brand 3	0.090	0.287	0.099	0.299
Foreign Brand 4	0.463	0.499	0.353	0.478
Foreign Brand 5	0.061	0.238	0.120	0.324
Sample size	24,915		13,389	

Notes: All the variables except *Age* are dummy variables. Their definitions are as follows:
Type A&B: equals one if the insured purchases a type A or B policy, zero otherwise;
Age: is the primary insured's age in years;
Female: equals one if the primary insured is female, zero otherwise;
Marital status: equals one if the primary insured is married, zero otherwise;
Dealer: equals one if the insurance policy was sold by car dealer, zero otherwise;
Urban: equals one if the primary insured lives in the city, zero otherwise;
Region North: equals one if the car is registered in the north of Taiwan, zero otherwise;
Region South: equals one if the car is registered in the south of Taiwan, zero otherwise;
Region East: equals one if the car is registered in the east of Taiwan, zero otherwise;
Domestic Brand: equals one if the car is produced domestically, zero otherwise; and
the five *Foreign Brand* dummies indicate five different foreign brands.

independence between ε_{1i} and ε_{2i}, the test statistic

$$w \equiv \left(\sum_{i=1}^{n} \hat{\varepsilon}_{1i}\hat{\varepsilon}_{2i}\right)^2 \Bigg/ \sum_{i=1}^{n} \hat{\varepsilon}_{1i}^2\hat{\varepsilon}_{2i}^2 \tag{3}$$

has an asymptotic chi-squared distribution with one degree of freedom.

Following Chiappori and Salanié's (2000) approach, we also estimate a bivariate probit model in which ε_{1i} and ε_{2i} jointly have a bivariate normal distribution with zero means, unit variances, and a correlation coefficient ρ. Again, under the null hypothesis of conditional independence between ε_{1i} and ε_{2i}, the maximum likelihood estimate of ρ has an asymptotic normal distribution.

Although this study uses the same testing procedures as Chiappori and Salanié (2000), it differs in two important respects in terms of the definition of y_{2i}, the occurrence of a claim. First, on the basis of the information about the timing of claims during the policy year, we define y_{2i} for each of the 12 months of the entire policy year. Second, on the basis of the information about the dollar amounts of claims, we define y_{2i} for various claim amount levels. More precisely, for $t = 1, 2, \ldots, 12$, and $v = \$300$ and \$900, we have

$$y_{2i}(t,v) = \begin{cases} 1, & \text{if } i \text{ has at least one claim in month } t \text{ of claim amounts greater than } v, \\ 0, & \text{otherwise.} \end{cases}$$

By extending the definitions of the occurrence of claims y_{2i} and unraveling detailed profiles of claim timing and their amounts, we may be able to find out not only whether but also why the two disturbance terms ε_{1i} and ε_{2i} are correlated. Our main reason for classifying claim occurrence by month is to distinguish between the effects of adverse selection and moral hazard. Typically, adverse selection influences claim occurrence uniformly across all policy months, whereas moral hazard should induce different patterns across policy months. By testing the conditional relationship between the choice of insurance coverage and claim occurrence by policy month, we can trace the source of the asymmetric information problems. To deal with the sample errors generated by the possibility that small claim accidents might not get reported, we further classify claim occurrence by dollar amounts to examine any potential biases in our empirical findings caused by smaller claims.

In Table 2, we present the number of claims, according to dollar amounts, associated with the different policy types (A&B versus C) and policy months. The numbers in the parentheses (in the third and fifth columns of Table 2) indicate the average amount (in thousands of NT dollars) per claim. The most interesting result in this table shows that, though the average dollar amount per claim remains approximately the same across policy months and policy types, the time profiles of claim numbers exhibit very distinctive patterns; specifically, monthly numbers of claims increase substantially in the last few policy months.

As we mentioned in the previous section, an increasing deductible system accounts for 95 percent of the comprehensive coverage in Taiwan. We propose an additional method to prove the existence of moral hazard by investigating the effects of increasing deductibles; any change in drivers' behavior due to the imposition of increasing deductibles provides evidence of moral hazard. To implement this idea, we go one step further and consider three successively smaller subsamples of insured consumers who have made j or more claims, where $j = 0, 1, 2$, and reapply the preceding

Table 2
Numbers of Claims (Average Claim Amounts)

Policy Month	All		Claim > $300		Claim > $900	
	C	A&B	C	A&B	C	A&B
1	78 (33)	557 (29)	45	357	21	97
2	89 (26)	674 (28)	52	433	24	128
3	79 (22)	642 (24)	45	418	16	105
4	82 (24)	599 (25)	56	410	15	104
5	83 (25)	629 (29)	55	469	12	103
6	68 (19)	585 (26)	45	431	12	110
7	71 (20)	587 (26)	46	453	11	93
8	61 (23)	616 (28)	36	474	9	124
9	55 (32)	641 (26)	38	491	17	104
10	63 (34)	826 (23)	39	636	13	136
11	80 (37)	1,852 (20)	47	1,490	18	215
12	139 (18)	5,491 (17)	69	4,299	19	435
Total	948 (26)	13,699 (22)	573	10,361	187	1,754

Notes: A&B stands for policy types A and B, whereas C stands for policy type C. Numbers in parentheses in the third and fifth columns are the average amount (in thousands of NT dollars) per claim.

estimation with the dummy variable y_{2i} for the occurrence of claims redefined as

$$y_{2i}(j) = \begin{cases} 1, & \text{if } i \text{ had } j+1 \text{ claims over the entire policy year,} \\ 0, & \text{otherwise.} \end{cases}$$

In each of the three subsamples, which we refer as the first (entire sample), second, and third subsamples, we can adopt the same procedure to test the null hypothesis of conditional independence between ε_{1i} and ε_{2i}. If the moral hazard problem exists and the increasing deductible system helps abate it, then the likelihood of rejecting the null hypothesis will increase as we move from the entire sample to the third subsample. In other words, even if we reject the null hypotheses and infer the existence of asymmetric information, whether adverse selection or moral hazard, from using the entire sample (i.e., the first subsample), we still might obtain an opposite testing result when we use the second and third subsamples to conduct the test. If such contradictory testing results emerge, we can only conclude that these insured persons change their driving behavior after their first and second claims because of the increasing deductible that ensures moral hazard exists.

We first make three comments regarding these subsample estimations. First, because it is not possible to compare the test statistics in Equation (3) directly across the three subsample estimations, we employ a testing procedure based on the bivariate probit model and try to evaluate the significance of the differences in correlation estimates informally across the subsamples. Second, because claims can occur during different policy months, the insured in the second and third subsamples face different remaining policy months before they can make their next claim. To control for this heterogeneity, we add the number of remaining policy months as an additional control variable when we estimate the bivariate probit model. Third, to avoid any possible month effect that might influence the probability of claims, we conduct the analysis separately for each policy month and test the correlations. We do not find any significant month effect that would materially influence our empirical results.

To provide further empirical evidence for the conjecture that the increasing deductible provision helps discourage moral hazard, we conduct a more direct test by examining whether the policyholders of types A and B who filed claims in earlier policy months, comparing with the policyholders of type C who also filed earlier claims, are less likely to file additional claims later in the policy year. Specifically, we propose a probit regression model for the dummy variable y_{2i}(10–12, \$300), which equals 1 if individual i makes at least one claim between the 10th and the 12th policy months of greater than \$300, and 0 otherwise. For the explanatory variables of the proposed probit model, in addition to the explanatory variables $\mathbf{x}_i$ we use in the probit regression model (1), we include three additional variables: the choice variable (type A&B) y_{1i}, the previous claim variable y_{2i}(1–9, \$300), and their interaction $y_{1i} \times y_{2i}$(1–9, \$300). Because the dependent variable of the proposed probit model is the claim dummy y_{2i}(10–12, \$300) and an important explanatory variable is also the claim dummy y_{2i}(1–9, \$300) over the previous policy months, we dub this regression model "the forward probit model." In this approach, we are particularly interested in the regression coefficient of the interaction term. Because policy types A and B include the increasing deductible provision but type C does not, we expect this regression coefficient to be negative, which would imply that policyholders of types A and B are less likely than type C policyholders to file additional claims in the last three policy months if they have filed claims in the first nine months. This empirical investigation should supplement the aforementioned approach of subsample estimations and focus more squarely on the influence of increasing deductibles.

EMPIRICAL FINDINGS

We first report the results of Chiappori and Salanié's (2000) test using the yearly data for new car owners. The explanatory variables in the two reduced-form regression Equations (1) for the coverage choice and for the claim are the same and are those shown in Table 1 as discussed before. The χ^2 test statistics w from Equation (3) is 2824.68, and the estimated correlation ρ from the bivariate probit model is highly significant at 0.541. Table 3 reports test statistics w for $y_2(t, v)$ of two claim amounts v in each t of the 12 policy months. These empirical results match quite closely with the pattern we find in Table 2. The highly significant conditional correlation between the choice of insurance coverage and claim occurrence seems to support the proposition that Taiwan's auto insurance market has asymmetric information problems.

De Meza and Webb (2001) show that the correlation between the choice of coverage and claim occurrence could be negative if the insurance company cannot observe the risk preference of the individual consumers. Moreover, Finkelstein and McGarry (2006) point out that failing to find a positive correlation between coverage choice and claim occurrence does not necessarily imply the absence of asymmetric information because the effects of asymmetric information and unobservable risk preference work

TABLE 3
Test Statistics ω From Probit Estimations

Policy Month	Claim > \$300		Claim > \$900	
	Age = 0	Age = 1	Age = 0	Age = 1
1	373.48	236.43	88.67	75.74
2	458.05	293.81	174.35	94.88
3	362.28	248.78	77.72	63.48
4	396.89	265.53	93.96	94.04
5	391.43	276.84	73.67	75.63
6	340.53	273.22	99.19	100.16
7	404.85	225.57	98.60	84.98
8	505.56	254.68	148.99	79.95
9	436.96	258.54	87.40	65.89
10	1,002.64	433.25	223.68	129.11
11	3,011.02	1,302.43	288.02	197.53
12	10,752.15	5,356.17	1,257.06	577.36

Note: Age refers to car age.

in opposite directions. Because we do not formally control for the risk preference in this study, our empirical finding should be considered a mixed result of both asymmetric information (positive correlation between the choice and claim) and risk preference (negative correlation between the choice and claim). Therefore, the positive correlation between the choice and the claim that we find should be regarded as even stronger evidence in support of the existence of asymmetric information.

Table 4 reports corresponding estimates of the ρ parameter in the bivariate probit models. Estimation and testing occurs separately for cars of different ages (i.e., one versus two years old). These empirical results match quite closely with the pattern we find in Table 2 in terms of both the large values of the test statistics ω and the highly significant estimates of the ρ parameter. These findings suggest that both adverse selection and moral hazard might exist. The significance of the test statistics ω and the ρ estimates for all policy months might imply adverse selection in the sense of Chiappori and Salanié (2000); that the values and significance of these statistics become considerably larger in the last three policy months could suggest moral hazard.[8]

[8] Another interesting result from Table 4 is that correlations seem greater in the group of one-year-old cars than among brand-new cars. Because there is no clear reason why owners of one-year-old cars differ overall from owners of brand-new cars, this difference may provide additional evidence of the existence of asymmetric information. On the one hand, the moral hazard interpretation fits if we believe that owners of new cars in general have a stronger incentive to drive more carefully than used-car drivers. On the other hand, adverse selection represents a possible cause if we believe drivers of one-year-old cars who have learned more about their own driving skill tend to choose the coverage type that accords with their own driving pattern.

TABLE 4
ρ Estimates From Bivariate Probit Estimations

Policy Month	Car Age = 0				Car Age = 1			
	Claim > $300		Claim > $900		Claim > $300		Claim > $900	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
1	0.177	0.026	0.066	0.046	0.272	0.028	0.234	0.053
2	0.193	0.024	0.107	0.042	0.257	0.029	0.217	0.052
3	0.201	0.025	0.135	0.049	0.215	0.030	0.175	0.054
4	0.180	0.025	0.149	0.050	0.284	0.031	0.191	0.057
5	0.177	0.025	0.182	0.053	0.232	0.031	0.213	0.054
6	0.201	0.026	0.198	0.051	0.220	0.031	0.146	0.060
7	0.204	0.026	0.153	0.053	0.262	0.031	0.292	0.056
8	0.245	0.026	0.255	0.051	0.299	0.031	0.280	0.059
9	0.260	0.027	0.108	0.049	0.249	0.032	0.278	0.060
10	0.309	0.024	0.215	0.048	0.332	0.029	0.384	0.053
11	0.446	0.018	0.239	0.041	0.436	0.023	0.302	0.047
12	0.651	0.011	0.369	0.033	0.668	0.014	0.458	0.040

TABLE 5
ρ Estimates From Subsample Bivariate Probit Estimations

Subsample	Car Age = 0		Car Age = 1	
	Est.	SE	Est.	SE
Entire sample	0.541	0.009	0.557	0.011
Subsample 2	0.144	0.031	0.217	0.037
Subsample 3	0.004	0.072	0.050	0.093

Notes: Subsample 2 contains the insured who have made one or more claims; subsample 3 contains the insured who have made two or more claims.

We present the major testing results from the subsample estimation in Table 5 to demonstrate the effects of increasing deductibles. The ρ estimates decrease substantially from significant at 0.5 to almost 0 as we move from the first (i.e., entire sample) to the third subsample for both car ages. These results obviously imply that the degree of asymmetric information diminishes for drivers who have made increasingly more claims. The most likely explanation for this phenomenon is that the increasing deductible provision generates strong incentives for drivers' behavior changes, so these empirical results represent especially pertinent evidence of the effects of increasing deductibles on the moral hazard problem.

In Table 6, we present the estimation results based on the forward probit model to test formally whether policyholders of types A and B who filed a claim in the first nine policy months, characterized by y_{2i}(1–9, $300), are less likely to file a claim in the last

TABLE 6
Estimates From Alternative Claim Timing Probit Estimations

	Claim y_{2i}(10–12, \$300)		Claim y_{2i}(7–9, \$300)	
Variable	Est.	SE	Est.	SE
Type A&B	1.3108**	0.0178	0.5287**	0.0200
Previous Claim	0.4193**	0.0406	0.4079**	0.0490
Interaction Term	0.3864**	0.0434	0.2278**	0.0537
Car age	−0.0524**	0.0039	−0.0103	0.0049
Age	0.0001	0.0007	0.0010	0.0009
Female	0.1006	0.0134	0.0183	0.0171
Marital Status	−0.0241	0.0128	0.0099	0.0166
Dealer	0.2442**	0.0149	0.0588**	0.0194
Urban	0.1097**	0.0128	−0.0266	0.0164
Region: North	0.1093**	0.0159	−0.0772**	0.0202
Region: South	0.2016**	0.0173	0.0100	0.0218
Region: East	−0.1150**	0.0363	0.0037	0.0427
Domestic Brand	0.0418*	0.0195	−0.1175**	0.0246
Foreign Brand 1	0.0853**	0.0283	0.0345	0.0357
Foreign Brand 2	0.1292**	0.0269	0.0986**	0.0337
Foreign Brand 3	−0.0005	0.0302	0.1199**	0.0370
Foreign Brand 4	0.1261**	0.0223	−0.0024	0.0279
Foreign Brand 5	−0.0462	0.0311	0.0435	0.0386
Intercept	−2.1160**	0.0392	−1.8766**	0.0481

Notes: Previous Claim equals y_{2i}(1–9, \$300) in the first model and y_{2i}(1–6, \$300) in the second model. *Interaction Term* equals Type A&B × *Previous Claim.*
**Significant at 1% level.
*Significant at 5% level.

three policy months, represented by the dependent variable y_{2i}(10–12, \$300), than are policyholders of type C. To serve as a robustness check, we also report in the last two columns of Table 6 the estimation results based on the claim dummies y_{2i}(1–6, \$300) (explanatory variable) and y_{2i}(7–9, \$300) (dependent variable). This particular specification should avoid any potentially disturbing impacts of the year-end effect on claim filing when the expiration date of the insurance policy nears. Finally, the first column of Table 6 lists all the explanatory variables of the forward probit model, including the gender dummy for female drivers; dummies for four regions of Taiwan; six different car brands; urbanization; marital status; the issuing agency (to indicate whether the consumer bought the insurance policy from a car salesperson); two age variables; the intercept term; and the three main explanatory variables: *Type A&B* as the choice dummy, *Previous Claim* for the claim dummies y_{2i}(1–9, \$300) or y_{2i}(1–6, \$300), and the interaction term.

The coefficients of the *Type A&B* variable in Table 6 are significantly positive; therefore, the policyholders of types A and B are more likely to make a claim in the last three policy months than are policyholders of type C, irrespective of whether they have claimed in the previous nine policy months. The coefficients of the *Previous*

Claim variable are also significantly positive, which implies that the insured who have claimed losses in the first nine policy months are more likely to claim again in the last three policy months, irrespective of policy types. The significantly negative coefficients of the *Type A&B* × *Previous Claim* interaction indicates that, compared with policyholders of type C, policyholders of types A and B who filed claims in the first nine policy months are less likely to file additional claims in the last three because A and B policies include the increasing deductible provision but type C does not, this finding provides fairly strong evidence that the increasing deductible provision helps discourage moral hazard. Finally, in the last two columns of Table 6, we show the estimation results without the possible year-end effect, from which we conclude that our results are robust.

CONCLUSION

We use the increasing deductible provision in Taiwanese automobile insurance to examine the moral hazard problem and obtain new empirical results regarding asymmetric information in the auto insurance market. The data we collected from the comprehensive automobile insurance coverage in Taiwan provide us with a unique opportunity to examine whether moral hazard exists in the market and whether increasing deductibles can help control it. Using the same econometric approach as Chiappori and Salanié (2000), we find that asymmetric information exists in the insurance market. Through subsample estimation, we also find strong evidence that the increasing deductible provision controls moral hazard. We must reiterate here that in each subsample, the insured cannot switch their choice of the coverage, so the effect of adverse selection is minimal. Thus, only moral hazard can explain the reduction in the conditional correlation, due to the increasing deductible provision. Our empirical evidence also implies the existence of moral hazard in the automobile insurance market.

Chiappori and Salanié (2000) find no evidence to support the presence of asymmetric information in the insurance market, and the previous literature has not reached a consensus about its existence. These contradictory findings suggest that differences in regulation, pricing mechanisms, and deductible system may all induce different types of asymmetric information problems. Sufficiently different insurance contracts may only exist in different countries. For example, Dionne and Gagne (2002) investigate the replacement cost endorsement in the Canadian automobile insurance market to separate moral hazard from adverse selection. Finkelstein and Poterba (2004) use contract designs in the U.K. annuity market to track the existence of adverse selection. We use the increasing deductible provision in the Taiwanese automobile insurance to examine the moral hazard problems. All these papers demonstrate that alternative insurance markets in different countries offer both natural experiments and fruitful data for further research.

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