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Does Opportunistic Fraud in Automobile theft Insurance Fluctuate with the Business Cycle ?

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Abstract:
We analyze the empirical relationship between opportunistic fraud and business cycle. We find that residual opportunistic fraud exists both in the contract with replacement cost endorsement and the contract with no-deductible endorsement in the Taiwan automobile theft insurance market. These results are consistent with previous literature on the relationship between fraud activity and insurance contracting. We also show that the severity of opportunistic fraud fluctuates in the opposite direction to the business cycle. Opportunistic fraud is stimulated during periods of recession and mitigated during periods of expansion.

Keywords: Opportunistic fraud, replacement cost endorsement, no-deductible endorsement, automobile theft insurance, business cycle

JEL Classification: G22, G20, D80, D81

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1. Introduction

Insurance fraud has become an increasingly important issue throughout the world. Many researchers have investigated this problem. Nonetheless, few studies have examined the relationship between fraud and the surrounding environment.[1] This paper fills this gap and investigates the impact of the environment on fraud from a macroeconomic standpoint. It underlines the impact of the business cycle on insurance fraud. To our knowledge, insurance fraud has never been directly linked to any macroeconomic factors in the literature.

Dionne (2000) provides many reasons for insurance fraud, such as changes in morality, poverty, intermediaries' behavior, insurers' attitude, and nature of insurance contracts. Although it has been pointed out that morality or poverty could affect insurance fraud,[2] no studies have provided related empirical evidence. However, fraud has been associated with morality, and morality has been linked to a country's poverty level. In addition, the poverty level of society is commonly linked to economic circumstances.

Dionne and Gagné (2002) find a particular pattern of claim timing in Quebec's automobile insurance contracts and conclude that opportunistic fraud is induced by the replacement cost endorsement. Dionne and Gagné (2001) also show how insurance fraud is affected by the deductible level in insurance contracts. Similarly, our contribution posits that opportunistic fraud

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[1] Boyer (2001) is one of the few researchers to discuss the impact of economic factors on insurance fraud, specifically that of the tax scheme of the insurance benefit. See also Bates et al.'s (2010) study of health production efficiency.

[2] Dionne and Gagné (2002) underline that poverty is a possible reason for fraud. In the theoretical model of Dionne, Giuliano, and Picard (2009), the moral cost of fraud is one of the factors that affect individuals' decision to defraud.

is induced by the nature of the insurance contract, and further explores the impact of the business cycle.

It is unclear whether the business cycle has a positive or negative impact on insurance fraud. From the risk aversion standpoint, people could become more risk-averse and hesitate to play this type of lottery by committing fraud when an economic recession reduces their wealth level. Conversely, the morality standard could decrease when the economic situation worsens. The marginal benefit from fraud could also increase while the wealth level decreases during a recession, and the incentive to defraud could increase. Hence, competing predictions on the relationship between the business cycle and insurance fraud are worth testing.

Insurance fraud is an increasingly important problem in Taiwan. In automobile theft insurance, a significant line in the property-liability insurance market,[3] the amount of fraud accounts for about 5% of total claims. It reached 150 million NT dollars in 2008.[4] With the loss ratio of auto theft insurance at more than 35% each year, fraud could be one of the reasons for such a high loss ratio in this important business line. Further, the loss ratio fluctuates over time and coincides with the business cycle.[5]

We have collected automobile theft insurance data from Taiwan's largest property-liability insurance company.[6] Our monthly data span a long policy period, comprising policies written in 2000 to 2007, i.e. a study period of 96 policy months.[7] We can thus test the relationship between opportunistic fraud and the business cycle.

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[3] From 2000 to 2007, about 26.37% of private sedans were covered by theft insurance. The premium is over 40 billion NT dollars (about 1.33 billion US dollars) per year, and the growth rate is about 10% per year.

[4] This is roughly equivalent to 5 million US dollars.

[5] If we treat GDP as a proxy variable for the fluctuation of business cycle, we find that the loss ratio of automobile theft insurance is significantly negative correlated with the level of GDP. We list the automobile theft insurance loss ratio of non-commercial vehicles and the GDP of Taiwan in Appendix A, from 1998 to 2009. The opposite relationship between the loss ratio and GDP is apparent. The significant correlation coefficient is -0.98896.

[6] This insurance company controls more than 20% of Taiwan's automobile insurance market.

[7] For all the contracts written from 2000 to 2007, we collect their complete claim records for the policy year. For example, the claim records of policies written in 2007 are extended to the dates in 2008.

We find a particular pattern of total theft claim timing linked to the replacement cost endorsement. The month-by-month test[8] indicates that unlike partial theft claims, total theft claims under replacement cost endorsement contracts increase over time during the contract year. This finding confirms that opportunistic fraud, rather than ex ante moral hazard, arises from the replacement cost endorsement. Further, testing by each policy month during the policy year points to another particular pattern of claim timing for opportunistic fraud induced by no-deductible endorsement. The total theft claims of no-deductible endorsement are more common during the early months of the contract year. This opportunistic fraud evidence can also be separated from ex ante moral hazard.

Further, the empirical evidence affirms that opportunistic fraud fluctuates conversely with the business cycle. The claim timing patterns for the two types of contracts mentioned above are even more pronounced during a recession, which implies that a recession amplifies the incentives for opportunistic fraud induced by contracts.

The paper is organized as follows. The next section analyses the empirical hypotheses. The third section describes the data and the fourth section discusses the empirical methodology used in this paper. The fifth section presents the empirical results. The final section concludes the paper.

2. Hypotheses

Opportunistic fraud incentive is induced by the nature of the insurance contract.[9] Two important contract types are replacement cost endorsement and no-deductible endorsement. We

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[8] In this paper, the periods have been reorganized according to policy periods. Hence, we test policy months instead of calendar months.

[9] Picard (2000) infers that the severity of insurance fraud ranges from build-up to planned criminal fraud. The opportunistic fraud we investigate in this paper is in the middle of the fraud spectrum. There are also many other contributions discussing the optimal contract design that could reduce the incentive to defraud. Crocker and Morgan (1998) theoretically investigate the optimal insurance contract under costly state falsification. Crocker and Tennyson (1999) empirically tested for the nature of the optimal insurance contract under costly falsification. Bond and Crocker (1997) and Boyer (2004) design the optimal insurance contract under costly state verification (see Derrig,

posit that the degree of incentive to defraud is also affected by the business cycle. In this section, four hypotheses are proposed for the empirical tests. Before we explore the impact of the business cycle, the claim timing pattern of opportunistic fraud induced by each contract is identified.[10]

There are many factors explaining opportunistic fraud.[11] On the demand side, maximizing their expected utility, each insured has a critical value of the probability of a fraud being successful. The lower this critical value, the greater the insured's incentive to commit fraud. One can show that this critical value decreases when the difference between the vehicle's replacement cost and the vehicle's market value increases near the expiration of the insurance contract. Accordingly, the insured would consider opportunistic fraud near the contract's expiration with increasing probability. On the supply side, the probability of the insurer's conducting an audit also decreases near the contract's expiration because the market value of the vehicle decreases over time.[12] Hence, as the theoretical model of Dionne and Gagné (2002) indicates, opportunistic fraud probability is higher near the expiration of the replacement cost endorsement.

We also infer the probability of opportunistic fraud under such an equilibrium model. On the demand side, the individual's expected utility model is similar to that of Dionne and Gagné (2002). On the supply side, we modify their insurer's audit probability to become flat over time.[13]

2002, and Picard, 2000, for reviews of the literature).

[10] Identifying the existence of fraud under asymmetric information is an important aim in the literature. For example, Artis et al. (2002) adopt a new methodology to identify fraud by allowing the misclassification error in the existing method to separate fraudulent claims from honest claims.

[11] Picard (1996) built an equilibrium model between the insurer and the insured to explain the successful fraud probability in the market. Dionne and Gagné (2002) extended this model. The result is that auditing is not sufficient to deter fraud. Hence, the success probability of fraud does not correspond to the probability of non-audit.

[12] The stringency of audit could affect the success probability of fraud, but it is not constant over time. Dionne, Giuliano and Picard (2009) use red flags as the signals for conducting stringent audit in their optimal auditing strategy. Dionne and Gagné (2002) assume that the stringency of audit decreases near the expiration of the replacement cost endorsement.

[13] We make this assumption because insurers in Taiwan do not, in practice, implement a particularly stringent audit at the beginning of the contract. First, the market value of a vehicle does not vary as much as in Quebec from the beginning to the end of the overall policy period, because the contract length is only for one year, and the replacement cost endorsement contract is not designed for new vehicles exclusively in Taiwan. Second, insurance

The theoretical model under replacement cost endorsement is presented in Appendix B. The main result is consistent with Dionne and Gagné (2002) in that the equilibrium fraud probability is higher near the end of the policy year.

When we study opportunistic fraud induced by the replacement cost endorsement contract in the empirical test, this contract is compared with the reference contract with both depreciation and deductible. We treat the contract with deductible and replacement cost endorsement as a high-coverage contract, and the reference contract as a low-coverage contract. A contract with replacement cost endorsement reimburses the total value of the car evaluated at the beginning of the contract period. The former exhibits the claim timing pattern described above, whereas the latter does not. Hence, our first hypothesis:

Hypothesis 1: *If the claims are induced by opportunistic fraud, individuals who choose a replacement cost endorsement contract have a higher probability of filing a claim, and this probability is even higher near the end of the contract period.*

In addition, we examine incentives to defraud induced by the no-deductible endorsement contract. Dionne and Gagné (2001) propose a theoretical model and empirically verify that the design of the deductible would increase the incentive to build up a claim. However, this conclusion cannot be applied directly to our research design because we investigate opportunistic fraud rather than build-up. People putatively build up claims to exceed the deductible threshold in the insurance contract after the event has occurred. Hence, the design of a deductible would encourage the incentive to build up. If the event has not actually occurred, people would have a greater incentive to invent fraudulent claims when there is no deductible designed in the contract. The incentive of opportunistic fraud is therefore higher under a no-deductible endorsement. We

companies in Taiwan rely heavily on the mechanism of deductible design in the replacement cost endorsement and a more stringent depreciation rate in the no-deductible contract. There is actually no difference in the audit approach between the beginning and the end of the policy year as a whole.

derive this result in Appendix C. We also discuss the claim timing pattern for the contract with depreciation in Appendix C. While the vehicle depreciation from the insurer's indemnity is much more stringent than that in the market, and when the incentive to cheat is large enough, the insured would have a stronger incentive to organize opportunistic fraud at the beginning of the contract period under a contract with depreciation. Hence, under a flat audit mechanism, the equilibrium fraud probability is higher at the beginning of the policy year.

To identify opportunistic fraud induced by the no-deductible endorsement contract in our empirical test, we compare this contract with the reference contract, which comprises both a deductible and depreciation. The contract with depreciation and no-deductible endorsement is thus a high-coverage contract, and the reference contract is a low-coverage contract. As shown in Appendix C, the relative claim timing pattern is focused on the beginning months of the policy year. Our second hypothesis is therefore:

Hypothesis 2: *If the claims are induced by opportunistic fraud, individuals who choose the non-deductible endorsement contract have a higher probability of filing claims. This relative probability is even higher at the beginning of the contract period.*

Although the main research problem is opportunistic fraud, we cannot deny that the former parts of the above two hypotheses could also be the result of adverse selection. Under adverse selection, high-risk individuals tend to purchase the two types of high-coverage contracts and have a higher probability of making a claim. However, the claim would be equally distributed among the twelve months. In contrast, only opportunistic fraud would create a particular pattern in the timing of the claim during the months of the policy year. This characteristic enables us to clearly rule out adverse selection. Hence, when the first and second hypotheses are empirically sustained, they would provide evidence of opportunistic fraud rather than adverse selection.

It is important to distinguish opportunistic fraud from ex ante moral hazard.[14] Opportunistic fraud results from an individual's decision to invent a fraudulent claim or not. Ex ante moral hazard arises from the decision to pay more or less attention to self-protection. Under the replacement cost endorsement, ex ante moral hazard could be stronger near the end of the policy year.[15] Conversely, under the no-deductible endorsement contract, ex ante moral hazard could be stronger at the beginning of the policy year.[16] Ex ante moral hazard thus has the same claim timing pattern as opportunistic fraud.

Dionne and Gagné (2002) show that opportunistic fraud can be induced only when the benefit from fraud is sufficiently large. They maintain that the benefit from fraud based on partial theft is minor. The incentive to defraud through total theft is much stronger than that related to partial theft. This difference in incentives provides an opportunity to distinguish opportunistic fraud from ex ante moral hazard. Self-protection has an equal effect in terms of reducing the probability of both total theft and partial theft, but fraud solely leads to a stronger incentive to file a total theft claim. Accordingly, opportunistic fraud could emerge mainly based on the probability of a total theft claim instead of a partial theft claim. Hence, our third hypothesis is to distinguish opportunistic fraud from ex ante moral hazard.

Hypothesis 3: *If the claim timing patterns in the first and second hypotheses emerge only in relation to the total theft claim, opportunistic fraud exists rather than ex ante moral hazard. If the*

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[14] In the literature, the consequences of ex ante moral hazard and fraud are often mixed. For example, when Weiss et al. (2010) discussed the distortion effect of regulated insurance pricing, they mention that regulation could cause ex ante moral hazard because the safety investments of drivers may be diminished. This regulation could also cause fraudulent claims because the disincentive of filing fraudulent claims may also be reduced.

[15] As described in Dionne and Gagné (2002), the benefits of prevention decrease over time under the replacement cost endorsement. Hence, the presence of replacement cost endorsement reduces self-protection activities, increasing the probability of theft.

[16] The depreciation rate used for the insurer's indemnity is more stringent than that in the regular market. Hence, the difference between the loss indemnity and the vehicle's market value would be larger near the end of the year. This would give the insured more incentive to pay more attention to self-protection and to reduce the ex ante moral hazard near the end of the year. Accordingly, under a no-deductible contract, there is greater ex ante moral hazard at the beginning of the policy year.

above patterns also emerge relative to the partial theft claim, then ex ante moral hazard may exist in the market, and we cannot conclusively determine whether opportunistic fraud exists.

Investigating the impact of the business cycle on opportunistic fraud is the second objective of this research. Whether opportunistic fraud will fluctuate consistently or inversely with the business cycle is unclear.

Regarding risk aversion, it has been accepted that most people are risk-averse and exhibit decreasing absolute risk aversion. In an economic recession, people's wealth decreases and they become more risk-averse. This will make them more hesitant to adopt risky actions, including fraud. Hence, the probability of opportunistic fraud could decrease during a recession.

Alternatively, because the individual's wealth decreases during a recession, the increment of utility from the benefit of fraud increases concomitantly. Furthermore, if recession reduces individuals to the poverty level, they may feel they have much less to lose if they get caught committing fraud. This may increase people's likelihood of defrauding during a recession.

Fraud is highly related to an individual's morality . Morality may also vary with wealth level. Husted et al. (1999) argue that societal corruption is highly related to GNP per capita. They provide empirical evidence that indirectly shows that individuals' morality level is positively related to their wealth. Dionne, Giuliano and Picard (2009) establish in a theoretical model that moral cost is a factor that affects individuals' decision to defraud. Therefore, from the standpoint of morality, recession reduces the average wealth level. A lower wealth level could weaken morality and reduce the moral cost of fraud, which raises the probability of fraud. Because our fourth hypothesis encompasses two conflicting effects, we do not make a prediction on the sign of the effect.

Hypothesis 4: *Opportunistic fraud could be positively or negatively affected by the business cycle.*

3. Data

Our data set includes all the characteristics of the insured and the insured vehicles, such as the gender, age, marital status of the insured; the brand, age, size, registered area, usage purpose of the insured vehicle; the information on the contract, such as coverage; the selling channel of the contract; and the claim information for each policy. Regarding the claim information, we collect not only the records on the claim amount and reason, but also the records on the date of the claim. This could help identify the timing of the claim, specifically the policy month during the policy period.

Further, we use the corresponding calendar date to investigate the impact of the business cycle. Our policy data are reorganized by policy year, and the claim timing is described by policy month, whereas the business cycle index is recorded by calendar year and calendar month. Accordingly, because we investigate the relationship between business cycle and opportunistic fraud for each policy month, we match the calendar date of the claim to the corresponding calendar month in the monthly business cycle index.

The data examined comprise the policies written from 2000 to 2007 and their corresponding claims until the end of 2008. This length of data allows us to match the monthly variation in the macroeconomic business cycle index to test the relationship between opportunistic fraud and business cycle. Hence we use the corresponding business cycle index of a potential claim's calendar month to measure the effect of the business cycle.

The business cycle index is the trend-adjusted monthly index of the composite coincident index from January 2000 to December 2008. This index, obtained from the published data of the Council for Economic Planning and Development of Taiwan, reflects the fluctuations of the business cycle. The value of the index is higher when the economy is healthier, and vice versa.

The total number of observations in our data set is 1,761,536. When we test whether opportunistic fraud exists under the replacement cost endorsement, we use a sub-sample of replacement cost endorsement contracts together with contracts with deductible and depreciation. The number of observations in this sub-sample is 1,715,736. When we test whether opportunistic fraud exists under no-deductible contracts, we use the sub-sample of no-deductible contracts plus contracts with deductible and depreciation. The number of observations in this sub-sample is 1,170,012. Because we cannot observe the occurrence of partial theft for the contracts without the endorsement of auto parts accessories, we can use only a smaller sub-sample of contracts with the endorsement of auto parts accessories when we test the relationship between coverage and claim timing for the partial theft case. This smaller sub-sample comprises 564,175 observations.

Observing the basic statistics of the variables in our empirical data can help us understand the data characteristics and their representativeness. The variables are defined in Table 1. The descriptive statistics for these variables are listed in Table 2. A total of 32.92% of theft insurance policies involve replacement cost endorsement, and only about 2.48% of the policies have zero deductible. About 40% of the policies are sold through dealer-owned agents.

Regarding the structure of the insured individuals, most of the insured (91.23%) are married, between 30 and 60 years old (87.97%), and female (62.55%). As for the structure of the insured vehicles, 64.27% of the insured vehicles have engine capacities equal to or less than 2000 c.c., and 39.29% of the insured vehicles are concentrated in the most popular brand in the market. Concerning vehicle distribution across the registered areas, 47.95% are registered in the north, 27.84% in the south, and 2.29% in the east of Taiwan. 53.51% of the vehicles are registered in cities.

About 20% of the vehicles are brand new, and more than 70% are less than four years old. A total of 96.43% of the insured vehicles are non-commercial or long-term rental sedans. These characteristics indicate that people are more willing to purchase theft insurance for vehicles for non-commercial use and for new vehicles.

4. Empirical methodology

The first empirical task in this paper is to identify whether opportunistic fraud exists in the automobile theft insurance market in Taiwan. We test the evidence for fraud based on the timing pattern of the conditional correlation between coverage and claims. The contract with high coverage is defined as either the replacement cost endorsement or no-deductible contract. The claim is further identified as the total theft claim and partial theft claim.

To test the conditional correlation between coverage and claims, we use a two-stage method similar to the methodology for a conditional correlation analysis in Dionne, Gouriéroux and Vanasse (2001). To identify the time pattern of the conditional correlation between coverage and claim, we test their conditional correlation by policy month. Hence, in each model,[17] we conduct the following conditional correlation test on twelve pairs from the first policy month to the twelfth policy month.

The two-stage method is as follows. In the first stage, we estimate the claim probability of the *j*-th policy month for each policy by means of the Probit regression

$$\text{Prob}(claim_{jkit} = 1 | X_{1it}) = \Phi(X_{1it}\beta_{1jk}), \quad j = 1,\dots 12, \; k = t, p, \; i = 1,..n, \quad t = 2000,\dots 2007 \qquad (1)$$

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[17] When we identify the existence of opportunistic fraud, we test the conditional correlation between claim and coverage under four models. In the first model, we test the conditional correlation between total theft claim and coverage of contract with replacement cost endorsement. In the second model, we test the conditional correlation between total theft claim and coverage of contract with no-deductible endorsement. In the third model, we test the conditional correlation between partial theft claim and coverage of contract with replacement cost endorsement. In the fourth model, we test the conditional correlation between partial theft claim and coverage of contract with no-deductible endorsement. When we identify the relationship between opportunistic fraud and business cycle, we test under two additional models. In the fifth model, we test the effect of the business cycle on the conditional correlation between total theft claim and the coverage of contract with replacement cost endorsement. In the sixth model, we test the effect of the business cycle on the conditional correlation between total theft claim and the coverage of contract with no-deductible endorsement.

where $\text{Prob}(\cdot)$ denotes the probability function, Φ is the cumulative standard normal distribution function, $i = 1, \cdots, n$, denotes the observations. The observations represent an unbalanced panel from policy year 2000 to policy year 2007. *k* = *t* is for total claim and *k* = *p* is for partial claim. X_{1it} is the vector of explanatory variables that includes the characteristics of the insured and the insured vehicle, which are listed in Table 1. Some of the explanatory variables, such as sex, age of insured, and age of the insured vehicle, are invariant during policy years. Other explanatory variables could vary over policy years; these include registered area of vehicle, marriage status, and policy year variable. β_{1jk} is the corresponding parameter vector, and $claim_{jkit}$ is the variable identifying whether the insured claimed or not. $claim_{jkit}$ is defined by policy month (*j*), from first policy month to 12th policy month of the whole policy year, for each insured *i*. $claim_{jkit} = 1$ when insured *i* has filed a claim in j-th policy month of policy year *t*, otherwise $claim_{jkit} = 0$.

In the second stage, we run the other Probit regression for the probability of purchasing a high-coverage contract as:

$$\begin{aligned}&\text{Prob}(coverage_{lit} = 1 | X_{2it}, claim_{jkit}, Pr\hat{o}b(claim_{jkit})) \\ &= \Phi(X_{2it}\beta_{2,l,j} + \beta_{c,l,j} claim_{jkit} + \beta_{ec,l,j} Pr\hat{o}b(claim_{jkit}))\end{aligned} \quad (2)$$

This regression is also based on the standard normal distribution used to estimate the probability of purchasing high coverage. The variable $coverage_{lit}$ is a choice variable of the insured; namely whether he or she purchased a high-coverage contract or not in policy year *t*. There are two definitions of high coverage (*l*) in this paper: $l = R, ND$, which denotes the replacement cost endorsement, and the no-deductible contract, respectively. The reference contracts are the contracts with depreciation and deductibles. They are defined as low-coverage.

X_{2it} is the vector of explanatory variables that contains the same variables as in X_{1it}. $claim_{jkit}$ has been defined above, and $Pr\hat{o}b(claim_{jkit})$ is the estimated probability of $claim_{jkit}$. $\beta_{2,l,j}, \beta_{c,l,j}, \beta_{ec,l,j}$ are the corresponding parameter vectors for the estimation under each policy month *j*, and when we investigate the high-coverage contract as *l*=*R* or *l*=*ND*. The key estimated coefficient used to test the problems of asymmetric information is $\beta_{c,l,j}$. There is a significantly positive correlation between the *l* coverage and claim in *j*-th policy month if the estimated $\beta_{c,l,j}$ is significantly positive.

To disentangle opportunistic fraud from ex ante moral hazard, we test the conditional correlation between coverage and total theft claim, and between coverage and partial theft claim. Hence, the claim in the above two regressions is further defined according to total claim (*k*=*t*) or partial claim (*k*=*p*). When we conduct the above test for the conditional correlation between coverage and total theft claim, we can use the observations from the full sample. When we conduct the above test for the conditional correlation between coverage and partial theft claim, we can use only a sub-sample of insured who have also purchased the auto parts accessories endorsement. Because we are estimating total theft claims, we test only for the existing effective contracts in each policy month. In other words, the contracts for which total claims have been filed are terminated and eliminated from our sample.

According to the first hypothesis, we test for the total theft claim (*k*=*t*) and replacement endorsement (*l*=*R*). If the estimated $\beta_{c,l,j}$, *l*=*R* in equation (2) is significantly positive only for some *j*-th policy months near the end of the policy year, it indicates moral hazard instead of pure adverse selection. Opportunistic fraud could be induced by the replacement cost endorsement. According to the second hypothesis, we test for the total theft claim (*k*=*t*) and no-deductible endorsement (*l*=*ND*). If the estimated $\beta_{c,l,j}$, *l*=*ND* in equation (2) is significantly positive only for some *j*-th policy months occurring early in the policy year, this points to moral hazard instead of pure adverse selection. Opportunistic fraud could thus be induced by the no-deductible endorsement.

When the particular time pattern emerges, we distinguish opportunistic fraud from ex ante moral hazard. According to the third hypothesis, we test the partial theft claim (*k*=*p*) for replacement cost endorsement (*l*=*R*) as well as for no-deductible endorsement (*l*=*ND*). If estimated $\beta_{c,l,j}$ s in equation (2) for all twelve policy months ($j = 1,...12$) in the policy year are insignificant, we can infer that the emerging claim timing patterns are evidence of opportunistic fraud instead of ex ante moral hazard.

We now have to test the relationship between opportunistic fraud and the business cycle. We can also test this relationship through a two-stage method. We keep the regression in the first stage unchanged. We then add the business cycle index to the explanatory variables in the regression of the second stage:

$$\begin{aligned}&\text{Prob}(\text{cov}erage_{lit} = 1 \mid X_{2it}, claim_{jkit}, claim_{jkit} * Buscyc_m, Pr\hat{o}b(claim_{jkit}))\\&= \Phi(X_{2it}\beta_{2,l,j} + \beta_{C,l,j} claim_{jkit} + \beta_{BC,l,j} claim_{jkit} * Buscyc_m + \beta_{ec,l,j} Pr\hat{o}b(claim_{jkit}))\end{aligned} \quad (3)$$

$Buscyc_m$ is the monthly business cycle index, which corresponds to each calendar month in each year with a potential claim. In our paper, the claim records are ranged among 108 months from January 2000 to December 2008, and are ranked from “0100” to “1208”.[18] We match each of the claim dates in our sample to its corresponding calendar date, and find the corresponding month for $Buscyc_m$. $Buscyc_m$ is introduced as an interaction term with $claim_{jki}$. The key

[18] The first two codes of *m* represent the calendar month, and the second two codes of *m* represent the calendar year. For example, *m*=0100 is for the business cycle index of January 2000.

coefficients used to measure the relationship between opportunistic fraud and the business cycle for contract l are $\beta_{BC,l,j}$ s during some *j*-th policy months. According to our fourth hypothesis, the opportunistic fraud rate could rise or decline with the recession according to either of the two conflicting effects. If fraud is more severe in a recession, for high coverage contract representing contracts with replacement cost endorsement, the $\beta_{BC,l,j}$ s (*l*=*R*) in equation (3) should be significantly negative only for those *j*-th policy months near the end of the whole policy year; for high coverage contracts representing the no-deductible contract, the $\beta_{BC,l,j}$ s (*l*=*ND*) in equation (3) should be significantly negative only for those *j*-th policy months at some beginning months of the policy year. This indicates that opportunistic fraud is more severe while the economy is in a recession. Conversely, if the estimated $\beta_{BC,l,j}$ s are significantly positive in the above-mentioned policy months, this affirms that opportunistic fraud is more severe while the economy is booming. Finally, if all the estimated $\beta_{BC,l,j}$ s are insignificant, the business cycle has no impact on opportunistic fraud.

5. Empirical results

The first empirical task is to identify whether opportunistic fraud exists in the automobile theft insurance market in Taiwan. We try to disentangle ex post moral hazard from adverse selection and ex ante moral hazard.

Table 3 shows that for total theft claims, the estimated $\beta_{c,l,j}$ s (*l*=*R*) are significantly positive only after the sixth policy month of the contract in the subsample of replacement cost endorsement contracts versus the reference contracts; the estimated $\beta_{c,l,j}$ s (*l*=*ND*) are significantly positive only before the third policy month of the contract in the subsample of no-deductible endorsement contracts versus the reference contracts.[19] The conditional correlations between coverage and claims exhibit significant time patterns under both contracts for total theft claims. The former finding is consistent with that of Dionne and Gagné (2002), and supports our first hypothesis. The second finding sustains the particular condition in our second hypothesis and its inference. Hence, these outcomes provide evidence only for the possible existence of opportunistic fraud rather than adverse selection.

In the case of partial theft claims, all of the estimated $\beta_{c,l,j}$ s are not significant in both subsamples, meaning that the conditional correlations between coverage and partial theft claims are all insignificant. These outcomes preclude the existence of ex ante moral hazard and confirm the evidence of opportunistic fraud. Therefore, our third hypothesis is supported. All the outcomes, which support the first to third hypotheses, confirm that opportunistic fraud is induced by the two contract characteristics: replacement cost endorsement and no-deductible endorsement.

Regarding the test associated with the business cycle, the empirical results of the estimated coefficients of $\beta_{C,l,j}$ and $\beta_{BC,l,j}$ in the second stage are listed in Table 4.[20] Because the test here is to identify the impact of the business cycle on opportunistic fraud, we need only test this relationship for total theft claims.

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[19] There are 48 pairs of regressions when we test the conditional correlation between two dimensions of claim (total theft claim as well as partial theft claim) and two dimensions of coverage (the coverage of contracts with replacement cost endorsement as well as the coverage of contracts with no-deductible endorsement). It is redundant to report complete results for all 48 pairs of regressions. Hence, we display only 48 key estimated coefficients ($\beta_{c,l,j}$) from the second-stage regression in Table 3, and report two examples of ensuing regression results in Appendix D.

[20] There are 24 pairs of regressions when we test the relationship between business cycle and opportunistic fraud. For similar reasons as before, it is redundant to report complete results for all 24 pairs of regressions. Hence, we display only the key estimated coefficients ($\beta_{C,l,j}$ and $\beta_{BC,l,j}$) from the second-stage regression in Table 4, and report two examples of these coefficients in Appendix E.

Table 4 demonstrates that under replacement cost endorsement, all of the estimated $\beta_{BC,l,j}$ s (l=R) are negative and are significant only after the 10th policy month. The estimated $\beta_{C,l,j}$ s retained their time pattern: they are significantly positive only for policy months near the end of the first policy year. Under a no-deductible contract (l=ND), all the estimated $\beta_{BC,l,j}$ s are still negative; they are significant only in the first two policy months. These outcomes mean that the conditional correlation between coverage and claim is stronger when economic conditions are deteriorating. The claim timing patterns for these types of contracts are reinforced by the business cycle. Such empirical evidence is consistent with the hypothesis that opportunistic fraud increases during a recession. The business cycle accentuates the timing pattern of the two contracts.

6. Conclusion

The main goal of this paper was to investigate the impact of the business cycle on opportunistic fraud. Few studies have associated the fraud problem with the surroundings, and none have discussed the impact of the business cycle on the severity of fraud. We find that opportunistic fraud is more severe during a recession.

We also test whether opportunistic fraud could be induced by different kinds of insurance contracts. We confirm that there are particular time patterns for total theft claims induced by replacement cost endorsement and no-deductible endorsement. We separate this evidence from adverse selection. We also find that these particular claim timing patterns exist only in total theft claims, as opposed to partial theft claims. This additional evidence serves to differentiate opportunistic fraud from ex ante moral hazard. These conclusions corroborate the finding of Dionne and Gagné (2002).

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Appendices

Appendix A: The relationship between Taiwan's auto theft insurance loss ratio of non-commercial vehicles and GDP

Year	Loss ratio	GDP
1998	66.93	9,204,174
1999	62.67	9,649,049
2000	54.38	10,187,394
2001	56.64	9,930,387
2002	54.81	10,411,639
2003	49.55	10,696,257
2004	47.83	11,365,292
2005	45.87	11,740,279
2006	39.47	12,243,471
2007	35.72	12,910,511
2008	36	12,698,501
2009	36.83	12,512,678

Note: The yearly loss ratio data come from the Taiwan Insurance Institute. The yearly GDP data come from the Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. The unit of GDP is million NT dollars. We estimated the correlation coefficient between the loss ratio and GDP for these twelve years. The correlation coefficient is -0.98896, and is significantly different from 0 at 1% of significance level.

Appendix B: Opportunistic fraud under replacement cost endorsement

Assume that the consumer is risk-averse. The expected utility of an insured is equal to

$$gU(W+\theta\frac{A}{h(t)}+A-D)+(1-g)U(W)\ ,$$

where U is the utility function for the risk averse individual, W is the person's wealth, not including the value of the vehicle, A is the market value of the vehicle at the beginning of the policy year, $h(t)$ is the depreciation rate for the market value of the vehicle, which is an increasing function of time t, and t denotes the month of the policy year. θ is the discount rate when the fraudulent individual sells his vehicle on the black market, $0\le\theta\le 1$. D is the deductible specified in the contract. g is the probability of the fraud being successful.

The model assumes that the market value of the vehicle will be totally expropriated if the fraudulent behavior of the individual is discovered by the insurance company. This causes the wealth level of the fraudulent individual who is caught to be limited to W.

The individual will defraud if

$$gU(W+\theta\frac{A}{h(t)}+A-D)+(1-g)U(W)\ge U(W+\frac{A}{h(t)})\ .$$

There exists a critical value of the probability ($\tilde{g}$) at which there is indifference between being honest and dishonest:

$$\tilde{g}U(W+\theta\frac{A}{h(t)}+A-D)+(1-\tilde{g})U(W)=U(W+\frac{A}{h(t)})\ .$$

Furthermore, this critical value of the probability of the fraud being successful is:

$$\tilde{g}=\frac{U(W+\frac{A}{h(t)})-U(W)}{U(W+\theta\frac{A}{h(t)}+A-D)-U(W)}\ .$$

The expected utility function of an individual who has a probability (α) of engaging in fraudulent behavior can therefore be written as:

$$EU = \alpha[\tilde{g}U(W + \theta \frac{A}{h(t)} + A - D) + (1 - \tilde{g})U(W)] + (1 - \alpha)U(W + \frac{A}{h(t)}) .$$

The individual has a probability equal to one of engaging in fraud when the probability of the fraud being successful is above $\tilde{g}$. On the contrary, the individual has a probability equal to zero of engaging in fraud when the probability of the fraud being successful is below $\tilde{g}$. In addition, there is a probability of fraud of between 1 and 0 when the probability of the fraud being successful is equal to $\tilde{g}$. To summarize, the probability of an individual engaging in fraud decreases with $\tilde{g}$.

As time increases:

$$\frac{d\tilde{g}}{dt} = \{\frac{-[U(W + \frac{A}{h(t)}) - U(W)]U'(W + \theta \frac{A}{h(t)} + A - D)[-(\theta \frac{A}{h(t)^2})]}{[U(W + \theta \frac{A}{h(t)} + A - D) - U(W)]^2}$$

$$+ \frac{U'(W + \frac{A}{h(t)})(-\frac{A}{h(t)^2})}{[U(W + \theta \frac{A}{h(t)} + A - D) - U(W)]}\}h'(t) .$$

We restate the denominator (den) of the above equation as:

$$den = U(W + \theta \frac{A}{h(t)} + A - D) - U(W) ,$$

$$\frac{d\tilde{g}}{dt} = \frac{(\frac{A}{h(t)^2})}{(den)^2}\{[U(W + \frac{A}{h(t)}) - U(W)]U'(W + \theta \frac{A}{h(t)} + A - D)\theta$$
$$-[U(W + \theta \frac{A}{h(t)} + A - D) - U(W)]U'(W + \frac{A}{h(t)})\}h'(t).$$

Because the incentive for an individual to engage in fraud is higher when $\theta \frac{A}{h(t)} + A - D \geq \frac{A}{h(t)}$, the first set of square brackets is smaller than the second set in the above equation, and the first derivative of the utility under $W + \theta \frac{A}{h(t)} + A - D$ is also smaller than the corresponding derivative under $W + \frac{A}{h(t)}$. In addition, θ is between 0 and 1. All of these factors make the value inside the brackets negative. Moreover, $h'(t) > 0$, hence the sign of the above equation ($\frac{d\tilde{g}}{dt}$) is negative.

The above analysis infers that $\tilde{g}$ will decrease with t, and that the probability α will increase with t. Hence, the probability of individual (α) engaging in fraud is higher near the end of the policy year. If the audit probability of the insurance company is flat over the whole policy year, the equilibrium rate of fraud could also be higher near the end of the policy year.

Appendix C: Opportunistic fraud under the no-deductible contract

First, we examine whether the incentive of opportunistic fraud is higher under a no-deductible endorsement.

We still assume the individual is risk-averse,

$$gU(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)}-D)+(1-g)U(W).$$

Hence, the individual's insurance contract is indemnified with depreciation. The depreciation rate ($k(t)$) increases with time t. Furthermore, the depreciation rate from the indemnity of the insurance company ($k(t)$) is more stringent than that in the market ($h(t)$), i.e., $k(t)>h(t)$ and $\frac{1}{k(t)^2}k'(t)>\frac{1}{h(t)^2}h'(t)\ \forall t$. The definitions of g, W, θ, and A are the same as those in the model in Appendix B. The totally expropriated constraint is also the same as in Appendix B.

There exists a critical value of the probability ($\tilde{g}$) of the fraud being successful at which there is indifference between being honest and dishonest:

$$\tilde{g}U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)}-D)+(1-\tilde{g})U(W)=U(W+\frac{A}{h(t)}).$$

Furthermore, this critical value of the probability of the fraud being successful is:

$$\tilde{g}=\frac{U(W+\frac{A}{h(t)})-U(W)}{U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)}-D)-U(W)}=\frac{\Delta_1}{\Delta_2}.$$

As the deductible increases:

$$\frac{d\tilde{g}}{dD}=\frac{\Delta_1}{(\Delta_2)^2}U'(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)}-D)>0.$$

The above inequality means that the deductible increases, as does the critical value of the probability of successful fraud, while the incentive to defraud decreases. Hence, people who purchase no-deductible contracts have a stronger incentive to defraud.

We also discuss the claim timing pattern for the contract with depreciation but without deductible. The expected utility of an individual to defraud under such a contract is as follows:

$$gU(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})+(1-g)U(W).$$

There exists a critical value of the probability of the fraud being successful ($\tilde{g}$) at which point the individual is indifferent between being honest and being dishonest:

$$\tilde{g}U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})+(1-\tilde{g})U(W)=U(W+\frac{A}{h(t)}).$$

Furthermore, this critical value of the probability of the fraud being successful is:

$$\tilde{g}=\frac{U(W+\frac{A}{h(t)})-U(W)}{U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})-U(W)}.$$

The expected utility function of an individual who has the probability (α) of engaging in fraud is therefore expressed as follows:

$$EU=\alpha[\tilde{g}U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})+(1-\tilde{g})U(W)]+(1-\alpha)U(W+\frac{A}{h(t)}).$$

The individual has a probability of 1 of engaging in fraud when the probability of the fraud being successful is above $\tilde{g}$. On the contrary, the individual has a probability of 0 of engaging in fraud when the probability of the fraud being successful is below $\tilde{g}$. Finally, the individual has a probability of fraud of between 1 and 0 when the probability of the fraud being successful equals $\tilde{g}$. To summarize, the probability of the individual's engaging in fraud decreases with $\tilde{g}$. As time increases:

$$\frac{d\tilde{g}}{dt}=\frac{-[U(W+\frac{A}{h(t)})-U(W)]U'(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})[-(\theta\frac{A}{h(t)^2}h'(t)+\frac{A}{k(t)^2}k'(t))]}{[U(W+\theta\frac{A}{t}+\frac{A}{t})-U(W)]^2}$$

$$+\frac{U'(W+\frac{A}{h(t)})(-\frac{A}{h(t)^2})h'(t)}{[U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})-U(W)]}.$$

We restate the denominator of the above equation as $den=U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})-U(W)$,

$$\frac{d\tilde{g}}{dt}=\frac{-1}{(den)^2}\{[U(W+\tfrac{A}{h(t)})-U(W)]U'(W+\theta\tfrac{A}{h(t)}+\tfrac{A}{k(t)})(\theta\tfrac{A}{h(t)^2}h'(t)+\tfrac{A}{k(t)^2}k'(t))$$
$$-[U(W+\theta\tfrac{A}{h(t)}+\tfrac{A}{k(t)})-U(W)]U'(W+\tfrac{A}{h(t)})(\tfrac{A}{h(t)^2}h'(t))\}.$$

Here, the first set of square brackets is smaller than the second set of square brackets and the first derivative of the utility function under $W+\theta\frac{A}{h(t)}+\frac{A}{k(t)}$ is smaller than the first derivative of the utility under $W+\frac{A}{h(t)}$. However, the term $(\theta\frac{A}{h(t)^2}h'(t)+\frac{A}{k(t)^2}k'(t))$ could be higher than the term $(\frac{A}{h(t)^2}h'(t))$, which makes the value inside the brackets ambiguous. If the value of θ is large enough so that:

$$\theta>\frac{[U(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})-U(W)]U'(W+\frac{A}{h(t)})}{[U(W+\frac{A}{h(t)})-U(W)]U'(W+\theta\frac{A}{h(t)}+\frac{A}{k(t)})}-\frac{\frac{A}{k(t)^2}k'(t)}{\frac{A}{h(t)^2}h'(t)},$$

the above condition will make the sign of $\frac{d\tilde{g}}{dt}$ positive. This condition is especially true when the depreciation for the indemnity provided by the insurance company is much higher than the depreciation in the market, i.e., $k(t)>>h(t)$ and $\frac{A}{k(t)^2}k'(t)>>\frac{A}{h(t)^2}h'(t)$.

The above inference implies that while the vehicle depreciation from the insurer's indemnity is much more stringent than that in the market, if the incentive to cheat is large enough (the discount on vehicles sold on the black market $(1-\theta)$ is not too high), $\tilde{g}$ will increase with t, and α will decrease with t. Hence, the probability of individual (α) engaging in fraud will be higher at the beginning of the contract period. If the probability of the insurance company conducting an audit remains flat over the whole of the policy year, the equilibrium rate of fraud may also be higher at the beginning of the policy year.

Lastly, we discuss the relative claim timing pattern for the contract with depreciation and no-deductible endorsement in contrast to the reference contract.

We consider the impact of timing on the incentive induced by the no-deductible endorsement. In other words, we consider the impact of t on $\frac{d\tilde{g}}{dD}$. Let $H = \frac{d\tilde{g}}{dD}$,

$$\frac{dH}{dt} = \frac{1}{(\Delta_2)^3}\left[\Delta_1\Delta_2 U''(R_1) - 2\Delta_1 U'(R_1)\right] \left[\theta \frac{A}{h(t)^2} h'(t) + \frac{A}{k(t)^2} k'(t)\right] + U'(R_1)U'(R_2)(\frac{A}{h(t)^2} h'(t)),$$

where $R_1 = W + \theta \frac{A}{h(t)} + \frac{A}{k(t)} - D$, $R_2 = W + \frac{A}{h(t)}$. The sign of this derivative is ambiguous. Because the term before the plus sign is negative, the term after the plus sign is positive, and the net value of these two terms are uncertain. Hence, if the term before the plus sign is larger than the latter , the above equation is negative. This means that the degree of critical value of fraud probability decreases from month to month during a policy year. In other words, the degree that no-deductible endorsement contracts create a relatively higher incentive to defraud decreases over time. This corresponds to the second part of our second hypothesis, which states that the probability of fraud (for no-deductible endorsement contracts) is higher at the beginning of the policy year.

Appendix D: Complete empirical results of the 12th policy month of Model (1), and the 1st policy month of Model (2)

Variables	*12th policy month in model (1)*				*1st policy month in model (2)*			
	1st stage		*2nd stage*		*1st stage*		*2nd stage*	
	Estimate	*P-value*	*Estimate*	*P-value*	*Estimate*	*P-value*	*Estimate*	*P-value*
Intercept	-17.253	0.890	-0.481	<.0001	-18.772	0.845	-0.561	<.0001
clm_hat			0.121	0.063			1.972	0.001
clm_1			1.703	<.0001			0.894	0.022
sexf	-0.065	0.087	0.129	<.0001	-0.138	<.0001	0.226	0.008
marria_	0.067	0.290	-0.288	<.0001	-0.037	0.547	0.087	0.001
age1	4.402	0.001	-0.812	0.036	3.379	0.995	-7.157	0.001
age2	4.241	0.003	-0.398	0.293	3.085	0.995	-6.724	<.0001
age3	3.957	0.007	-0.193	0.596	2.852	0.996	-6.411	<.0001
age4	3.978	0.007	-0.228	0.534	2.883	0.996	-6.472	<.0001
age5	-0.997	0.999	0.312	0.252	2.809	0.996	-6.231	<.0001
carage0	0.673	0.011	0.164	<.0001	0.285	<.0001	-0.768	<.0001
carage1	0.377	0.002	0.339	<.0001	0.257	<.0001	-0.340	0.032
carage2	0.233	0.004	0.340	<.0001	0.256	<.0001	-0.454	0.004
carage3	-0.032	0.771	0.265	<.0001	0.200	0.006	-0.361	0.004
carage4	0.171	0.070	0.160	<.0001	0.157	0.045	-0.300	0.002
city	0.100	0.009	-0.303	<.0001	0.083	0.041	-0.169	0.001
north	-0.143	0.003	0.931	<.0001	-0.295	0.000	0.565	0.002
south	0.045	0.340	-1.298	<.0001	-0.089	0.055	0.162	0.004
east	-0.327	0.093	-1.283	<.0001	-0.060	0.591	0.345	<.0001
tramak_n	-0.021	0.943	0.776	<.0001	-5.230	0.988	10.338	0.001
tramak_f	-0.058	0.386	-0.468	<.0001	-0.094	0.178	0.086	0.149
tramak_h	0.176	0.003	-0.172	<.0001	0.204	<.0001	-0.469	<.0001
tramak_t	-0.081	0.073	1.205	<.0001	-0.056	0.254	-0.094	0.008
tramak_c	0.180	0.006	-0.209	<.0001	0.079	0.228	-0.200	0.021
catpcd_1	0.356	0.014	0.798	<.0001	0.022	0.820	-0.617	0.003
catpcd_2	0.457	0.023	-0.548	0.003	0.307	0.023	-0.334	0.019
vehcc_s	-0.031	0.879	-0.237	0.147	-0.028	0.879	-0.512	0.008
channel_D	-0.002	0.913	-0.688	0.006	-0.007	0.801	-0.341	0.011
channel_R	-0.082	0.213	0.439	0.012	-0.069	0.277	0.397	0.010
channel_T	0.019	0.233	-0.511	0.006	0.013	0.201	-0.486	<.0001

channel_L	-0.071	0.308	-0.398	0.017	-0.054	0.429	-0.217	0.020
channel_F	0.009	0.879	-0.487	0.021	0.011	0.711	-0.610	0.005
channel_A	-0.121	0.137	-0.508	0.010	-0.175	0.168	-0.113	0.042
y_2000	0.217	0.781	-1.021	<.0001	0.303	0.500	0.998	<.0001
y_2001	0.268	0.645	1.130	<.0001	0.191	0.712	0.716	<.0001
y_2002	0.277	0.598	-1.044	<.0001	0.301	0.511	0.823	<.0001
y_2003	0.262	0.523	-1.211	<.0001	0.198	0.698	0.645	<.0001
y_2004	0.227	0.618	1.037	<.0001	0.288	0.516	0.811	<.0001
y_2005	0.213	0.790	-1.002	<.0001	0.192	0.689	0.930	<.0001
y_2006	0.298	0.433	-0.581	<.0001	0.411	0.322	0.752	<.0001
Hausman test	2.83		1.97		2.07		1.33	

Note : In model (1), we estimate the conditional correlation between total theft claim and the contract coverage replacement cost endorsement.

In model (2), we estimate the conditional correlation between total theft claim and the contract coverage no-deductible endorsement.

We applied the Hausman test and did not reject the random effect model. The computed chi-square statistics are reported in the table.

Appendix E: Complete empirical results of the 12th policy month of Model (1'), and the 1st policy month of Model (2')

Variables	*12th policy month in model (1')*				*1st policy month in model (2')*			
	1st stage		*2nd stage*		*1st stage*		*2nd stage*	
	Estimate	*P-value*	*Estimate*	*P-value*	*Estimate*	*P-value*	*Estimate*	*P-value*
Intercept	-17.253	0.890	-0.875	<.0001	-18.772	0.845	-0.766	<.0001
clm_hat			2.836	0.524			5.448	0.481
clm_1			15.000	0.025			9.276	0.018
*clm*Buscyc*			-0.148	0.038			-0.093	0.016
sexf	-0.065	0.087	0.011	<.0001	-0.138	<.0001	-0.861	0.421
*marria_*	0.067	0.290	-0.537	<.0001	-0.037	0.547	-0.190	0.536
age1	4.402	0.001	-12.562	0.145	3.379	0.995	22.629	0.362
age2	4.241	0.003	-11.727	0.907	3.085	0.995	21.096	0.436
age3	3.957	0.007	-10.872	0.644	2.852	0.996	19.963	0.489
age4	3.978	0.007	-10.929	0.670	2.883	0.996	20.050	0.484
age5	-0.997	0.999	2.345	0.921	2.809	0.996	20.099	0.491
carage0	0.673	0.011	-1.394	<.0001	0.285	<.0001	1.296	0.550
carage1	0.377	0.002	-0.907	<.0001	0.257	<.0001	1.101	0.573
carage2	0.233	0.004	-0.720	<.0001	0.256	<.0001	1.133	0.562
carage3	-0.032	0.771	0.007	<.0001	0.200	0.006	1.028	0.505
carage4	0.171	0.070	-0.609	<.0001	0.157	0.045	0.494	0.677
city	0.100	0.009	-0.425	<.0001	0.083	0.041	0.415	0.517
north	-0.143	0.003	1.472	<.0001	-0.295	0.000	-1.507	0.508
south	0.045	0.340	-0.594	<.0001	-0.089	0.055	-0.554	0.430
east	-0.327	0.093	-0.011	<.0001	-0.060	0.591	-0.389	0.458
tramak_n	-0.021	0.943	0.868	<.0001	-5.230	0.988	-34.947	0.997
tramak_f	-0.058	0.386	-0.038	<.0001	-0.094	0.178	-0.477	0.521
tramak_h	0.176	0.003	-1.222	<.0001	0.204	<.0001	1.230	0.440
tramak_t	-0.081	0.073	0.940	<.0001	-0.056	0.254	-0.445	0.332
tramak_c	0.180	0.006	-0.491	0.017	0.079	0.228	0.387	0.502
catpcd_1	0.356	0.014	0.836	<.0001	0.022	0.820	-0.745	0.002
catpcd_2	0.457	0.023	-0.620	<.0001	0.307	0.023	-0.869	<.0001
vehcc_s	-0.031	0.879	-0.125	<.0001	-0.028	0.879	-0.238	<.0001
channel_D	-0.002	0.913	-0.701	0.001	-0.007	0.801	-0.544	0.002

channel_R	-0.082	0.213	0.537	0.007	-0.069	0.277	0.312	0.011
channel_T	0.019	0.233	-0.562	0.007	0.013	0.201	-0.076	0.065
channel_L	-0.071	0.308	-0.427	0.010	-0.054	0.429	-0.297	0.114
channel_F	0.009	0.879	-0.672	0.006	0.011	0.711	-0.581	0.003
channel_A	-0.121	0.137	-0.629	0.005	-0.175	0.168	-0.267	0.218
y_2000	0.217	0.781	-1.345	<.0001	0.303	0.500	0.839	<.0001
y_2001	0.268	0.645	1.394	<.0001	0.191	0.712	0.764	<.0001
y_2002	0.277	0.598	-1.907	<.0001	0.301	0.511	1.011	<.0001
y_2003	0.262	0.523	-1.720	<.0001	0.198	0.698	0.876	<.0001
y_2004	0.227	0.618	1.007	<.0001	0.288	0.516	0.882	<.0001
y_2005	0.213	0.790	-1.609	<.0001	0.192	0.689	0.988	<.0001
y_2006	0.298	0.433	-0.425	<.0001	0.411	0.322	1.032	<.0001
Hausman test	2.83		2.05		2.07		1.98	

Note : In model (1’), we estimate the conditional correlation between total theft claim and the contract coverage replacement cost endorsement.

In model (2’), we estimate the conditional correlation between total theft claim and the contract coverage no-deductible endorsement.

We applied the Hausman test and did not reject the random effect model. The computed chi-square statistics are reported in the table.

Table 1　Definitions of variables

Variable	**Definition**
claim_jki$_t$	A variable that equals 1 when policy-holder_i has filed a *k*-type theft claim in the *j*-th month during the policy year *t*, *j*=1 to 12, *k*=*t* or *p*, (*t* means total theft, and *p* means partial theft), and 0 otherwise.
cvrgcd_H	A variable that equals 1 when the theft insurance contract has a replacement cost endorsement, and 0 otherwise.
cvrgcd_HH	A variable that equals 1 when the theft insurance contract is a no-deductible contract, and 0 otherwise.
sexf	A variable that equals 1 if the insured is female, and 0 otherwise.
*marria_*	A variable that equals 1 if the insured is married, and 0 otherwise.
Age2025	A variable that equals 1 if the insured is between the ages of 20 and 25, and 0 otherwise.
age2530	A variable that equals 1 if the insured is between the ages of 25 and 30, and 0 otherwise.
age3060	A variable that equals 1 if the insured is between the ages of 30 and 60, and 0 otherwise.
age6070	A variable that equals 1 if the insured is between the ages of 60 and 70, and 0 otherwise.
ageabove70	A variable that equals 1 if the insured is over 70 years old, and 0 otherwise.
carage0	A variable that equals 1 when the car is under one year old, and 0 otherwise.
carage1	A variable that equals 1 when the car is one year old, and 0 otherwise.
carage2	A variable that equals 1 when the car is two years old, and 0 otherwise.
carage3	A variable that equals 1 when the car is three years old, and 0 otherwise.
carage4	A variable that equals 1 when the car is four years old, and 0 otherwise.
city	A variable that equals 1 when the owner of the car lives in a city, and 0 otherwise.
North	A variable that equals 1 when the car is registered in the north of Taiwan, and 0 otherwise.
south	A variable that equals 1 when the car is registered in the south of Taiwan, and 0 otherwise.
east	A variable that equals 1 when the car is registered in the east of Taiwan, and 0 otherwise.
tramak_q	A variable that equals 1 when the vehicle is brand *q*, *q*=*n*, *f*, *h*, *t*, *c*, and 0

	otherwise.
catpcd_1	A variable that equals 1 when the car is a sedan and is for non-commercial or for long-term rental purposes, and 0 otherwise.
catpcd_2	A variable that equals 1 when the vehicle is a small freight truck used for non-commercial purposes, and 0 otherwise
vehcc_s	A variable that equals 1 when the insured car has an engine capacity that is 2000 c.c. or less, and 0 otherwise.
channel_m	A variable that equals 1 when the policy is sold through the *m* channel, *m*=*D*, *R*, *T*, *L*, *F*, *A*, and 0 otherwise.
year_t	A variable that equals 1 when the data belong to the policy year *n*, *t*=2000 to 2006, and 0 otherwise.

Note: (1) Both the variables *cvrgcd_H* and *cvrgcd_HH* use the contracts with a deductible and with depreciation as the reference group.

(2) The reference group of variables *age2025* to *ageabove70* is the group of insured whose age is under 20.

(3) The reference group of variables from *carage0* to *carage4* is the group of cars over four years old.

(4) The reference group for the three variables of area includes the cars registered in central Taiwan.

(5) The reference group for the policy year variables is the group of data from the policy year 2007.

Table 2 Descriptive statistics

Variable	Mean	Std. Dev.
cvrgcd_H	0.3292	0.4699
cvrgcd_HH	0.0248	0.1554
sexf	0.6255	0.4840
*marria_*	0.9123	0.2828
age2025	0.0091	0.0949
age2530	0.0639	0.2446
age3060	0.8797	0.3253
age6070	0.0410	0.1986
ageabove70	0.0066	0.0773
carage0	0.2070	0.3942
carage1	0.1545	0.3694
carage2	0.1371	0.3462
carage3	0.1190	0.3213
carage4	0.1014	0.2978
city	0.5351	0.4988
north	0.4795	0.4996
south	0.2784	0.4482
east	0.0229	0.1496
tramak_n	0.0062	0.0743
tramak_f	0.1049	0.3064
tramak_h	0.0788	0.2585
tramak_t	0.3929	0.4884
tramak_c	0.0823	0.2773
catpcd_1	0.9643	0.1817
catpcd_2	0.0183	0.1237
vehcc_s	0.6427	0.4792
channel_D	0.4177	0.4971
channel_R	0.0004	0.0201
channel_T	0.0040	0.0594
channel_L	0.0330	0.1417
channel_F	0.0145	0.1224
channel_A	0.0278	0.1726

Table 3 Conditional correlation between coverage and claim

Policy months	Total theft claim (*k*=*t*)		Partial theft claim (*k*=*p*)	
	Model (1) Replacement (*l*=*R*)	Model (2) No-deductible (*l*=*ND*)	Model (3) Replacement (*l*=R)	Model (4) No-deductible (*l*=*ND*)
1st policy month	0.287	0.894	0.213	0.097
(*j*=*1*)	(0.221)	(0.022)	(0.211)	(0.623)
2nd policy month	0.301	0.507	0.165	0.209
(*j*=*2*)	(0.192)	(0.040)	(0.332)	(0.301)
3rd policy month	0.141	0.389	0.194	0.174
(*j*=*3*)	(0.541)	(0.079)	(0.272)	(0.283)
4th policy month	0.230	0.198	0.091	0.097
(*j*=*4*)	(0.188)	(0.299)	(0.609)	(0.531)
5th policy month	0.092	0.168	0.062	0.109
(*j*=*5*)	(0.681)	(0.395)	(0.478)	(0.238)
6th policy month	0.523	0.114	0.097	0.074
(*j*=*6*)	(0.023)	(0.422)	(0.581)	(0.652)
7th policy month	0.965	0.138	0.100	0.039
(*j*=*7*)	(<0.0001)	(0.321)	(0.270)	(0.884)
8th policy month	0.683	0.045	0.081	0.052
(*j*=*8*)	(0.002)	(0.761)	(0.613)	(0.688)
9th policy month	0.731	0.039	0.122	0.189
(*j*=*9*)	(0.003)	(0.812)	(0.297)	(0.258)
10th policy month	0.552	0.005	0.013	0.047
(*j*=*10*)	(0.019)	(0.974)	(0.899)	(0.768)
11th policy month	1.356	0.094	0.057	0.005
(*j*=*11*)	(<0.0001)	(0.592)	(0.682)	(0.923)
12th policy month	1.703	0.211	0.079	0.075
(*j*=*12*)	(<0.0001)	(0.228)	(0.672)	(0.691)

Note: The P-values are in parentheses. All the values displayed in the above table are the estimated coefficients of $\beta_{c,l,j}$. We test the conditional correlation between coverage and claim by $\beta_{c,l,j}$. For each policy month (*j*, *j*=1~12), we estimate the conditional correlation between claim (*k*, *k*=*t* represents total theft claim; *k*=*p* represents partial theft claim) and contract coverage (*l*, *l*=*R* represents replacement cost endorsement; *l*=*ND* represents no-deductible contract) by the two stage method. In model (1), we estimate the conditional correlation between total theft claims and the coverage of contracts with replacement cost endorsement. In model (2), we estimate the conditional correlation between total theft claims and the coverage of contracts with no-deductible endorsement. In model (3), we estimate the conditional correlation between partial theft claims and the coverage of contracts with replacement cost endorsement. In model (4), we estimate the conditional correlation between partial theft claims and the coverage of contracts with no-deductible endorsement.

When we conducted a two-stage conditional correlation analysis on the above 48 pairs, we applied the Hausman test to each of the 96 regressions. In all cases, the results do not reject the random effect model.

Table 4 Relationship between opportunistic fraud and the business cycle

—the panel data model

Policy months	Model (1') replacement (*l*=*R*)		Model (2') no-deductible (*l*=*ND*)	
	Coefficient $\beta_{C,l,j}$	Coefficient $\beta_{BC,l,j}$	Coefficient $\beta_{C,l,j}$	Coefficient $\beta_{BC,l,j}$
1st policy month	0.203	-0.003	9.276	-0.093
(*j=1*)	(0.962)	(0.946)	(0.018)	(0.016)
2nd policy month	2.073	-0.018	14.667	-0.153
(*j=2*)	(0.656)	(0.695)	(0.065)	(0.062)
3rd policy month	3.013	-0.030	6.171	-0.064
(*j=3*)	(0.561)	(0.565)	(0.213)	(0.207)
4th policy month	4.924	-0.053	6.348	-0.065
(*j=4*)	(0.347)	(0.314)	(0.261)	(0.260)
5th policy month	2.947	-0.030	3.139	-0.033
(*j=5*)	(0.526)	(0.515)	(0.256)	(0.221)
6th policy month	3.019	-0.033	8.242	-0.088
(*j=6*)	(0.541)	(0.511)	(0.293)	(0.274)
7th policy month	2.706	-0.030	2.621	-0.023
(*j=7*)	(0.614)	(0.573)	(0.460)	(0.461)
8th policy month	0.552	-0.007	1.952	-0.018
(*j=8*)	(0.924)	(0.908)	(0.562)	(0.596)
9th policy month	5.540	-0.052	2.222	-0.023
(*j=9*)	(0.375)	(0.407)	(0.619)	(0.629)
10th policy month	11.620	-0.125	2.140	-0.023
(*j=10*)	(0.063)	(0.093)	(0.692)	(0.680)
11th policy month	13.658	-0.145	1.216	-0.009
(*j=11*)	(0.050)	(0.040)	(0.666)	(0.737)
12th policy month	15.000	-0.148	0.707	-0.007
(*j=12*)	(0.025)	(0.038)	(0.871)	(0.879)

Note: P-values are in parentheses. All the values displayed above are the estimated coefficients of $\beta_{C,l,j}$ and $\beta_{BC,l,j}$. We test the conditional correlation between coverage and claim by $\beta_{C,l,j}$. We test the correlation between opportunistic fraud and the business cycle by $\beta_{BC,l,j}$. For each policy month (*j*, *j*=1~12), we estimate the condition correlation between claim (We test only for total theft claim here, hence *k*=*t* only.) and contract coverage (*l*, *l*=*R* represents replacement cost endorsement; *l*=*ND* represents no-deductible contract) using the two-stage method. In model (1'), we estimate the conditional correlation between total theft claim and the coverage of contracts with replacement cost endorsement. In model (2'), we estimate the conditional correlation between total theft claims and the coverage of contract with no-deductible endorsement.

When we conducted the two-stage conditional correlation analysis on the above 24 pairs, we applied the Hausman test to each of the 48 regressions. In all cases, the results do not reject the random effect model.