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Typhoons and Opportunistic Fraud: Claim Patterns of Automobile Theft Insurance in Taiwan

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Abstract

We present evidence to support the existence of opportunistic fraud in the automobile theft insurance market in Taiwan. After encountering a typhoon hit, the insured who purchase automobile theft insurance but do not purchase typhoon/flood insurance tend to have a significantly higher probability of filing a total theft claim than other insured. The above relationship exists mainly in places affected by typhoons. Such evidence does not exist in partial theft claim. These claim patterns of automobile theft insurance provide us with strong evidence that supports the existence of opportunistic fraud in the market.

Introduction

Fraud has been a serious threat to insurance companies throughout the world.[1] Cummins and Tennyson (1992, 1996), Tennyson (1997), Carroll and Abrahamse (2001), and Dionne and Gagné (2001, 2002) all provide evidence regarding the existence of fraud in the automobile insurance market. Meanwhile, Dionne (1984), Sparrow (1996),

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[1]The Automobile Insurers Rating Bureau of Massachusetts (1990), Florida Insurance Research Center (1991), Weisberg and Derrig (1991, 1992), and Derrig et al. (2006) find fraud to exist in many U.S. states. Foppert (1994) points out that the annual cost of fraud in the United States amounts to nearly $70 billion. Dionne and Belhadji (1996) and Caron and Dionne (1999) find fraud in Canada. Medza (1998) points out that the Insurance Bureau of Canada has estimated the total annual cost of fraud to be about $2 billion.

Hyman (2001, 2002), and Sulzle and Wambach (2005) provide evidence of fraud in the health insurance market. On the other hand, Dionne and St-Michel (1991) and Butler et al. (1996) provide such evidence on the basis of workers' compensation insurance. Following this line of research, this article intends to provide other empirical evidence to support the existence of opportunistic fraud in the automobile theft insurance market.

Our article is closely related to that of Dionne and Gagné (2002) who identify opportunistic fraud by finding that the insurance contracts with replacement cost endorsement had a higher probability of total theft claims and that those claims were particularly concentrated near the end of the policy period. By following their idea that opportunistic fraud may result in a particular time pattern insofar as claims are concerned, this article intends to investigate a special pattern of claims in the automobile theft insurance market in Taiwan. Although Dionne and Gagné explore the time pattern of opportunistic fraud near the end of the policy period, we study the particular claim pattern of opportunistic fraud when the insured has encountered a specific event, namely, a huge typhoon hit. In their article, Dionne and Gagné identify opportunistic fraud by comparing claim patterns between insurance contracts both with and without replacement cost endorsements. In this article, we examine the opportunistic fraud problem between the insured who purchase only automobile theft insurance and the insured who purchase both automobile theft insurance and typhoon/flood insurance.

In Taiwan, automobile theft claims have sometimes experienced a sharp increase right after typhoons, which caused floods. Why are the occurrences of automobile theft and typhoon incidents correlated? There are two competing hypotheses. First, many of the vehicles that have theft insurance have been damaged by flooding. This may have given some opportunistic vehicle owners with only theft insurance (without typhoon/flood insurance) an incentive to lie to the insurance company by stating that their vehicle had been stolen.[2] They thereby filed a total theft claim. Second, the typhoon has resulted in many flood-damaged cars being in need of repair. The demand for automobile parts on the black market thus dramatically increases at such times. This may have increased the incentive for car thieves to work particularly hard after a typhoon hit and resulted in a higher rate of automobile theft claims.

The way we disentangle opportunistic fraud from ordinary theft is through the type of insurance coverage that the insured had when he or she has encountered a huge typhoon hit. If the insured vehicles were damaged by a typhoon, those insured with only theft insurance coverage but without typhoon/flood insurance coverage could not make a claim against the losses incurred due to the typhoon. Hence, the opportunistic fraud could have been perpetrated by those with only automobile theft insurance who did not purchase typhoon/flood insurance, in contrast to those with both types of coverage. On the other hand, the increase in theft caused by the increase in demand for automobile parts on the black market provided no basis for pointing at either one of these two groups of insured. This therefore provides us with a good

[2]In Taiwan, car owners can voluntarily choose to purchase automobile theft insurance as well as typhoon/flood insurance. Accordingly, some of the insured with automobile theft insurance also have coverage for typhoon/flood insurance simultaneously, while some of them do not.

opportunity to disentangle fraudulent claims based on opportunism from ordinary theft claims.

We test the conditional correlation between the automobile total theft claims and the insurance coverage according to whether the insured has encountered a typhoon hit or not. When we identify whether the insured has encountered a typhoon hit, we identify two dimensions: whether it is during the period right after the typhoon hit and whether the insured lives in the typhoon-hit region. The evidence of opportunistic fraud is identified by the significantly conditional correlation between the total theft claim and the coverage with only automobile theft insurance among the insured who have encountered a typhoon hit, namely, among the insured who live in the typhoon-hit region and measured during the period right after a typhoon.

Our data are obtained from a large insurance company in Taiwan and cover the period from 2004 to 2008. We test whether opportunistic fraud exists for each of 10 typhoons, which resulted in more than 800 millimeters of cumulative rainfall. For each typhoon, our sample includes more than 0.2 million insured who purchased automobile theft insurance coverage.

We first find that among the insured who encountered a typhoon hit, the insured who purchased automobile theft insurance but did not purchase typhoon/flood insurance had a significantly higher possibility of filing a total theft claim than the insured who purchased both types of coverage. These empirical results introduce the particular claim pattern and support the view that opportunistic fraud exists in the market. To further confirm this claim pattern, we compare this conditional correlation among the insured who have not encountered a typhoon hit. We find no evidence of such a relationship for those insured who live in other regions, or for the periods before the typhoon. By showing that the insurance coverage and the total theft claims are only significantly related among the insured who have encountered a typhoon hit but not for others, the empirical evidence strengthens our argument with regard to the existence of a particular claim pattern brought about by the opportunistic fraud.

Dionne and Gagné (2002) also point out that opportunistic fraud requires a sufficient monetary incentive. In Taiwan, some insured with total theft insurance can purchase supplementary coverage for partial theft claims; that is, the coverage covers stolen automobile parts.[3] It is reasonable to believe that when compared to a partial theft claim, a total theft claim provides the insured with more monetary incentives to engage in opportunistic fraud. In fact, we find that the particular claim pattern of opportunistic fraud cannot be observed when we evaluate partial theft claims. By ruling out the particular pattern concerning partial theft claims, the patterns of total theft claims provide us with stronger evidence to support the existence of opportunistic fraud.

The remainder of this article is organized as follows. In the second section we introduce the constitution and the structure of our empirical samples. In the third section we present our methodology. Our main empirical results are displayed in the fourth section. We then perform three robustness tests in the fifth section. Finally, we conclude in the sixth section.

[3]The partial theft claim in our sample only includes the loss of accessories or spare parts that are installed in the car by the original manufacturer.

DATA

This article aims to prove that a particular claim pattern exists in Taiwan's automobile theft insurance claims resulting from a typhoon hit. Hence, we start by choosing our sample typhoons. We identify the typhoon periods using historical records of accumulated rainfall caused by a typhoon. A typhoon is included in our sample if it results in more than 800 millimeters of cumulative rainfall.[4] Such data on rainfall are obtained from the statistics compiled by the Central Weather Bureau.

During our sample period from January 1, 2004 to December 31, 2008, there were 10 typhoons based on the above definition. The periods right after and before the typhoons, and the hit regions of each typhoon are provided in Table 1. The length of a period is defined based on practical experience as 1 month.[5]

We use the automobile theft insurance data from one particular insurance company in Taiwan to test whether evidence of an opportunistic fraud phenomenon is found to exist within the particular region of the typhoon hit, at a particular time right after the typhoon. Our sample company has a share of over 20 percent of Taiwan's automobile insurance market. Our data cover the period from the year 2004 to the year 2008 and encompass the content of the insurance contract, the claim record, as well as the characteristics of the insured and the insured vehicle, which are used by the insurance company for underwriting and pricing. All variable definitions are listed in Table 2.

The data structures for this full sample are listed in Panel A of Table 3. We find that over half of the insured who have automobile theft insurance do not at the same time purchase typhoon/flood insurance for their vehicles.[6] The total theft probability for these automobile insurance contracts is 0.74 percent.

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[4]According to historical experience, vehicles impacted by flood damage are found to emerge when the cumulative rainfall exceeds 800 millimeters. We have also previously conducted empirical tests using another approach to identify our sample typhoons. We employ the records for flood damaged vehicle claims obtained from the insurance company to define the typhoon period. The insured whose vehicle suffers flood damage will declare a claim within 1 month if its owner has purchased typhoon/flood insurance. Hence, a typhoon is included in our sample only if a substantial number of claims related to typhoon/flood insurance are filed. Whenever there is a claim filed after the typhoon hit, we define the claim date of the first claim case of the typhoon as the beginning date of the period right after that typhoon. There are three typhoon periods in this alternative approach, and their periods are consistent with Typhoon 7, Typhoon 8, and Typhoon 10. The empirical outcomes of this alternative approach are consistent with the outcomes whereby we define a typhoon according to the cumulative rainfall. There is a significantly positive conditional correlation between a total theft claim and coverage of only theft insurance in each period right after the typhoon in the region in which the typhoon hit. This evidence only emerges in this period and in this region, not in others, and also does not exist when we investigate a partial theft claim.

[5]The period right after the typhoon is defined as the 1-month period after a huge typhoon hit. The reason why we evaluate the claims based on a period of 1 month is that claims for the flood damage were usually made within 1 month according to the experiences of the insurance company. Correspondingly, the period before the typhoon is also defined as the 1-month period before a huge typhoon hit. We will also later conduct a set of sensitivity tests to confirm this standard in the section on robustness tests.

[6]The typhoon/flood insurance is expensive in comparison to automobile theft insurance. The premium rate of typhoon/flood insurance is about two times the premium rate of

TABLE 1
The Dates and Hit Regions of Typhoon Periods

Typhoon	Hit Date	Hit Region	Period Right After Typhoon	Period Before Typhoon
Typhoon_1	06.29.2004	East and North	06.29.2004 ~ 07.28.2004	05.29.2004 ~ 06.28.2004
Typhoon_2	09.22.2004	Middle and North	09.22.2004 ~ 10.21.2004	08.22.2004 ~ 09.21.2004
Typhoon_3	10.07.2004	North	10.07.2004 ~ 11.06.2004	08.22.2004 ~ 09.21.2004
Typhoon_4	07.12.2005	North and East	07.12.2005 ~ 08.11.2005	06.12.2005 ~ 07.11.2005
Typhoon_5	06.11.2007	East	06.11.2007 ~ 07.10.2007	05.11.2007 ~ 06.10.2007
Typhoon_6	08.24.2007	East	08.24.2007 ~ 09.23.2007	07.24.2007 ~ 08.23.2007
Typhoon_7	10.11.2007	North and East	10.11.2007 ~ 11.10.2007	07.24.2007 ~ 08.23.2007
Typhoon_8	07.29.2008	South	07.29.2008 ~ 08.28.2008	06.29.2008 ~ 07.28.2008
Typhoon_9	08.01.2008	South	08.01.2008 ~ 08.31.2008	06.29.2008 ~ 07.28.2008
Typhoon_10	09.19.2008	South	09.19.2008 ~ 10.18.2008	06.29.2008 ~ 07.28.2008

Notes: There are four typhoon periods that overlap with the previous typhoon periods. For these periods, the corresponding before typhoon periods coincide with the previous before typhoon periods. Hence, the period before *Typhoon_3* coincides with the period before *Typhoon_2*; the period before *Typhoon_7* coincides with the period before *Typhoon_6*; the period before *Typhoon_9* and the period before *Typhoon_10* coincide with the period before *Typhoon_8*.

Based on this full sample, we use different subsamples from different angles when we perform our empirical analyses. First, two subsamples based on 10 sample typhoons are created: one is the subsample for the periods right after the typhoons, and the other is the subsample for the periods before the typhoons. The basic statistics of the two subsamples are listed in Panel B of Table 3.

Second, to compare the monetary incentives provided by the fraudulent claims, we later separately test the conditional correlation analysis for total theft claims and for partial theft claims. Hence, when we conduct the test for partial theft claims, we reduce our sample to a smaller sample because the partial theft claims can only be observed by the contracts with auto parts accessories endorsements. This smaller sample comprises about 33.8 percent of our full sample. On the basis of this smaller sample, we also separately create two subsamples for the periods right after the typhoons and the periods before the typhoons. The basic statistics are listed in Panel C of Table 3.

automobile theft insurance. This may be the reason why only a very small proportion of the insured have also purchased the typhoon/flood insurance.

TABLE 2
Definitions of Variables

Variable	Definition
Explained variables	
coverage_s	A dummy variable that equals 1 when the insured with automobile theft insurance is not covered by the typhoon and flood insurance at the same time, and 0 otherwise.
claim	A dummy variable that equals 1 when the insured has filed a claim, and 0 otherwise.
Explanatory variables	
sexf	A dummy variable that equals 1 if the insured is female, and 0 otherwise.
married	A dummy variable that equals 1 if the insured is married, and 0 otherwise.
age 25–30	A dummy variable that equals 1 if the insured is between the ages of 25 and 30, and 0 otherwise.
age 30–60	A dummy variable that equals 1 if the insured is between the ages of 30 and 60, and 0 otherwise.
age above 60	A dummy variable that equals 1 if the insured is above 60 years old, and 0 otherwise.
carage0	A dummy variable that equals 1 when the car is under 1 year old, and 0 otherwise.
carage1	A dummy variable that equals 1 when the car is 1 year old, and 0 otherwise.
carage2	A dummy variable that equals 1 when the car is 2 years old, and 0 otherwise.
carage3	A dummy variable that equals 1 when the car is 3 years old, and 0 otherwise.
carage4	A dummy variable that equals 1 when the car is 4 years old, and 0 otherwise.
carage5	A dummy variable that equals 1 when the car is 5 years old, and 0 otherwise.
city	A dummy variable that equals 1 when the owner of the car lives in a city, and 0 otherwise.
north	A dummy variable that equals 1 when the car is registered in the north of Taiwan, and 0 otherwise.
south	A dummy variable that equals 1 when the car is registered in the south of Taiwan, and 0 otherwise.
east	A dummy variable that equals 1 when the car is registered in the east of Taiwan, and 0 otherwise.
tramak_q	A dummy variable that equals 1 when the vehicle is brand q, $q = n, f, h, t, c$, and 0 otherwise.
sedan	A dummy variable that equals 1 when the car is a sedan and is for noncommercial or for long-term rental purposes, and 0 otherwise.
vehcc_s	A dummy variable that equals 1 when the insured car has an engine capacity that equals or is under 1,800 cc, and 0 otherwise.
vehcc_m	A dummy variable that equals 1 when the insured car has an engine capacity between 1,800 cc and 2,000 cc, and 0 otherwise.

In the panels of these subsamples, we can preliminarily compare the probability of a theft claim right after a typhoon and before the typhoon.[7] In Panel B, a total of 0.064 percent of the theft claims were made during the periods right after the typhoons, and 0.053 percent of the total theft claims were made during the periods before the typhoons. According to these preliminary observations, we find that the total theft claim probabilities right after the typhoons are higher than those before the typhoons.[8] As for the partial theft claims, in Panel C, under the 10 sample typhoons, the probability of partial theft claims during the periods right after the typhoons is 0.052 percent, while the probability of the partial theft claims during the periods before the typhoons is 0.063 percent. These data show that no higher probability of partial theft claims is found to exist in these periods right after the typhoon. These observations seem to preliminarily highlight the observation that the higher probability of theft claims during the periods right after the typhoons arose only because of the total theft claims and not because of the partial theft claims.

METHODOLOGY

With the help of these data, our empirical work aims to test whether an insured who has encountered a typhoon hit and has only theft insurance has a higher tendency to file a claim than others. Hence, we test the conditional correlation between the choice of the coverage and the occurrence of a claim separately according to the different regions hit by typhoons or others, and by the period right after or before the typhoon hit. We adopt the two-stage method to conduct the conditional correlation test. This methodology is similar to that used by Dionne et al. (2001).

We separately run two probit regressions for the probability of a claim and the probability of coverage. The conditional correlation test is performed in the second stage of the regression, which includes the dummy variable for filing a claim and the estimated probability of the claim measured from the first stage. The first regression is as follows:

$$\text{Prob}(claim_i = 1 | X_i) = \Phi(X_i \beta_{claim}), \tag{1}$$

where Prob(•) denotes a probability function that is derived from the standard normal cumulative distribution function (Φ). Note that X_i is the vector of explanatory variables, which includes the characteristics of the measurement insured and the insured

[7]We sort the claims that were made within the period right after the typhoon or within the period before the typhoon according to the date of the loss recorded by the insurance company. The insured whose vehicle suffered an accident will make a claim within 1 month. The insurance company will assign the date of the loss according to the date on which the insured filed the claim form.

[8]We further observe these total theft claims by separating them according to their contract coverage, as occurred during the period 1 month before these 10 typhoons, and 1 month right after these 10 typhoons. In the period 1 month right after the typhoon hit, the proportion of total theft claims for autos without typhoon/flood coverage is 0.8024, and the proportion of total theft claims for autos with typhoon/flood coverage is 0.1976. In the period 1 month before the typhoon hit, the proportion of total theft claims for autos without typhoon/flood coverage is 0.6327, and the proportion of total theft claims for autos with typhoon/flood coverage is 0.3673.

vehicle. These characteristics are used for underwriting or pricing by the insurance company and are listed in Table 2 . Note that, β_{claim} is the corresponding estimated coefficients vector. The explained dummy variable is $claim_i$. Note that, $claim_i = 1$ if the measurement insured filed a claim during the measurement period, otherwise $claim_i = 0$. When we test for a total theft claim, $claim_i$ is measured by $ttclaim_i$. When we test for a partial theft claim, $claim_i$ is measured by $ptclaim_i$.

The regression of the second stage is:

$$\begin{aligned} &\text{Prob}(coverage\_s_i = 1 | claim_i, \hat{claim}_i, X_i) \\ &\quad = \Phi(\beta_{cov,clm} claim_i + \beta_{estclm} \hat{claim}_i + X_i \beta_{coverage}). \end{aligned} \tag{2}$$

The definition of X_i and the measurement of $claim_i$ are the same as in the first stage. The estimated probability of claim ($\hat{claim}_i$) is measured from the first stage. In this regression, the explained dummy variable is $coverage\_s_i$. Note that, $coverage\_s_i = 1$ means that the measurement insured has only automobile theft insurance coverage during the measurement period. Note that, $coverage\_s_i = 0$ means that the measurement insured not only has automobile theft insurance coverage, but also coverage for typhoon/flood insurance during the measurement period. The key coefficient we use for testing the conditional correlation is $\hat{\beta}_{cov,clm}$. If $\hat{\beta}_{cov,clm}$ is positive and significantly different from 0, it means that during the measurement period, the measurement insured with only theft coverage is significantly more likely to file a claim after a typhoon than the measurement insured with both theft insurance and typhoon/flood insurance.

We conduct four sets of the above conditional correlation test for each typhoon period. These four sets of the test include: the test for the typhoon-hit region during the period right after the typhoon, the test for the typhoon-hit region during the period before the typhoon, the test for the other region during the period right after the typhoon, and the test for the other region during the period before the typhoon. We also test the patterns of both the total theft claims and the partial theft claims. On the basis of the predictions for opportunistic fraud, we expect that after a typhoon, an insured who lives in a typhoon-hit region and has only theft coverage is more likely to file a total theft claim than other insured. However, we do not expect to observe such a pattern before the typhoon. On the other hand, for the partial theft claims, we do not expect to observe any correlation between coverage and claims either from the period dimension, or from the region dimension.

There is other methodology that could be used to perform the conditional correlation test, which is the residual correlation analysis derived by Gourieroux et al. (1987) and proposed by Chiappori and Salanie (2000). We treat this method as the robustness test based on the two-stage method.

In the residual correlation analysis, we run two probit regressions first,

$$\text{Prob}(coverage\_s_i = 1 | X_i) = \Phi(X_i \beta_{cov}), \tag{3}$$

$$\text{Prob}(claim_i = 1 | X_i) = \Phi(X_i \beta_{clm}). \tag{4}$$

TABLE 3
Statistic Description for the Full Sample and the Subsample (Contracts With the Endorsement of Auto Parts Accessories)

Panel A: Full Sample

Variable	Mean	Std. Dev.
coverage_s	0.6784	0.4729
claim	0.0074	0.0719
sexf	0.6028	0.4893
married	0.8244	0.3805
age 25–30	0.0775	0.2674
age 30–60	0.7698	0.4210
age above 60	0.0440	0.2050
carage0	0.3912	0.4880
carage1	0.1217	0.3270
carage2	0.0981	0.2975
carage3	0.0849	0.2788
carage4	0.0715	0.2576
carage5	0.0597	0.2369
city	0.5159	0.4997
north	0.4310	0.4952
south	0.3041	0.4600
east	0.0185	0.1346
tramak_n	0.0040	0.0632
tramak_f	0.0731	0.2603
tramak_h	0.0555	0.2290
tramak_t	0.3232	0.4677
tramak_c	0.0564	0.2307
sedan	0.7180	0.4500
vehcc_s	0.6110	0.4875
vehcc_m	0.3637	0.4811

Panel B: Subsample of 10 Typhoon Periods (for Total Theft Claim)

	Subsample for Periods Right After Typhoon		Subsample for Periods Before Typhoon	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
coverage_s	0.69474	0.37233	0.69464	0.37305
claim	0.00064	0.02521	0.00053	0.02308
sexf	0.59812	0.49028	0.59875	0.49015
married	0.82507	0.37991	0.82854	0.37691
age 25–30	0.07816	0.26842	0.07797	0.26812
age 30–60	0.76907	0.42143	0.77292	0.41894
age above 60	0.04420	0.20555	0.04414	0.20541
carage0	0.39360	0.48855	0.38855	0.48742
carage1	0.11370	0.31744	0.11553	0.31966
carage2	0.09857	0.29809	0.09922	0.29896
carage3	0.08689	0.28167	0.08797	0.28325
carage4	0.07450	0.26258	0.07519	0.26370
carage5	0.06106	0.23945	0.06126	0.23981

(*Continued*)

TABLE 3
Continued

Panel B: Subsample of 10 Typhoon Periods (for Total Theft Claim)				
	Subsample for Periods Right After Typhoon		Subsample for Periods Before Typhoon	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
city	0.51597	0.49974	0.51986	0.49961
north	0.44082	0.49649	0.44508	0.49697
south	0.29748	0.45715	0.30078	0.45860
east	0.01874	0.13562	0.01899	0.13648
tramak_n	0.00393	0.06254	0.00393	0.06260
tramak_f	0.07295	0.26006	0.07410	0.26193
tramak_h	0.05676	0.23138	0.05689	0.23164
tramak_t	0.31664	0.46517	0.31958	0.46631
tramak_c	0.05665	0.23118	0.05766	0.23310
sedan	0.70896	0.45424	0.71748	0.45022
vehcc_s	0.61638	0.48627	0.61298	0.48707
vehcc_m	0.35840	0.47953	0.36190	0.48055

Panel C: Subsample of 10 Typhoon Periods (for Partial Theft Claim)				
	Subsample for Periods Right After Typhoon		Subsample for Periods Before Typhoon	
Variables	Std. Dev.	Mean	Std. Dev.	Mean
coverage_s	0.57701	0.34986	0.57661	0.35113
claim	0.00052	0.02274	0.00063	0.02501
sexf	0.62554	0.48398	0.62406	0.48437
married	0.90672	0.29083	0.90759	0.28960
age 25–30	0.06171	0.24063	0.06164	0.24049
age 30–60	0.87891	0.32623	0.87940	0.32566
age above 60	0.04987	0.21768	0.04935	0.21659
carage0	0.24163	0.42807	0.24292	0.42885
carage1	0.16673	0.37273	0.16854	0.37435
carage2	0.14174	0.34878	0.14120	0.34823
carage3	0.12399	0.32957	0.12367	0.32920
carage4	0.09180	0.28874	0.09177	0.28870
carage5	0.06930	0.25397	0.06862	0.25281
city	0.58180	0.49326	0.58162	0.49329
north	0.46774	0.49896	0.46825	0.49899
south	0.24563	0.43046	0.24597	0.43066
east	0.01191	0.10848	0.01208	0.10925
tramak_n	0.00586	0.07631	0.00580	0.07593
tramak_f	0.08227	0.27478	0.08364	0.27684
tramak_h	0.14972	0.35680	0.14911	0.35619
tramak_t	0.17144	0.37690	0.17054	0.37611
tramak_c	0.07161	0.25784	0.07255	0.25940
sedan	0.93108	0.25331	0.93302	0.24999
vehcc_s	0.34829	0.47643	0.34910	0.47669
vehcc_m	0.57055	0.49500	0.57046	0.49501

The definition and measurement of *coverage_s*$_i$ and *claim*$_i$ are the same as in the two-stage method. The explanatory variable vector also includes the same characteristic variables listed in Table 2. Note that, β_j, $j = cov, loss$, is the corresponding parameter vector in the probit regression. The estimated residuals $\hat{\varepsilon}_i^j$ from Equations (3) and (4) are defined as

$$\hat{\varepsilon}_i^j = E\left(\varepsilon_i^j \mid j_i, X_i\right) = \frac{\varphi(X_i\beta_j)}{\Phi(X_i\beta_j)} j_i - (1 - j_i)\frac{\varphi(X_i\beta_j)}{\Phi(-X_i\beta_j)}\; j = cov, clm. \tag{5}$$

Gourieroux et al. (1987) creates a statistic W_{jk} to test the conditional correlation between *j* and *k*. The *W* statistic is defined as

$$W_{jk} = \frac{\left(\sum_{i=1}^{n} \hat{\varepsilon}_i^j \hat{\varepsilon}_i^k\right)^2}{\sum_{i=1}^{n} \left(\hat{\varepsilon}_i^j\right)^2 \left(\hat{\varepsilon}_i^k\right)^2}, \quad j \neq k. \tag{6}$$

This *W* statistic is distributed asymptotically as $\chi^2(1)$ under the null hypothesis of $cov(\varepsilon_i^j, \varepsilon_i^k) = 0$. If *W* is significantly larger than the critical value, we can reject the null hypothesis that choice and claim are conditionally independent. Particularly worth mentioning is that Chiappori and Salanie (2000) included a weight w_i in the *W* statistic, which represents different contract lengths for each observation. In this research, we do not need the weight in our *W* statistic because we only observe the contract for the full length of the period. All the observations have the same contract lengths in each period. In other words, the observations included in each period are for the contract that started earlier than and expired later than our measurement period.

The conditional correlation test is judged by the significance of the *W* statistic. However, this can only tell us whether the claim and coverage are significantly conditionally correlated, and we cannot tell whether they are positively or negatively correlated. We further estimate the conditional correlation coefficient ($\rho_{\varepsilon^j,\varepsilon^k}$) for the above two residuals ε^j and ε^k to clarify their relationship.

This residual correlation test is also conducted by four sets of different regions and different periods. According to our prediction for opportunistic fraud, we expect that the *W* statistics would be significant and that $\rho_{\varepsilon^j,\varepsilon^k}$ would be positive and significantly different from zero only for the insured who have encountered a typhoon hit. Furthermore, such evidence is only sustained while we are testing for the total theft claims instead of the partial theft claims.

THE EMPIRICAL RESULTS

In Panel A of Table 4, the estimated coefficient $\hat{\beta}$ is separately estimated for the insured who lives in a corresponding typhoon-hit region versus other regions, for each of the 10 periods right after the typhoons and for each corresponding period before the typhoons. Among the tests for the typhoon-hit region during the period right after the typhoons, only two typhoon periods did not give rise to a significantly positive

TABLE 4

The Conditional Correlation Between Total Theft Claims and Simple Coverage for Different Regions and Different Periods—The Estimated Coefficient β in the Two-Stage Method

	Periods Right After Typhoon		Periods Before Typhoon	
	Typhoon-Hit Region	Other Region	Typhoon-Hit Region	Other Region
	Panel A: Total Theft Claim			
Typhoon_1	5.4570	2.9634	2.4197	3.0170
	(0.0839)	(0.9935)	(0.9610)	(0.9933)
	<95,442>	<108,729>	<96,428>	<104,103>
Typhoon_2	5.5912	2.9659	2.2726	3.0537
	(0.0798)	(0.9943)	(0.9526)	(0.9948)
	<171,603>	<72,541>	<155,379>	<69,608>
Typhoon_3	4.7596	3.2540	2.2726	3.0537
	(0.1003)	(0.9967)	(0.9526)	(0.9948)
	<102,762>	<149,716>	<155,379>	<69,608>
Typhoon_4	5.4214	–0.7523	2.3371	2.1988
	(0.0801)	(0.7903)	(0.9447)	(0.9647)
	<111,476>	<169,562>	<113,871>	<172,873>
Typhoon_5	–0.9218	2.0220	No claim filed in	2.2143
	(0.9962)	(0.9498)	this region	(0.9408)
	<4,338>	<223,612>	<4,240>	<220,943>
Typhoon_6	No claim filed in	2.1451	–10.2853	2.0725
	this region	(0.9449)	(0.9997)	(0.9427)
	<4,868>	<241,308>	<4,613>	<235,114>
Typhoon_7	7.9648	2.0651	–10.2853	2.0725
	(<0.0001)	(0.9619)	(0.9997)	(0.9427)
	<121,384>	<135,474>	<4,613>	<235,114>
Typhoon_8	8.0954	2.1657	2.3358	2.1385
	(<0.0001)	(0.9582)	(0.9737)	(0.9627)
	<63,271>	<144,125>	<65,697>	<146,077>
Typhoon_9	9.9935	2.2791	2.3358	2.1385
	(<0.0001)	(0.9496)	(0.9737)	(0.9627)
	<63,003>	<144,271>	<65,697>	<146,077>
Typhoon_10	7.9427	2.0296	2.3358	2.1385
	(0.0007)	(0.9676)	(0.9737)	(0.9627)
	<121,777>	<63,366>	<65,697>	<146,077>
	Panel B: Partial Theft Claim			
Typhoon_1	3.7527	–0.8409	3.5316	3.5352
	(0.9856)	(0.0539)	(0.9893)	(0.9897)
	<6,760>	<6,766>	<6,722>	<6,778>
Typhoon_2	2.8411	−2.0506	3.1270	3.6989
	(0.9686)	(0.0247)	(0.9708)	(0.9944)
	<10,043>	<3,919>	<10,032>	<3,894>
Typhoon_3	3.4473	−1.1407	3.1270	3.6989
	(0.9905)	(0.0708)	(0.9708)	(0.9944)

(*Continued*)

TABLE 4
Continued

	Periods Right After Typhoon		Periods Before Typhoon	
	Typhoon-Hit Region	Other Region	Typhoon-Hit Region	Other Region
	Panel B: Partial Theft Claim			
	<6,833>	<7,235>	<10,032>	<3,894>
Typhoon_4	3.2962	3.3179	3.5028	3.7046
	(0.9901)	(0.9950)	(0.9891)	(0.9941)
	<7,462>	<7,832>	<7,409>	<7,706>
Typhoon_5	No claim filed in	2.3494	No claim filed in	2.8059
	this region	(0.9505)	this region	(0.9698)
	<265>	<20,059>	<260>	<20,047>
Typhoon_6	No claim filed in	2.9448	No claim filed in	2.4896
	this region	(0.9706)	this region	(0.9725)
	<259>	<20,061>	<265>	<20,202>
Typhoon_7	3.6093	2.8085	No claim filed in	2.4896
	(0.9895)	(0.9791)	this region	(0.9725)
	<9,344>	<10,446>	<265>	<20,202>
Typhoon_8	3.0249	2.9878	−2.1240	2.2134
	(0.9818)	(0.9712)	(0.8484)	(0.9805)
	<4,191>	<12,879>	<4,166>	<12,758>
Typhoon_9	4.8392	3.0117	−2.1240	2.2134
	(0.9971)	(0.9901)	(0.8484)	(0.9805)
	<4,202>	<12,934>	<4,166>	<12,758>
Typhoon_10	2.7706	2.7912	−2.1240	2.2134
	(0.9752)	(0.9707)	(0.8484)	(0.9805)
	<11,940>	<4,748>	<4,166>	<12,758>

Notes: The *p*-values are in parentheses; the numbers of observations are in angular quote brackets. There are four typhoon periods that overlap with the previous typhoon periods. For these periods, the corresponding before typhoon periods coincide with the previous before typhoon periods. Hence, the period before *Typhoon_3* coincides with the period before *Typhoon_2*; the period before *Typhoon_7* coincides with the period before *Typhoon_6*; the period before *Typhoon_9* and the period before *Typhoon_10* coincide with the period before *Typhoon_8*.

correlation between the total theft claims and contracts with only theft insurance.[9] Except for these two, all typhoon-hit regions during the period right after the typhoon have $\hat{\beta}$s that are positive and significantly different from zero. This finding implies that there exists a significantly positive conditional correlation between total theft claims and contracts with only automobile theft insurance coverage among the

[9]These two periods with no significantly positive conditional correlation are the periods in which the corresponding typhoons hit in the eastern area of Taiwan. The eastern area of Taiwan has low population density. Hence, one of these two periods is without any claims filed during this period. Furthermore, the insignificant results of the other period may also be because that typhoon did not cause too much damage to the vehicles in this low population density area.

insured who encountered a typhoon hit. By contrast, for all other sets, the $\hat{\beta}$s, the estimated coefficients, are not significantly different from zero, which means that there is no significantly conditional correlation between the total theft claims and contracts with only automobile theft insurance coverage during the periods and/or within the regions not affected by the typhoons. These outcomes show that from the year 2004 to the year 2008, the particular patterns of total theft claims for the insured with only automobile theft insurance do exist because of the huge typhoon hit. These patterns could reflect the phenomenon of opportunistic fraud instead of the ordinary theft induced by the demand from the black market.[10]

The above results, which provide evidence of opportunistic fraud, are derived by using the approach that separately tests the conditional correlation between the total theft claim and coverage for four sets of different regions and different periods. However, this conclusion has not yet been confirmed through any formal test. Hence, we adopt the idea of a difference-in-difference-in-difference identification approach, and use an interaction term for the "total theft claim," "typhoon hit region," and "period right after typhoon" to formally test for opportunistic fraud.[11] For each typhoon, we pool the two original samples of corresponding periods, the period right after the typhoon and the period before the typhoon, together. On the basis of this pooled sample, we reperform the two-stage test. In the second stage probit regression, we add the interaction term as the "difference-in-difference-in-difference" estimate.[12] The results for the 10 typhoon periods are listed in Table 5.[13] We find that, except for

[10]The ordinary automobile theft probability is gradually decreasing through the years. This can be attributed to the progress in the investigatory skills of the police authorities, the improved antitheft devices including the setting up of video monitors in sparsely populated alleys, engine code seals, and so on. The fact that automobile theft probability is gradually decreasing may be the reason why we cannot find evidence that the particular higher theft probability was caused by ordinary theft.

[11]We are grateful to the referee for the valuable suggestion. This approach could further help us in formally testing our inference.

[12]As Angrist and Pischke (2009) point out, the difference-in-difference identification strategy could lead us to capture the group-level fixed effect. In our research, we are interested in understanding whether the group of insured, who live in the region hit by a typhoon, have been affected by the typhoon. When they filed the total theft claim, they tended to have insurance coverage only for automobile theft. Hence, we need an interaction term that is composed of three factors, namely, "total theft claim," "typhoon-hit region," and "period right after the typhoon" to identify the difference-in-difference-in-difference effect.

[13]In Table 5, we report the "partial effect." Cornelissen and Sonderhof (2009) point out that the coefficients in the nonlinear regression, such as the probit regresson, cannot be interpreted directly. In particular, when there is an interaction term, the estimated standard errors are false, and the sign of the coefficient could even be opposite to that of the correct partial effect. In their article, they have introduce the proper formulation to calculate the partial effect when there is a difference-in-difference-in-difference component. The partial effects that we report are calculated according to their method. The relative variables for these D-I-D-I-D components include: three single variables (*claim*, *typd*, *typhar*), three interaction terms for each set of two variables (*claim∗typd*, *claim∗typhar*, *typd∗typhar*), and the interaction term for these three (*claim∗typd∗typhar*). It is redundant to list the partial effect for all these D-I-D-I-D components. We only report the partial effect of what we focus on: *claim∗typd*, *claim∗typhar*, and *claim∗typd∗typhar*.

TABLE 5
The Conditional Correlation Between Total Theft Claims and Simple Coverage for Different Regions and Different Periods—The Partial Effect of Difference-in-Difference Estimates and Difference-in-Difference-in-Difference Estimates

	Est. of *typd∗claim*	Est. of *typhar∗claim*	Est. of *typd∗typhar∗claim*
Typhoon_1	0.0021	0.0029	0.0606
	(0.8406)	(0.7692)	(0.0862)
Typhoon_2	0.0020	0.0026	0.1347
	(0.8514)	(0.7360)	(0.0049)
Typhoon_3	0.0019	0.0022	0.0475
	(0.9182)	(0.8360)	(0.0991)
Typhoon_4	0.0022	0.0023	0.1230
	(0.7478)	(0.8525)	(0.0076)
Typhoon_5	No	No	No
Typhoon_6	No	No	No
Typhoon_7	0.0025	0.0021	0.1905
	(0.7095)	(0.8366)	(< 0.0001)
Typhoon_8	0.0019	0.0021	0.2103
	(0.8994)	(0.8058)	(< 0.0001)
Typhoon_9	0.0022	0.0023	0.2953
	(0.8944)	(0.8763)	(< 0.0001)
Typhoon_10	0.0020	0.0030	0.2793
	(0.8603)	(0.7848)	(< 0.0001)

Notes: The p-values are in parentheses. We cannot estimate the difference-in-difference-in-difference effects in *Typhoon_5* and *Typhoon_6* because there is no claim filed in the typhoon-hit region during the period right after *Typhoon_5* hit, and there is no claim filed in the typhoon-hit region during the period before *Typhoon_5* hit.

the two typhoons, which hit the low population density area of east Taiwan, all the partial effects of the interaction term (*typd∗typhar∗claim*) are positive and significantly different from zero. By contrast, the partial effects for *typd∗claim* and *typhar∗claim* are all insignificantly different from zero in each typhoon period. These results formally verify that the significantly positive conditional correlation between the total theft claim and coverage with only theft insurance only exists during the period right after the typhoon for those insured who live in the region hit by the typhoon. Through this difference-in-difference approach, we reconfirm the evidence of opportunistic fraud using a formal test.

As for the empirical results displayed in Panel B of Table 4, they are the outcomes of the conditional correlation between the occurrence of a partial theft claim and the choice of the coverage contract for each of the 10 typhoons from different dimensions of region and period. In this panel, we can find that not only are the $\hat{\beta}$s for the regions other than the typhoon-affected regions and/or for the periods before the typhoons insignificantly different from zero, but also the $\hat{\beta}$s for the typhoon-hit regions during the period right after the typhoon are insignificantly different from zero. This implies that there is no conditional correlation between the occurrence of a partial theft claim and the choice of coverage contract in any particular period or any particular region, regardless of whether it is right after or before a typhoon, and regardless of whether it is the region hit by the typhoon or not.

On the basis of the above results in Tables 4 and 5, these findings support the prediction of opportunistic fraud provided by Dionne and Gagné (2002) that opportunistic fraud follows a particular claim pattern and involves a sufficient monetary incentive. This opportunistic fraud phenomenon is brought about by the occurrence of some typhoons. After the typhoons with their huge rainfall occur, some opportunistic flood-damage vehicle owners who live in the typhoon-hit region and only have theft insurance (i.e., they are without typhoon/flood insurance) pretend to have had their automobiles stolen and file false claims to compensate for their loss from the flood damage.

To confirm that our empirical inference is indeed convincing, we still need to perform further tests to resolve various concerns that could interfere with the robustness of our conclusion. The first concern relates to the length of a period. The second concern has to do with whether our empirical results are the particular outcomes brought about by the particular methodology that we have employed. In accordance with the above concerns, two robustness tests will be adopted in the next section.

ROBUSTNESS ANALYSIS

In this section, two robustness tests concerned with different period lengths and different empirical methodologies are performed in order. The first robustness test involves our adopting different lengths for one period. To this end, we engage in sensitivity analysis by varying the length of such a period from $^1/_2$ month, to 1 $^1/_2$ months, to 2 months. We test the conditional correlations between the total theft claims and contracts with only automobile theft insurance coverage within each period and region. The outcomes of this sensitivity analysis are presented in Table 6.

When we define one period as $^1/_2$ month in Panel A, we can see that all the $\hat{\beta}$s are insignificantly different from zero during different periods and within different regions. These outcomes imply that there is no claim pattern if we shorten the length of one period from 1 month to $^1/_2$ month.

By contrast, in Panel B, when we lengthen the length of one period from 1 month to 1 $^1/_2$ months, the significance in Typhoon 3 and Typhoon 4 disappears because of our lengthening the observation period. Although in Typhoons 1, 2, 7, 8, 9, and 10, the significant and positive $\hat{\beta}$ still exists, these outcomes mean that when we lengthen the observation period by $^1/_2$ month more, there still exists a claim pattern, although the significances of some sets disappear. Although there are fewer typhoon periods with sets of positive $\hat{\beta}$ that are significant, they still imply a consistent result in that a particular pattern emerges for those insured with only automobile theft insurance.

Because the typhoon period is lengthened, some typhoon periods will overlap with others. If the overlapping typhoons hit the same region, this brings another interesting phenomenon in that the value and the significance level of the estimated coefficient are raised, such as in the cases of Typhoons 2, 8, and 9. The significance of $\hat{\beta}$ in some of the other periods disappears when we lengthen the period from 1 month to 2 months,

TABLE 6
The Sensitivity Test for the Definitions of the Typhoon Periods

	Periods Right After Typhoon		Periods Before Typhoon	
	Typhoon-Hit Region	Other Region	Typhoon-Hit Region	Other Region
Panel A: Define Each Period by $^1/_2$ Month				
Typhoon_1	3.5993	2.9560	2.1291	3.0055
	(0.5565)	(0.9953)	(0.9630)	(0.9955)
Typhoon_2	3.4996	2.9623	2.0867	2.7765
	(0.5598)	(0.9962)	(0.9447)	(0.9968)
Typhoon_3	3.3773	2.9879	2.0867	2.7765
	(0.5140)	(0.9965)	(0.9447)	(0.9968)
Typhoon_4	3.2805	2.0412	2.0249	2.2295
	(0.5559)	(0.9720)	(0.9512)	(0.9708)
Typhoon_5	–0.8784	1.8102	No claim filed in this region	2.2768
	(0.9995)	(0.9553)		(0.9505)
Typhoon_6	No claim filed in this region	2.1616	−7.0292	2.0965
		(0.9584)	(0.9998)	(0.9556)
Typhoon_7	4.0167	2.3047	−7.0292	2.0965
	(0.1642)	(0.9713)	(0.9998)	(0.9556)
Typhoon_8	3.9064	1.9776	2.2750	1.9146
	(0.4732)	(0.9544)	(0.9747)	(0.9614)
Typhoon_9	4.5551	2.0160	2.2750	1.9146
	(0.1181)	(0.9501)	(0.9747)	(0.9614)
Typhoon_10	4.5315	1.5546	2.2750	1.9146
	(0.1316)	(0.9775)	(0.9747)	(0.9614)
Panel B: Define Each Period by 1 $^1/_2$ Months				
Typhoon_1	5.0779	3.1455	2.4286	3.0260
	(0.0945)	(0.9947)	(0.9509)	(0.9922)
Typhoon_2	5.7423	3.3739	2.3188	3.0903
	(0.0649)	(0.9970)	(0.9396)	(0.9934)
Typhoon_3	4.0648	3.2588	2.3188	3.0903
	(0.21255)	(0.9961)	(0.9396)	(0.9934)
Typhoon_4	4.4585	−0.5728	2.5404	2.1897
	(0.1543)	(0.1773)	(0.9525)	(0.9579)
Typhoon_5	−1.4024	2.2744	No claim filed in this region	2.3961
	(0.7937)	(0.9561)		(0.9519)
Typhoon_6	1.5477	2.3483	−7.9604	2.3049
	(0.9993)	(0.9553)	(0.9998)	(0.9529)
Typhoon_7	6.0591	2.2636	−7.9604	2.3049
	(0.0543)	(0.9694)	(0.9998)	(0.9529)
Typhoon_8	8.1758	2.1318	2.4282	2.1420
	(< 0.0001)	(0.9542)	(0.9771)	(0.9488)
Typhoon_9	10.0203	2.1473	2.4282	2.1420
	(< 0.0001)	(0.9517)	(0.9771)	(0.9488)
Typhoon_10	6.7257	2.2071	2.4282	2.1420
	(0.0028)	(0.9760)	(0.9771)	(0.9488)

(*Continued*)

TABLE 6
Continued

	Periods Right After Typhoon		Periods Before Typhoon	
	Typhoon-Hit Region	Other Region	Typhoon-Hit Region	Other Region
	Panel C: Define Each Period by 2 Months			
Typhoon_1	3.6443	3.0282	2.3938	3.0381
	(0.8591)	(0.9908)	(0.9423)	(0.9913)
Typhoon_2	5.6605	3.3566	2.5782	3.1120
	(0.0868)	(0.9968)	(0.9556)	(0.9925)
Typhoon_3	2.4646	3.4958	2.5782	3.1120
	(0.9468)	(0.9949)	(0.9556)	(0.9925)
Typhoon_4	2.4393	−0.4966	2.4900	2.4149
	(0.9482)	(0.2292)	(0.9462)	(0.9679)
Typhoon_5	−0.5837	2.2542	No claim filed in	2.4050
	(0.9994)	(0.9501)	this region	(0.9443)
Typhoon_6	0.7742	2.3473	−9.0134	2.2743
	(0.9990)	(0.9455)	(0.9998)	(0.9463)
Typhoon_7	4.2192	2.2542	−9.0134	2.2743
	(0.1574)	(0.9676)	(0.9998)	(0.9463)
Typhoon_8	9.0820	2.1419	2.3999	2.1408
	(< 0.0001)	(0.9507)	(0.9753)	(0.9446)
Typhoon_9	10.0361	2.1685	2.3999	2.1408
	(< 0.0001)	(0.9494)	(0.9753)	(0.9446)
Typhoon_10	4.2816	2.2717	2.3999	2.1408
	(0.1574)	(0.9736)	(0.9753)	(0.9446)

Notes: The *p*-values are in parentheses. There are four typhoon periods that overlap with the previous typhoon periods. For these periods, the corresponding before typhoon periods coincide with the previous before typhoon periods. Hence, the period before *Typhoon_3* coincides with the period before *Typhoon_2*; the period before *Typhoon_7* coincides with the period before *Typhoon_6*; the period before *Typhoon_9* and the period before *Typhoon_10* coincide with the period before *Typhoon_8*.

such as for Typhoons 1, 3, 4, 7, and 10. Only the overlapping typhoons, Typhoons 2, 8, and 9, which hit the same region, are still found to be significant.

The outcomes displayed from Panel A to Panel C might suggest that engaging in fraudulent behavior requires time, such as the time needed to hide the vehicle. So we cannot observe opportunistic fraud in only the half-month period following the typhoon. On the other hand, the insured may not be prepared to wait too long either if they intend to engage in fraudulent acts.

The second robustness test involves adopting a different methodology to perform the conditional correlation test. In this second methodology used to conduct this robustness test, we adopt the residual correlation analysis derived by Gourieroux et al. (1987). The residual correlation analysis is conducted for total theft claims as well as for partial theft claims, and the outcomes are displayed in Table 7. All the

TABLE 7
The Residual Correlation Between Claims and Coverage Under Each Typhoon Event

	Periods Right After Typhoon				Periods Before Typhoon			
	Typhoon-Hit Region		Other Region		Typhoon-Hit Region		Other Region	
	ρ	W	ρ	W	ρ	W	ρ	W
	Panel A: Total Theft Claim							
Typhoon_1	0.0582	4.9712	0.0004	0.0118	0.0009	0.2153	0.0004	0.1294
	(0.0211)	(0.0257)	(0.8976)	(0.9133)	(0.7724)	(0.6426)	(0.8976)	(0.7191)
Typhoon_2	0.0489	4.6667	0.0004	0.0147	0.0005	0.1591	0.0004	0.0570
	(0.0331)	(0.0308)	(0.9100)	(0.9035)	(0.8598)	(0.6900)	(0.9068)	(0.8113)
Typhoon_3	0.0315	3.7718	0.0003	0.0186	0.0005	0.1591	0.0004	0.0570
	(0.0931)	(0.0521)	(0.9135)	(0.8915)	(0.8598)	(0.6900)	(0.9068)	(0.8113)
Typhoon_4	0.0608	5.5469	0.0048	0.7737	0.0008	0.1355	0.0004	0.0365
	(0.0468)	(0.0185)	(0.3471)	(0.3791)	(0.7846)	(0.7128)	(0.8976)	(0.8485)
Typhoon_5	–0.0019	0.1185	0.0005	0.3134	No claim	No claim	0.0009	0.1523
	(0.8999)	(0.7307)	(0.7981)	(0.5756)			(0.6875)	(0.6963)
Typhoon_6	No claim	No claim	0.0007	0.2852	0.0001	0.0373	0.0005	0.0433
			(0.7495)	(0.5933)	(0.9964)	(0.8469)	(0.8081)	(0.8352)
Typhoon_7	0.0960	10.4176	0.0006	0.1887	0.0001	0.0373	0.0005	0.0433
	(0.0014)	(0.0012)	(0.8274)	(0.6640)	(0.9964)	(0.8469)	(0.8081)	(0.8352)
Typhoon_8	0.0858	7.7932	0.0006	0.0590	0.0009	0.0567	0.0006	0.0474
	(0.0048)	(0.0052)	(0.8077)	(0.8080)	(0.8102)	(0.8118)	(0.8332)	(0.8277)
Typhoon_9	0.1308	15.6504	0.0007	0.0965	0.0009	0.0567	0.0006	0.0474
	(< 0.0001)	(< 0.0001)	(0.7772)	(0.7561)	(0.8102)	(0.8118)	(0.8332)	(0.8277)
Typhoon_10	0.0762	7.0682	0.0007	0.0684	0.0009	0.0567	0.0006	0.0474
	(0.0192)	(0.0078)	(0.8573)	(0.7967)	(0.8102)	(0.8118)	(0.8332)	(0.8277)
	Panel B: Partial Theft Claim							
Typhoon_1	0.0102	0.5383	0.0042	0.1299	0.0071	0.3885	0.0067	0.3463
	(0.4014)	(0.4631)	(0.6891)	(0.7185)	(0.5588)	(0.5331)	(0.5799)	(0.5562)
Typhoon_2	0.0045	0.5701	0.0068	0.4949	0.0063	0.3504	0.0122	0.4990
	(0.6520)	(0.4502)	(0.5001)	(0.4813)	(0.5285)	(0.5539)	(0.4467)	(0.4799)
Typhoon_3	0.0052	0.5153	0.0029	0.1558	0.0063	0.3504	0.0122	0.4990
	(0.6630)	(0.4729)	(0.7120)	(0.6931)	(0.5285)	(0.5539)	(0.4467)	(0.4799)
Typhoon_4	0.0044	0.1337	0.0011	0.0109	0.0044	0.1381	0.0011	0.1214
	(0.7024)	(0.7146)	(0.9222)	(0.9168)	(0.7024)	(0.7102)	(0.9205)	(0.7275)
Typhoon_5	No claim	No claim	0.0024	0.1387	No claim	No claim	0.0032	0.2854
			(0.7152)	(0.7096)			(0.6467)	(0.5932)
Typhoon_6	No claim	No claim	0.0034	0.1543	No claim	No claim	0.0012	0.0559
			(0.6349)	(0.6945)			(0.8673)	(0.8131)
Typhoon_7	0.0019	0.1085	0.0028	0.1993	No claim	No claim	0.0012	0.0559
	(0.8517)	(0.7419)	(0.7757)	(0.6553)			(0.8673)	(0.8131)
Typhoon_8	0.0054	0.1511	0.0025	0.0917	0.0021	0.1213	0.0014	0.0327
	(0.7254)	(0.6975)	(0.7816)	(0.7620)	(0.8697)	(0.7276)	(0.8709)	(0.8565)
Typhoon_9	0.0026	0.1047	0.0069	0.1847	0.0021	0.1213	0.0014	0.0327
	(0.8940)	(0.7463)	(0.5218)	(0.6674)	(0.8697)	(0.7276)	(0.8709)	(0.8565)
Typhoon_10	0.0024	0.1910	0.0850	0.8301	0.0021	0.1213	0.0014	0.0327
	(0.7932)	(0.6621)	(0.2775)	(0.3622)	(0.8697)	(0.7276)	(0.8709)	(0.8565)

Notes: The p-values are in parentheses. There are four typhoon periods that which overlap with the previous typhoon periods. For these periods, the corresponding before typhoon periods coincide with the previous before typhoon periods. Hence, the period before *Typhoon_3* coincides with the period before *Typhoon_2*; the period before *Typhoon_7* coincides with the period before *Typhoon_6*; the period before *Typhoon_9* and the period before *Typhoon_10* coincide with the period before *Typhoon_8*.

results shown in Table 7 provide predictions consistent with our main findings in the previous section.

When we test the patterns evaluated by the total theft claims for the insured with only automobile theft insurance, in Panel A all typhoons except for Typhoons 5 and 6 give rise to significant patterns in typhoon-hit regions during the periods right after the typhoon hit. Their W statistics are significant, and their $\rho_{\varepsilon^j,\varepsilon^k}$s are positive and significantly different from zero. Although none of the W statistics are significant and all the $\rho_{\varepsilon^j,\varepsilon^k}$s are also insignificantly different from zero in the remaining sets, these results exhibit a particular claim pattern for regions hit by typhoons during the periods right after the typhoons.

By contrast, in Panel B, we provide the outcomes of the conditional correlation between the partial theft claims and contracts with only automobile theft insurance coverage. We find, for all periods and regions, that no significant conditional correlation is found to exist. Each W statistic is found to be insignificant, and each $\rho_{\varepsilon^j,\varepsilon^k}$ is also insignificantly different from zero. No pattern emerges when we evaluate the partial theft claims for the insured with only automobile theft insurance.

CONCLUSIONS

We find that those insured who live in typhoon-affected regions and who only purchased auto theft insurance and did not have typhoon and flood insurance are simultaneously characterized by a higher possibility of filing a total theft claim right after a typhoon. This phenomenon is not found to exist in the period right after the typhoon, in the region that was not hit by the typhoon, or in partial theft claims.

Such evidence of opportunistic fraud can be derived regardless of whether the empirical methodology we adopt consists of the two-stage method or residual conditional correlation analysis, or both of the above. We also performed sensitivity analysis for different period lengths to confirm the robustness of our findings. Hence, we can conclude that opportunistic fraud exists in the automobile theft insurance market in Taiwan. This opportunistic fraud is induced by flooding that is triggered by a typhoon.

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