Claims Auditing in Automobile Insurance

by

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ABSTRACT

Research on insurer management of opportunism in claiming has developed in two parallel literatures. One is a theoretical literature on insurance contracting that yields predictions about the nature of optimal auditing strategies for the deterrence of fraud. The other is a literature based upon statistical analysis of claims that yields empirical strategies for the detection of fraudulent claims. This article links the two literatures by providing an empirical assessment of insurers' auditing practices in relation to the predictions of the two approaches. The analysis makes use of a data set on the disposition of over 1000 randomly selected automobile personal injury protection (PIP) claims settled in the state of Massachusetts. The findings of the paper are consistent with the use of economically rational auditing strategies by insurers, and with a significant (but not exclusively) deterrent role for auditing.

1. INTRODUCTION

The issue of claims fraud (illegitimate claims) and build-up (exaggerated loss amounts) is a major concern among automobile insurance companies. Empirical studies of automobile insurance claims have concluded that large percentages of claims appear to involve fraud or exaggeration.[1] For example, Weisberg and Derrig's series of studies of automobile personal injury claims in the state of Massachusetts found that anywhere from one-quarter to three-quarters of claims showed some evidence of fraud or build-up (Weisberg and Derrig, 1991, 1992, 1996). The Insurance Research Council (1996) analyzed claims from nine states and found that 21 percent to 36 percent of the claims involved suspected fraud or build-up.[2] In all of these studies, the vast majority of suspicious claims involved potential build-up rather than outright fraud.

In the presence of build-up, the active verification of claims through investigation or auditing is an important claims management tool. The role of auditing in reducing claims build-up is recognized in both insurance theory and practice. There is a large theoretical literature examining the design of auditing strategies in the insurance claiming context.[3] Using optimization techniques, this literature derives the auditing strategy that minimizes the total costs incurred from build-up, where the costs include both the costs of performing audits and the costs of paying built-up claims that are not detected. The key insight from theory is that the primary role of auditing in an optimally designed system is deterrence of build-up rather than its detection.

There is also a growing empirical literature aimed at designing better fraud detection systems (Derrig and Weisberg, 1995; Derrig and Ostaszewski, 1995; Derrig, Weisberg and Chen, 1994; Brockett, Xia and Derrig, 1998, Weisberg and Derrig, 1998). This literature focuses on the practical complexities faced by an insurer determining which claims to audit when claims differ in many characteristics. This literature provides insights into auditing for the detection of built-up claims. Auditing as a deterrent

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[1] More econometrically oriented studies by Cummins and Tennyson (1996) and Abrahamse and Carroll (1999) also find evidence of fraud or build-up in automobile insurance markets.

[2] In both sets of studies, the determination of suspicion was made by insurance company claims reviewers. Irrespective of whether these reviewers are correct in their assessments, the results provide evidence that the problem is perceived to be large by insurance companies.

mechanism has received less attention in this literature. Audit system success is typically measured by the reduction in payment amounts on audited claims, or the number of fraudulent or built-up claims detected.

While clearly different in focus, these two approaches need not be incompatible. The theoretical literature on auditing of necessity makes a number of simplifying assumptions about the nature of claims and the information available to the insurance company, and thus yields only very general predictions about optimal auditing strategies. For example, the theory predicts that larger claims, and claims for which the potential for opportunism is greater, should be audited with a higher probability than other claims (Picard, 2000). Consistent with this, the empirically based design of fraud detection systems can be viewed as an attempt to identify those specific categories of claims that should be audited with higher probability, given complex claims characteristics and imperfect knowledge of the degree of opportunism in the claiming population.

Nonetheless, the difference in focus across the two literatures raises questions about the use and role of auditing in insurance markets. While there are several studies that examine the determinants of claims audits in practice (Weisberg and Derrig, 1995, 1996, 1998), to our knowledge there have been no studies that examine auditing practices in relation to the predictions of theory. Nor has the relative importance of the detection versus deterrence objectives in auditing been examined. This study analyzes claims auditing in an automobile insurance market to provide empirical evidence on these issues. The study makes use of a data set of individual automobile insurance claims that includes information regarding the handling of the claim by the insurance company.

The outline of the remainder of the paper is as follows. Section 2 describes the database of automobile insurance claims. Section 3 describes the patterns of auditing observed in the data. Section 4 develops specific hypotheses to be tested. Section 5 presents an econometric analysis of auditing and interprets the results. The final section of the paper offers conclusions.

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[3] See, for example, Kaplow (1994); Picard (1996), Bond and Crocker (1997) and Boyer (1998), among

2. THE DATA

The study utilizes data on automobile personal injury protection (PIP) claims settled in the state of Massachusetts. PIP coverage is first-party injury protection provided under no-fault automobile insurance systems. This coverage indemnifies the insured, his family or other occupants of the insured's car for losses from accident-related injuries, regardless of fault in the accident. In Massachusetts PIP covers 100 percent of medical expenses and 75 percent of wage losses, up to a maximum of $8000. However, if the claimant has private health insurance, medical and related losses in excess of $2000 are first submitted to the health insurance provider. Any amounts, including deductibles, that are not covered by the health insurer are paid under the PIP coverage (up to the $8000 limit).

The PIP claims data were obtained from a Massachusetts Automobile Insurers' Bureau (AIB) study of claims handling. The initial sample consisted of 1,207 randomly selected PIP claims settled by the ten largest insurers in the state in 1993. The claims data were reviewed and coded into the claim survey form by non-company coders trained by the AIB. The survey form reported information regarding the accident, the claimant and the claimant's injuries, the claimed amount and the amount paid by the PIP insurer. In addition, the survey reported whether the claim was settled routinely, or whether non-routine investigation was undertaken. For investigated claims, the survey also reported the type(s) of investigation undertaken and the results of each investigation – whether the investigation confirmed, refuted or created doubt about the claimed information.

In constructing the claims sample for analysis, we eliminated claims for which the settlement process was incomplete, claims that were closed without payment due to statutory ineligibility for coverage, claims for which the expenses reported in the data were known to be less than the full amount of the claimant's loss, and claims for which no loss amount was reported. [4] These selection criteria produced a sample of 1,091 claims for use in the analysis.

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others. Picard (2000) provides an excellent in-depth review of this theoretical literature.

[4] Statutory ineligibility occurs if the claimant had no PIP coverage, the claimant was under the influence of alcohol or drugs in the accident, or the claim was covered under workers' compensation. Under-reporting of expenses occurred in some claim files when only the maximum amount that could be paid under PIP

For each claim we constructed the total claimed amount as the sum of medical bills and medical-related expenses (ambulance services, prescriptions, replacement services, rehabilitation services, medical equipment, funeral expenses and others), and 75 percent of wage losses. Table 1 displays the distribution of claimed amounts in the sample of 1,091 claims. Claims range greatly in size, from a minimum of $10 to a maximum of $104,487.00. As in most insurance claims distributions, however, there are many more claims for small amounts than for large amounts. The mean claim amount is $2,761.44 and the median claim amount is $1,765.00.

TABLE 1. Distribution of PIP Claim Amounts

Mean	2,761.44
Standard Deviation	4,755.46
Minimum	10.00
25th Percentile	488.00
Median	1,765.00
75th Percentile	3,464.00
Maximum	104,487.00

Despite the relatively low coverage limits under PIP, automobile insurers have found it necessary to monitor PIP claims for build up. This may be due in part to the relationship between PIP claims and tort-eligibility. In Massachusetts an automobile-related injury may be eligible for a bodily injury liability (BIL) claim if the claimant's medical expenses exceed $2000. Liability claims are compensated on an at-fault basis, but are not subjected to the strict coverage limitations of PIP. BIL insurance claimants may be compensated for the full value of documented losses and for undocumentable losses such as "pain and suffering" (through general damages awards). Because a claimant may file a BIL claim if medical expenses filed under the PIP claim exceed the tort threshold, there are significant incentives for PIP claims build up.

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coverage was reported, rather than the full amount of the claimant's loss. We eliminated these claims due to concerns that the insurer's auditing strategy might have been affected by information not included in our data set.

An interesting feature of the PIP claim distribution is thus the relationship between claim amounts and claimant tort eligibility. Under Massachusetts' liability rules, all injured passengers and pedestrians, and injured drivers who are less than 50% at-fault in the accident, are eligible for BIL compensation if medical losses exceed $2000. Table 2 shows the cross-tabulation of claimant fault and reported loss amounts, by whether the reported loss is below the tort threshold or above the tort threshold. The table shows strong suggestive evidence of claimant opportunism.[5]

Notice in the table that claims amounts are approximately equally divided into the below $2000 and above $2000 partitions (556 claims and 535 claims, respectively). However, the distribution of fault among claimants is very different for claimed amounts below and above $2000. 148 (26.6%) of claimants with reported losses below the tort-threshold were at fault in the accident, but only 49 (8.2%) of claimants with reported losses above the tort-threshold were at fault in the accident. This pattern suggests that injured parties who were not at fault in their accident may have exaggerated their losses in order to gain BIL eligibility (evidence of claims build-up), or that not-at-fault parties with medical expenses meeting the tort threshold were more likely to file a PIP claim due to their BIL eligibility (evidence of claims-reporting moral hazard).

TABLE 2. Distribution of PIP Claim Amount by Claimant Fault

	Claim < $2000	Claim $ $2000	Total
Claimant not at fault	408	486	894
Claimant at fault	148	49	197
Total	556	535	1091

3. CLAIMS AUDITING PATTERNS

If a claim is selected for audit, there are many investigation methods that may be used. The non-routine investigation techniques included in the AIB survey form are an independent medical exam; a medical audit; a site investigation; recorded or sworn statements from the claimant, the insured and/or a witness to the accident; referral to a Special Investigative Unit (SIU); and an activity check. An independent medical exam involves an examination of the claimant by a doctor chosen by the insurance company.

[5] Similar findings were reported by Derrig, Weisberg and Chen (1994).

A medical audit involves a review of medical utilization and charges by a nurse or other medical professional hired by the insurance company. A site investigation involves a claims adjustor visiting the scene of the accident to determine the facts of the accident. Referral to an SIU involves active investigation by a specially trained anti-fraud unit of the insurance company. An activity check involves surveillance of the claimant or interviews with neighbors and others familiar with the claimant's activities.

Including all of the non-routine investigative techniques described above, 358 of the 1,091 claims in the sample (32.8%) were subjected to some form of audit. Table 3 reports the relative use of the different audit techniques for the claims that were audited. The table reports 553 instances of audit in the data. Since only 358 claims were audited, this means that some claims were audited with more than one technique. Thus, the percentages of claims audited by each investigative technique do not add up to 100.

TABLE 3. Type and Frequency of Audits

	Frequency	Percent of Total Claims	Percent of Audited Claims
Independent Medical Exam	180	16.5	50.3
Medical Audit	30	2.8	8.4
SIU Referral	21	1.9	5.9
Activity Check	7	0.6	2.0
Site Investigation	35	3.2	9.8
Recorded Statement	269	24.7	75.1
Sworn Statement	11	1.0	3.1
Total Number of Audits	553	--	--

The most frequently used auditing technique in the sample is a recorded statement. The table counts the use of a recorded statement for any party to the accident (the claimant, the insured, or a witness) under this heading. Recorded statements were utilized in 269 cases, or 75.1 percent of the audited claims. The second most frequent audit technique is an independent medical exam, utilized in 180 cases, or 50.3 percent of the audited claims.[6] The least commonly used techniques were sworn statements (used in 11 cases, 3.1 percent of audited claims) and activity checks (used in 7 cases, 2.0 percent of

audited claims.) The remaining techniques (medical audit, site investigation and SIU referral) were similarly utilized in 21 to 35 cases each, i.e. in 6 to 10 percent of audited claims.

The large percentage of audited claims for which the audit method was a recorded statement raised questions in our minds. It is arguable whether recording a statement constitutes an audit, because it is not necessarily an active application of resources toward investigation. The cost of conducting a recorded statement is negligible and may be less than or equal to the cost of other statement taking methods. Thus, some insurers may routinely record statements as a form of record keeping.[7] Further examination of the data showed that in 170 of the 269 instances (63.2 percent) of the use of recorded statements, the recorded statement was the only audit technique employed. This accounts for fully 115 of the 358 audited claims (32.1 percent). Because of the large number of recorded statements, and the ambiguity regarding their purpose, the remainder of the study examines the pattern of audits both including recorded statements as a form of audit ("all audits") and excluding recorded statements from audits (with the remaining methods termed "investigative audits").

Table 4 reports the relative intensity of auditing by insurers. The table reports the number of different types of audits to which each audited claim was subjected. In this tabulation each recorded or sworn statement (taken from a claimant, an insured or a witness) is counted as one audit.

TABLE 4. Audit Intensity

[6] This may be the case because the Massachusetts PIP insurance policy requires a claimant to cooperate if an independent medical exam is requested.
[7] We cannot distinguish the different insurers in the data, and so cannot determine whether this is the case.

Number of Methods	Number of Claims (All Audits)	Percent of Audited Claims	Number of Claims (Investigative Audits)	Percent of Investigated Claims
1	229	63.97	212	87.24
2	85	23.74	23	9.47
3	28	7.82	6	2.47
4	11	3.07	2	0.82
5	4	1.12	0	0.00
6	1	0.28	0	0.00

The table shows that the large majority of claims were audited using only one method. Of the 358 claims audited, 229 (64 percent) were audited using only one technique. Of the 243 claims audited using investigative techniques, 212 (87.2 percent) were investigated only once. Including recorded statements the maximum number of audit techniques used for any claim was six, for investigative audits the maximum number used was 4. However, this auditing intensity was observed only rarely in the data.

In addition to reporting the audit methods used for each claim, for each audit the claims survey records whether it resulted in the claim being "confirmed", "refuted" or "doubted". Table 5 reports the relative frequency of these outcomes for each of the auditing methods reported in the survey.

TABLE 5. Audit Results*

	Frequency	Confirmed (%)	Doubted (%)	Refuted (%)
Independent Medical Exam	180	108 (60.0)	59 (32.8)	13 (7.2)
Medical Audit	29	12 (41.4)	13 (44.8)	4 (13.8)
SIU Referral	21	10 (47.6)	6 (28.6)	5 (23.8)
Activity Check	7	3 (42.9)	3 (42.9)	1 (14.3)
Site Investigation	35	26 (74.3)	7 (20.0)	2 (5.7)
Recorded Statement	269	246 (91.4)	15 (5.6)	8 (3.0)
Sworn Statement	11	7 (63.6)	3 (27.3)	1 (9.1)
Total Audits	552	412 (74.6)	106 (19.2)	34 (6.2)

*Outcome information was missing for one audit.

Overall, and for most individual types of audits, the most frequent result of the audit

was confirmation of the claim, followed by doubt and trailed dramatically by refutation of the claim. Nearly 75 percent of audits led to the claim being confirmed. Only 6.2 percent of audits led to evidence that refuted the claim. The highest percentages of refuted claims result from SIU referrals (23.8 percent), activity checks (14.3 percent) and medical audits (13.8 percent). Site investigations refuted claims only 5.7 percent of the time and recorded statements succeeded in this regard in only 3 percent of cases.

Because some claims received more than one type of audit, and because different audit techniques may focus on confirming different types of information, the key assessment of audit outcome is whether an audited claim was confirmed by *all* of the audits to which it was subjected. To examine this, Table 6 reports the audit outcomes for each audited claim. Audited claims are grouped into two categories, those that were audited only once and those that were audited more than once. For each of these groups of claims, the table reports the fraction of audited claims for which all audits resulted in confirmation, the fraction for which at least some audits resulted in doubt, and the fraction for which at least some audits resulted in refutation. If any audit resulted in the claim being refuted, we report that claim in the "Some Refuted" column; that is, each audited claim is categorized by the worst outcome from all of the audits performed.

TABLE 6. Audit Outcomes by Audited Claim*

	Number of Claims	All Confirmed (%)	Some Doubt (%)	Some Refuted (%)
ALL AUDITS				
One Method	229	154(67.2%)	63 (27.5%)	12 (5.2%)
More than One Method	128	91(71.1%)	23 (18.0%)	14 (10.9%)
Total	357	245(68.6%)	86 (24.1%)	26 (7.3%)
INVESTIGATIVE AUDITS				
One Method	211	131 (62.1%)	65 (30.8%)	15 (7.1%)
More than One Method	31	11 (35.5%)	13 (41.9%)	7 (22.6%)
Total	242	142 (58.7%)	78 (32.2%)	22 (9.1%)

*Outcome information was missing for one claim.

From the table we see that of the 357 audited claims for which we have outcome data, 245 (68.6 percent) were confirmed by all audit techniques employed. Overall, 7.3 percent of audited claims were refuted by the audits and for the remaining 24.1 percent

at least one audit led the claim to be doubted. Claims audited using more than one method were more likely to be doubted or refuted than claims audited only once. For these claims 10.9 percent were refuted by audits, whereas only 5.2 percent of claims audited once were refuted.

The outcomes of investigative audits show a similar pattern, although investigative audits appear to be more efficient at identifying claiming irregularities. The most frequent investigative outcome was confirmation of the claim, which occurred in 142 cases (58.7 percent). Investigations refuted only 22 claims (9.1 percent) and created doubts for 78 claims (32.2 percent). As with all audit techniques combined, claims investigated with more than one method were less likely to be confirmed: with multiple investigations, 22.6 percent of claims were refuted as compared with only 7.1 percent of cases investigated only once.

4. THE ECONOMIC ROLE OF AUDITING

The analysis of audit patterns reveals that less than 1/3 of claims were audited, and if only investigative audits are included only about 1/5 of claims were audited. The majority of claims were audited using only one method, and the most common outcome of an audit was to confirm the claim. Audits rarely refuted a claim, although the percentage of claims refuted varied by audit method.

The high percentage of audited claims that were confirmed is a particularly notable finding. If the detection of fraud or build-up is the sole objective of auditing, this finding suggests that insurer audit systems may not be fully efficient. However, recognizing that audits may serve both detection and deterrence functions, this finding need not indicate a poorly performing system. In fact, a low rate of fraud detection could be evidence of audit system success, if it occurs because the rate of fraudulent claiming is low due to the deterrent effect. To determine which interpretation is more correct requires a closer examination of the predicted audit patterns under a deterrent versus a detection objective in auditing.

Economic theories of optimal auditing strategies utilize a principal-agent framework, under which it is posited that the insurer (the principal) designs auditing rules prior

to receiving any claims. The rules are designed recognizing that a claimant (the agent) has the ability to misrepresent the amount of his loss, and will report the amount of loss that maximizes his expected payoff (or expected utility of payoff).[8] The insurer may audit any claim to determine the true loss amount, but auditing is costly. The insurer's aim is to choose auditing rules that minimize (subject to constraints) the total costs of claims build-up, including both the cost of undetected built-up claims and the costs of auditing claims.

Although derived within a complex informational structure, the theoretically optimal auditing strategy conforms to basic economic principles. To minimize total costs, the insurer should audit to the extent that the expected marginal costs of auditing are just equal to the expected marginal savings from auditing. An important realization is that the savings from audits are not just the savings in claims costs from detecting built-up claims. There will be additional savings in claims costs due to the reduction in the extent of build-up that occurs when claimants know that claims are audited. Under ideal conditions the optimal auditing strategy will completely eliminate build-up and thus all savings will stem from deterrence.[9]

The optimal auditing strategy derived from this approach has several intuitively appealing properties. First, auditing will be random rather than deterministic; that is, each claim will be audited with some probability less than one. In combination with the use of penalties imposed upon those who are discovered to have built-up a claim, random auditing allows the insurer to conserve on audit costs relative to deterministic auditing. Although some claims are not audited, build-up is nonetheless deterred by the anticipation of penalties imposed if a claim is audited and found to be built-up.[10]

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[8] There is a large theoretical literature examining the problem of efficient contract design under information asymmetry, in which the problem of potential insurance claims build-up is just one example. The theoretical problem of designing an optimal contract with costly verification was first examined by Townsend (1979).

[9] If insurers can pre-commit to an (announced) auditing strategy prior to any claims being filed, then the optimal auditing strategy will completely eliminate all build-up and thus the savings from auditing arises from deterrence alone. If insurers cannot pre-commit, the optimal auditing strategy serves partially as a deterrent and partially to identify those claims that are fraudulent or built-up (Khalil, 1997). Thus, within this theoretical literature, the distinction between pure deterrence and detection objectives can be framed as insurer pre-commitment versus no commitment to an audit strategy.

[10] Penalties may involve, for example, less generous claims settlement, change in terms of future insurance contracts, reputational penalties or even prosecution.

In addition, only claims for losses above some threshold amount will be audited, because the potential benefits of audits must be weighed against the audit costs. Holding audit costs fixed, the potential benefits of audits will be greater for higher valued claims because a larger claim is more likely to be built-up. In practice, given the different costs of the different audit methods, this prediction implies that the probability that a claim is audited will be positively related to the size of the claim.

Lastly, the probability of audit will be positively related to the fraction of claimants in the population who are willing to build up a claim (Picard, 1996). While it is hard to measure the fraction of claimants willing to do this, the prediction can be interpreted in relation to different categories of claims. If there are specific claims categories that are more likely to be built-up than others, then the insurer should audit a higher percentage of those claims in order to ensure a sufficiently high probability that a built-up claim is detected and penalized.

Unfortunately for our purposes, these characteristics of the optimal auditing strategy will also be observed in well-designed fraud detection systems. Fraud detection systems aim to identify those claims most likely to be fraudulent or built-up. Only those claims thought to be sufficiently suspicious should be audited, and thus auditing will appear to be probabilistic. Similarly, higher valued claims should be more likely to be audited due to the potentially greater savings associated with detected build-up, as well as the greater likelihood of build-up among larger claims. Finally, the prevalence of auditing will vary across claims categories according to insurers' suspicion regarding the extent of fraud or build-up among different types of claims.

Two distinctions can be made between auditing patterns under deterrence versus detection objectives, however. The first regards the decision to audit. Under a deterrence objective, claims will be randomly selected for audit based on characteristics defined prior to a review of the claim. Under a detection objective, specific claims will be selected for audit based upon any characteristic thought to indicate fraud or build-up. Under either objective, the decision to audit may depend upon specific characteristics of the claim, and these may be characteristics that have been identified by some empirical

model. However, only under a detection objective may more subjectively determined suspicions regarding a specific claim be used to determine an audit. Thus, the use of subjective determinations by a claims adjustor to decide upon an audit provides evidence of auditing for fraud detection.

The predicted patterns of audit outcomes also differ under detection and deterrence objectives. If auditing is used solely to deter build-up, then although claims categories with a high potential for opportunism will be audited *more* frequently, these claims should be found to be built-up *no more* frequently than other claims. This is because optimal deterrence implies that the audit probability will be adjusted across claims categories to reflect the relative likelihood of build-up. Because auditing deters the filing of built-up claims, the observed outcomes of audits across different claims categories should be random. Conversely, if auditing serves as a detection device, high-opportunism claims should be audited with greater frequency and build-up should also be detected with greater frequency in these claims.

These predictions from theory form the basis for testing whether insurer auditing practices are consistent with the efficient use of auditing, and whether they are consistent with systems designed for build-up deterrence. The key predictions are that the probability of audit should increase with the size of the claim and that the probability of audit should increase with the degree of opportunism in the claiming environment. Different predictions under detection versus deterrent objectives also allow examination of the extent to which audit practices are consistent with a deterrent objective.

5. ECONOMETRIC ANALYSIS OF AUDITING

We develop and estimate an econometric model of claims audits. Because the statistics reported earlier in the paper suggest that auditing is probabilistic rather than deterministic, we estimate the probability that a claim is audited using a logistic model. A multivariate model is used to control for institutional and other factors that may influence the probability of audit.

5.1 The Empirical Specification

Because only a small percentage of claims in our data were audited more than once, we group claims into two categories, those that were not audited and those that were audited (once or more than once). Consistent with our earlier analysis, we estimate separate models for the probability of any audit and the probability of investigative audit. Recall that the distinction between the two audit variable definitions is that recorded statements are excluded from investigative audits.

A key explanatory variable in the model is the claimed amount of loss. This variable is included to test the hypothesis that the probability of audit is an increasing function of the claimed amount. The empirical specification includes both the claimed amount and the claimed amount squared, to allow for a potentially nonlinear relationship between the audit probability and the size of the claim.

The model includes several variables to test the prediction that the probability of audit increases as the degree of opportunism in claiming increases. With PIP claims, the incentives to build up a claim to exceed the tort-eligibility threshold should make tort-eligibility an indicator of the potential for opportunism. Previous studies of insurance claiming have also found that sprain claims appear to be subject to greater degrees of opportunism (Dionne and St-Michel, 1991; Crocker and Tennyson, 1999), due to the difficulty that medical doctors have in determining the severity of such injuries with precision (Dionne and St-Michel, 1991).

Accordingly, we include as an explanatory variable in the model a dummy variable indicating whether the claimant is eligible to file a tort claim. We also include dummy variables for the characteristic of the claimant's most severe injury, to test the hypothesis that claims involving primarily sprain injuries are more likely to be audited than claims involving other types of injuries. Due to small numbers of claims in many injury categories, dummy variables for only the injury categories of laceration, neck sprain, back sprain and other sprain are included in the model. All other primary injury types are grouped together as the excluded category. We expect to observe a significant and positive coefficient on both the tort-eligibility indicator and the sprain injury indicators.

Previous researchers have also identified specific characteristics of claims that lead insurance claims adjustors to be suspicious (Weisberg and Derrig, 1991). A study of PIP claims handling in Massachusetts identified 10 specific claims characteristics, from among many characteristics of the accident, that were significantly related to claims adjustors' perceptions of the suspiciousness of a claim (Weisberg and Derrig, 1998). These indicators are reported in our data set, and are listed in Table 7 (along with summary statistics for the remainder of the variables used in the logistic models).

Table 7. Summary Statistics

	Frequency	Percent
Basic Claim Characteristics:		
Private Health Insurance	202	18.52
PIP Coverage Limit	65	5.96
Tort Eligible	487	44.64
Laceration	178	16.32
Neck Sprain/Strain	161	14.76
Back Sprain/Strain	566	51.88
Other Sprain/Strain	48	4.4
Suspicion Indicators:		
No report by police at scene	522	47.85
No plausible explanation of accident	10	0.92
Claimant in an old, low-value vehicle	419	38.41
Insured felt set up, denied fault	40	3.67
Claimant appeared 'Claims-Wise'	214	19.62
Insured Uncooperative	29	2.66
No objective evidence of injury	675	61.87
Injuries inconsistent with police report	118	10.82
Large number of visits to a chiropractor	266	24.38
Long disability for a minor injury	61	5.59

For a number of the suspicion indicators it is easy to imagine an insurer establishing an ex-ante rule that any claim that has these characteristics will be audited with a higher probability. This could be the case, for example, for indicators such as "no police report", "claimant in an old, low-value vehicle", "no objective evidence of injury", "injuries inconsistent with police report", "large number of visits to a chiropractor", and "long disability for a minor injury". Others of the suspicion indicators are inherently subjective, however, in that they would have to be decided by a claims adjustor based

upon his or her experiences with the claim. "Claimant appeared claims-wise", and "insured uncooperative" are examples of this type of indicator.[11] To the extent that these subjective indicators are significantly related to the probability of audit, insurers are more clearly using them to identify individual claims that are potentially fraudulent or built-up. This would provide strong evidence of auditing for the detection of fraud or build-up.

Indicator variables for each of these 10 claims characteristics are included in the model. We test for the joint significance of the indicators, as together they are additional measures of the potential for opportunism. We also test for the significance of each individual indicator, with the aim of determining whether the more subjective indicators are significantly related to the probability of audit.

Lastly, the model includes two variables designed to control for institutional features of the claims payment environment. The first is an indicator variable set equal to one if the claimant has private health insurance and the value of the claim is greater than $2,000, because health insurance becomes the primary insurance policy after PIP payments of $2,000. The second institutional control is an indicator variable set equal to one if the claim amount exceeds the maximum PIP coverage level of $8,000. Because in these situations the insurer's expected PIP payment is lower (all else equal), the insurer should be less likely to audit the claim. Thus we expect to observe a negative relationship between these indicator variables and the probability that a claim is audited.

5.2 The Estimation Results

The results of the logistic model estimation are reported in Table 8. There are only relatively small differences in the estimation results under the alternative definitions of what constitutes an audit, and the estimation results overall are consistent with the theoretical predictions. However, as would be expected if recorded statements are sometimes used for non-investigative purposes, the model fit is superior with investigative audits as the dependent variable.

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[11] "Insured felt set-up, denied fault" appears to us to be more difficult to categorize as objective or subjective.

In all model specifications, the probability of audit is positively and significantly related to the claim amount, and negatively and significantly related to the claim amount squared. Thus, the audit probability increases with claim size but at a decreasing rate. The indicator variables for sprain-related claims are positive and significantly related to the probability of audit, with sprains other than back or neck sprains appearing to receive the greatest likelihood of scrutiny. The tort-eligibility indicator variable is also positive

Table 8. Logistic Models of Audit Probability

	ALL AUDITS		INVESTIGATIVE AUDITS	
	Model 1	Model 2	Model 1	Model 2
Intercept	-2.4270*	-2.3243*	-4.16*	-4.1691*
	(0.2678)	(0.2975)	(0.3817)	(0.4286)
Claimed Amount	3.09E-04*	2.77E-04*	4.64E-04*	4.64E-04*
	(7.30E-05)	(7.70E-05)	(8.70E-05)	(9.20E-05)
Claimed Amount Squared	-1.14E-08*	-1.00E-08*	-1.77E-08*	-1.69E-08*
	(3.78E-09)	(3.75E-09)	(4.95E-09)	(4.81E-09)
Private Health Insurance	-0.2557	-0.2170	-0.0865	-0.0176
	(0.1826)	(0.1887)	(0.1934)	(0.2023)
PIP Coverage Limit	-0.4538	-0.2934	-0.4771	-0.4133
	(0.4505)	(0.4602)	(0.4877)	(0.5001)
Tort Eligible	0.7527*	0.5226*	0.8164*	0.4159
	(0.2113)	(0.2229)	(0.2484)	(0.2641)
Laceration	0.8050*	0.7376*	0.6671	0.6696
	(0.3084)	(0.3157)	(0.4776)	(0.4914)
Neck Sprain/Strain	0.7471*	0.5107	1.3918*	0.8915*
	(0.2983)	(0.3265)	(0.3966)	(0.4426)
Back Sprain/Strain	0.8477*	0.5980*	1.655*	1.2500*
	(0.2466)	(0.2732)	(0.3365)	(0.3751)
Other Sprain/Strain	1.1196*	0.9554*	1.9424*	1.7734*
	(0.4014)	(0.4175)	(0.504)	(0.5301)
No report by police at scene	--	-0.2854	--	-0.1093
		(0.1561)		(0.1879)
No plausible explanation of Accident	--	1.0101	--	0.0299
		(0.7203)		(0.8502)
Claimant in old, low-value Vehicle	--	-0.1098	--	0.0205
		(0.1496)		(0.1757)
Insured felt set-up, denied fault	--	0.8664*	--	0.0667
		(0.3575)		(0.4447)
Claimant appeared 'Claims-Wise'	--	0.3111	--	0.6060*
		(0.1945)		(0.2038)
Insured Uncooperative	--	0.6617	--	1.0268*
		(0.4287)		(0.4733)
No objective evidence of injury	--	0.0926	--	0.1347
		(0.1667)		(0.2039)
Injuries inconsistent with police report	--	0.3496	--	0.2371
		(0.2377)		(0.2795)
Many visits to Chiropractor	--	0.7541*	--	0.8660*
		(0.1812)		(0.1937)
Long disability for minor Injury	--	-0.2787	--	-0.5780
		(0.3055)		(0.3198)
LR	141.04	181.50	227.67	277.66
Percent	71.4 %	74.9 %	79.8 %	82.6 %

Standard errors are in parenthesis. * indicates parameter is significantly different from zero at better than the 5 percent significance level, 2-sided test. The chi-square test statistic for the joint significance of all suspicion indicators is 45.098 ($p<0.0001$) in column 2 of the table, and 47.41 9 ($p<0.0001$), in column 4 of the table.

and statistically significant in most of the model specifications, demonstrating that insurers are more likely to audit claims that exceed the tort threshold.

The suspicion indicators are jointly significant under both definitions of the dependent variable. This finding is consistent with previous studies which found that summary indicators derived from these claims characteristics were significantly related to the probability that a claim is audited (Weisberg and Derrig, 1995, 1996, 1998). Only a few of the individual suspicion indicators are statistically significant. Using all audits as the dependent variable, only two indicators are significantly related to the probability of audit, and both can be viewed as potentially part of a pre-set auditing rule. Using investigative audits as a dependent variable, however, the two subjective suspicion indicators are significant and positively related to the probability of audit: "claimant appeared claims-wise" and "insured uncooperative". This result provides evidence that investigative audits are (at least in part) determined on an individual claim basis, with a detection objective in mind.

5.3 Analysis of Audit Outcomes

We use the predicted probabilities of audits obtained from the logistic model estimation to examine the relationship between the probability that a claim is audited and the outcome of the audit (for claims observed to be audited). As noted previously, if audits are used for deterrence, claims with a greater potential for opportunism will be audited with higher frequency, but the audit outcomes will be random across claims. If audits are used for detection of build-up, then high opportunism claims will be audited more frequently and build-up will be detected more frequently in these claims. To examine this distinction we analyze the relationship between the probability of audit for each claim and the outcome of the audit, if an audit is observed.

The probability of audit is the predicted probability from the logistic models in Table 8 (including the suspicion indicators). That is, all variables used for auditing decisions are summarized in one measure, the probability of audit. To allow for comparison we construct three intervals for the fitted probabilities, for all audits and for investigative audits. The first interval groups claims with a predicted probability of audit between 0 and 0.25, the second interval groups claims with a predicted audit probability between

0.25 and 0.50, and the third groups those between 0.50 and 1.0.

The relationship between audit probabilities and audit outcomes is shown in Table 9. Using the estimated model for all audits, 73 of the audited claims were predicted to be audited with probability less than 0.25, 149 were predicted to be audited with probability between 0.25 and 0.50 and 135 were predicted to be audited with probability greater than 0.50. Among the claims in the lowest probability band, 86.3 percent were confirmed by audit, and only 2.7 percent were refuted. Among those in the middle probability band, 71.1 percent were verified by audit and only 5.4 percent refuted. Of those in the highest probability band only 56.3 percent were confirmed by audit and 11.9 percent were refuted.

TABLE 9. Audit Outcomes by Audit Probability

	ALL AUDITS				INVESTIGATIVE AUDITS			
Probability	Confirmed (%)	Doubted (%)	Refuted (%)	Total (%)	Confirmed (%)	Doubted (%)	Refuted (%)	Total (%)
Less than 0.25	63 (86.3%)	8 (11.0%)	2 (2.7%)	73 (100%)	40 (65.6%)	15 (24.6%)	6 (9.8%)	61 (100%)
From 0.25 to 0.5	106 (71.1%)	35 (23.5%)	8 (5.4%)	149 (100%)	52 (57.1%)	35 (38.5%)	4 (4.4%)	91 (100%)
Greater than 0.5	76 (56.3%)	43 (31.9%)	16 (11.9%)	135 (100%)	50 (55.6%)	28 (31.1%)	12 (13.3%)	90 (100%)
Total	245 (68.6%)	86 (24.1%)	26 (7.3%)	357 (100%)	142 (58.7%)	78 (32.2%)	22 (9.1%)	242 (100%)

Overall, only a small percentage of claims were refuted by audit, and this percentage did not increase significantly over the audit probability intervals. However, grouping together doubted or refuted claims, the percentage of audited claims not confirmed did increase significantly over the audit probability intervals: 13.7 percent in the 0 to 0.25 interval, 28.9 percent in the 0.25 to 0.50 interval and 43.8 percent in the 0.50 to 1.0 interval.[12] This result is not consistent with a deterrence role for auditing.

Using the model for investigative audits, the percentage of investigated claims confirmed is smaller in all probability bands, and the rate of decline in confirmation percentages is flatter over the probability bands. Of the 61 investigated claims that were

[12] Chi-square test statistic is 21.762 (p-value 0.00).

predicted to be audited with probability less than 0.25, and 65.6 percent were confirmed by audit and 34.4 percent were not confirmed. Of the 91 investigated claims predicted to be audited with probability between 0.25 and 0.50, and 57.1 percent of were confirmed by audit and 42.9 percent were not. Of the 90 investigated claims predicted to be audited with probability greater than 0.50, 55.6 percent were confirmed by audit and 44.4 percent were not. These differences across the audit probability intervals are not statistically significant.[13] Thus the results for investigative audits are consistent with a deterrence role for auditing.

To reconcile the differences in outcome patterns for all audits versus investigative audits, recall that the sole difference between the two definitions is recorded statements. Previously we demonstrated that recorded statements were extremely likely to result in confirmation of the claim. Consistent with this, we observe in Table 9 that the fraction of audited claims confirmed is generally much greater than that under investigated claims. Only for those claims predicted to be audited with probability greater than 0.5 does the rate of confirmation of audited claims approach that for investigated claims. Thus, the difference in the outcomes under investigative audits appears to be due to the elimination of claims that were very likely to be confirmed.

6. CONCLUSIONS

This article has investigated the role of claims auditing in an automobile insurance market. Our findings reveal that auditing is probabilistic, with between one-fifth and one-third of claims receiving audits. The probability that a claim was audited increased with the value of the claimed amount. The probability of audit also varied with the potential for opportunism in claiming, as evidenced by sprain claims and tort-eligible claims being audited with greater frequency. These patterns are consistent with the use of economic decision models of audit determination by insurers.

Two measures of auditing were used in the analysis, one which counted recorded statement-taking as an audit method (all audits) and one which did not (investigative audits). We find the results under the latter definition of audits to be more credible, for several reasons. First, industry sources reported to us that some insurers may routinely

[13] Chi-square test statistic is 6.942 (p-value 0.14).

use recorded statements, and it is not clear that there is any cost incurred by the insurer from recording statements. In support of this interpretation, the data show that recorded statements are used much more frequently than other types of audits (269 cases versus 284 cases of all other audits combined). Moreover, recorded statements virtually always confirmed the claim in these data (91.4 percent of the time). Finally, logistic models of the probability of audit, using variables determined from theory, produced a better fit when recorded statements were not included in the definition of audit. We therefore put more weight on the results obtained from examining investigative audits.

Our results show that the pattern of auditing is consistent with the use of audits for fraud deterrence, rather than solely to detect fraudulent claims. Less than 10 percent of audited claims were refuted by investigative audits, and over 40 percent were fully confirmed. Additionally, while high-opportunism claims were more frequently subjected to investigative audits, the rate of fraud detection among those claims was not significantly greater than for claims investigated with lower probability. This pattern is consistent with auditing for deterrence, under which auditing probabilities will adjust across claims categories to the extent needed to deter fraudulent claiming.

Audits do not, however, appear to be used solely for deterrence. Subjective characteristics of claims that could only be determined on an individual claim basis were found to be significantly and positively related to the probability that a claim was investigated. This is not consistent with a pure deterrence objective, but is consistent with a detection objective. The patterns observed in these data thus suggest that insurers accrue both detection and deterrent benefits from auditing. The relative value of the deterrent benefits versus the detection benefits from insurance claims auditing is an important area for further study.

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