2009

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Society of Actuaries

Mary Kelly, Sapna Isotuba and Anne Kleffner "The impact of adjuster moral hazard on driving records: North American Actuarial Journal 13: 425-437: 2009
http://hdl.handle.net/1880/48707
journal article

The Impact of Adjuster Moral Hazard on Driving Records

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Abstract

In a first-party recovery scheme for automobile property damage, the first-party insurer compensates not-at-fault vehicular damage. In this scheme, adjusters may not have the incentive to assign liability when the driver is, in fact, at fault for the accident. This is due to adjusters not having to coordinate with a third-party adjuster, and, for insureds that carry collision coverage, the assignment of fault does not appreciably affect the compensation paid out. This in turn reduces the effectiveness of the experience-rating component of the insurance premium. Empirical evidence that supports the presence of incorrect fault assignment is provided. A stochastic model of experience rating analyzing the impact of incorrect fault assignment on driving record classes confirms that low-risk insureds pay more for insurance than if fault was correctly assigned.

1. Introduction

Insurance mechanisms for paying for vehicular property damage arising from an automobile accident vary by jurisdiction. In most jurisdictions the settlement of a property damage (PD) claim as a result of an accident involving more than one vehicle typically involves two or more insurers. Usually this damage is compensated by the third-party insurer, to the extent that the first party is not at fault. The exception would be jurisdictions with a contributory negligence standard. In this case recovery would occur only if the claimant is entirely not at fault. First-party vehicular property losses are typically covered by add-on coverages such as collision and comprehensive. Some jurisdictions, however, have a first-party recovery scheme for vehicular PD whereby the not-at-fault portion of damage is covered by the insured's own policy. This coverage is mandatory in some jurisdictions (such as Ontario) and not in others (such as Michigan). At-fault coverage is still provided by first-party collision insurance, which is optional in most jurisdictions.

In such a first-party recovery scheme, the claimant's insurer pays both the not-at-fault and the at-fault (if the insured carries collision coverage) portions of the loss. Because of this, it is possible that claims adjusters are less likely to be concerned about the correct assignment of fault for their own insureds. The reason for this is twofold: adjusters do not have to coordinate with a third-party adjuster (as in a tort jurisdiction) to settle a claim, and furthermore, for insureds that also carry at-fault collision coverage, the assignment of fault does not appreciably affect the compensation paid out. The difference in the amount paid by the insurer typically would be a portion of the insured's collision deductible.

Using data from three insurance companies in Canada, this paper presents empirical evidence that is consistent with the existence of adjuster moral hazard in fault assignment: the proportion of PD claims classified as not at-fault is higher for insurers in the first-party recovery scheme than in the traditional tort or third-party recovery scheme.

Although not assigning fault correctly has a relatively minor impact on the cost of claims paid, it has a more significant impact on pricing and risk classification. If adjusters are less likely to

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assign fault, then the risk classification that occurs via the experience-rating component of the insurance premium is less effective. Some drivers, who are actually high-risk drivers, will be misclassified as low risk, and there will be more pooling of risks within each risk class. It is conjectured that this misclassification will result in higher premiums for the low-risk drivers.

This impact on risk classification can be tested empirically. If moral hazard in claims settlement exists, then more drivers will be classified as low risk in first-party recovery than in third-party recovery jurisdictions. An analysis of company- and industry-level data for Ontario (first-party recovery) and Alberta (third-party recovery) reveals that more drivers are classified as low risk in Ontario than in Alberta. Such evidence does not contradict our hypothesis, although we acknowledge that other factors could lead to this observed difference.

To analyze the impact of incorrect assignment of fault on insurance premiums, a theoretical model of an insurer's portfolio of automobile insurance policies is constructed. We show that if adjusters incorrectly assign fault, then there are relatively more drivers in lower-risk than higher-risk driving record classes. With misclassification, the overall base premium is higher, and the resulting rate differentials between different driving record classes are smaller. More pooling exists in a model in which fault is not correctly assigned.

In practice, the true cost of moral hazard is difficult to measure, and insurers and regulators may not be aware of the moral hazard that exists in the settlement process in first-party recovery schemes. This research demonstrates that the potential impact of fault misclassification on the premiums structure is substantial.

2. Auto Insurance in Canada

Automobile insurance in Canada is the largest line of property/casualty insurance, accounting for 48.5% of net premiums written. In 2005 private insurers wrote $16.3 billion in net premiums, and government insurers wrote $5.1 billion in net premiums (Insurance Bureau of Canada 2006). In four provinces (British Columbia, Saskatchewan, Manitoba, and Quebec) the mandatory automobile insurance coverages are offered by (provincial) government-run monopolies. In all other provinces and territories, auto insurance is provided by the private marketplace. No-fault automobile insurance is in place in four provinces (Saskatchewan, Manitoba, Ontario, and Quebec) and provides compensation for bodily injury (BI) regardless of fault. Quebec and Manitoba use a pure no-fault system, Ontario has a modified no-fault system, and in Saskatchewan there is a choice system in which drivers select coverage under either the traditional tort system or a modified no-fault system, with no fault being the default. In the other provinces compensation for BI is provided through a combination of first-party accident benefits and tort liability.

With respect to vehicular PD, most provinces operate under a third-party recovery mechanism for not-at-fault losses. Ontario, Quebec, and New Brunswick, however, have direct compensation for vehicular PD losses. The first-party coverage allows a not-at-fault motorist to recover from the person's own insurer for damage to one's own car and any property inside the car to the extent that the person is not at fault. The rationale cited for first-party recovery of PD is that it improves the pricing mechanism (insureds purchase insurance based on the price to repair their own vehicles, rather than the cost of repairing the average vehicle), decreases the time to settlement, and reduces subrogation between insurers. Coverage for at-fault damage to one's own vehicle is optional except in Manitoba and Saskatchewan.

There is a degree of experience rating in automobile rate making in all jurisdictions in Canada, which is based on a driver's at-fault claims history. The experience-rating mechanism in Ontario and Alberta assigns drivers to a driving record class based on the number of years of at-fault-claims-free driving. Some insurers have separate driving record classes for third-party liability, first-party accident benefits, and first-party PD claims. Not-at-fault claims, by law, cannot be used to modify premiums and therefore do not affect the driving record class assignment. Drivers with zero years of at-fault-claims-free driving are placed in driving record class 0, drivers with one year of at-fault-claims-free driving are placed in driving record class 1, and so on up to driving record class 5. Drivers with 6 or more consecutive years of no at-fault claims are placed in class 6. Some insurers offer an additional discount for class 6 drivers with 10 or more years of consec-

utive at-fault-claims-free driving. In addition, most insurers offer modified accident forgiveness for class 6 drivers. Class 6 drivers with an at-fault claim are placed in class 5*. A driver in class 5* who has an at-fault claim moves to class 0 at the next renewal. A driver in class 5* moves back to class 6 if the person has 5 years of consecutive years of at-fault-claims-free driving. Because of the typically small probability of a claim, the majority of the driving population in both provinces studied are in class 6.

Premiums charged for each driving record class are then calculated as a multiple of the base class. Table 1 illustrates third-party liability differentials in 2007 for a large Canadian property/casualty insurer (denoted insurer A).

The classification of a claim as at-fault or not at-fault and the subsequent payment of claims affect the claims settlement process. Fault assignment rules also affect the claim settlement process. Doerpinghaus, Schmit, and Yeh (2003) find that in American states the negligence standard affects the settlement of bodily injury claims in that the defendant is less likely to be assigned fault under a pure comparative negligence rule. Flannigan et al. (1989) find that states that operate under a comparative negligence standard (partial recovery for claimants is possible even if the claimant is partially at fault) have higher automobile insurance costs than do states that operate under a contributory negligence standard (recovery is possible only if the claimant is completely not at fault). These studies suggest that differences in fault assignment mechanisms will impact the claims settlement process in different jurisdictions.

Fault determination rules differ somewhat between Ontario and Alberta, although in both provinces the standard for payment of PD claims is a pure comparative negligence rule. In Ontario, because recovery for not-at-fault PD losses is a first-party coverage, the negligence standard is of less importance if the insured also carries coverage for damage to one's own automobile because the insurer will be responsible for all losses (less a portion of the collision deductible). Fault determination rules in Ontario are defined by statute. They are given in the Insurance Act (Province of Ontario, 1990) and apply to all insurers in the province. In theory, the fault determination rules mechanically assign fault regardless of weather and road conditions. Standard accidents listed in the determination rules apportion fault at 0%, 25%, 50%, 75%, and 100%.

Table 1
Driving Record Rate Differentials for Third-Party Liability for Insurer A

Driving Record	Ontario (First-Party Recovery)	Alberta (Third-Party Recovery)
6	1.000	1.000
5* and 5	1.050	1.100
4	1.100	1.225
3	1.150	1.300
2	1.225	1.350
1	1.300	1.400
0	1.375	1.450

The assignment of any degree of fault is considered to be an at-fault accident and will affect the experience-rating component of the premium structure. Even if an insured is found to be only 25% at fault in an accident, the insurer records the claim as an at-fault accident, and the insured's driving record is impacted. Therefore, in practice, because of the recovery mechanism, fault is typically assigned as either 0% or 100%.

In Alberta fault determination rules are not legislated, and most insurers are signatories to the Insurance Bureau of Canada's ''Agreement Respecting Standardization of Claim Forms and Practices, and Guidelines for the Settlement of Claims'' (2002). This document, which is very similar to Ontario's fault determination rules, provides insurers with a mechanism to assign fault and more importantly, determine which insurer is responsible for paying claims. In practice, fault is typically assigned as 0%, 25%, 50%, 75%, or 100%.

Fault assignment is more crucial in Alberta because the assignment of fault in Alberta appreciably affects the compensation paid by each insurer. In multiple-vehicle accidents, fault assignment requires the agreement of at least two claims adjusters. As in Ontario, the assignment of any degree of fault affects the experience-rating component of the premium structure.

3. Impact of First-Party Recovery on Adjuster Incentives

One of the key arguments for first-party as opposed to third-party recovery for vehicular PD is

to eliminate the adversarial relationship that often results from two insurers having to negotiate the fair amount to be paid for a claim involving their own insureds. In addition, in tort jurisdictions, insureds are typically compensated for PD caused by an at-fault driver by their own insurer, who then subrogates against the at-fault driver's insurer. Because less subrogation occurs in first-party recovery schemes, the cost of settling claims will be significantly lower.

Mehr and Eldred (1974) addressed the settlement of PD claims and refuted this supposition. They concluded that a first-party recovery scheme for PD losses provided few benefits. Because of the speed at which collision claims are typically settled, they suggested that first-party recovery would not provide any significant decrease in the time to settlement of PD claims. In addition, Mehr and Eldred argued that there would be no reduction in the cost to settle PD claims because amounts for such claims typically were easily determined and very few claims required attorney involvement.

More recent work by Kelly, Kleffner, and Tomlinson (2010) showed that first-party recovery decreased the settlement time for PD claims, impacted the compensation received by claimants, and greatly reduced loss adjustment costs. They argued that in a first-party recovery scheme, because an adjuster does not have to reach agreement with the other party's insurer concerning both fault assignment and the amount of the claim, claims can be settled more quickly and efficiently.

Despite the potential benefit of first-party recovery, other costs arise as adjuster incentives are altered. If the insured carries collision coverage, then the insured would receive the same settlement for at-fault and not-at-fault claims, with the minor difference being the collision deductible. The incentive, from the adjuster's viewpoint, to correctly assign fault is therefore reduced: when settling a claim for the adjuster's own insured, it may be easier for the adjuster to assume the insured is not at fault.

There are many reasons why an adjuster might not assign fault correctly. Settling in favor of one's own insured may reduce settlement costs. Kelly, Kleffner, and Tomlinson (2010) collected data for one year's automobile PD claims for an insurer in Ontario (first-party recovery). The expenses attached to claims in which fault assignment was actively disputed by the insured were 1,500% higher than for claims in which fault was not disputed. Not assigning fault might also increase good will with one's insured. Discussions with claims managers corroborate the importance of the first-party relationship. Claims departments are likely to be more lenient with their own customer than with a third-party claimant.

Despite these reasons why adjusters may not assign fault correctly, it is also important to recognize that insurers benefit from premium increases that result from at-fault claims. This should provide incentives for correct assignment of fault. However, the silo nature of insurance companies allows the moral hazard to exist. Claims adjusters are concerned with settling claims, not the level of premiums that will be charged the insured when the insurance is renewed. This problem is largely addressed in a third-party payer system because agreement is needed between adjusters of both insurers; hence the assignment of fault is subject to more examination.

If adjusters are more inclined not to assign fault to their own insureds, then we would expect in first-party recovery jurisdictions a lower percentage of at-fault claims.

HYPOTHESIS 1

If fault is correctly assigned in a first-party recovery jurisdiction, then ceteris paribus, *there will be no difference in the percentage of at-fault claims recorded in first- and third-party recovery jurisdictions.*

Evidence against hypothesis 1 will provide support to the argument that fault is assigned incorrectly more often in a first-party than a third-party recovery scheme. To test this hypothesis, data were collected from three insurance companies operating in both Ontario and Alberta. For each company the underwriting guidelines and claims settlement procedures are similar in these two jurisdictions. Insurer A is the same insurer that provided rate differential information for Table 1. Insurers B and C are two other large Canadian property and casualty insurers. These three companies account for approximately 15% of direct written premiums for auto insurance in Canada in 2003, with auto insurance accounting for 55–80% of each company's book of business

(*Canadian Underwriter* 2004). The Canadian auto insurance market is much less concentrated than the auto insurance market in the United States: the largest private insurer held a 10% share of the Canadian auto insurance market in 2003, and the top five insurers controlled approximately 30% of the market.

All three companies write standard auto policies[1] and have achieved satisfaction ratings of 85% or better in past claimant satisfaction surveys undertaken by the Financial Services Commission of Ontario. Without providing sufficient evidence that the companies can be easily identified, two companies are stock companies and one is a mutual insurer; two companies distribute insurance via exclusive agents and one uses the brokerage network; one company has a U.S. parent and two companies operate only in Canada; two companies sell insurance in all 10 provinces and one sells insurance in 6 of the 10 provinces.

Insurer A provided us with a 10-year summary of the average percentage of at-fault to total PD claims for the years 1996–2006. The percentage of at-fault to total PD claims in Alberta is 62%, compared to 44% in Ontario. Insurers B and C provided annual data, as given in Table 2. For all three insurers the percentage of at-fault claims is significantly lower in Ontario than Alberta. This contradicts the hypothesis that fault assignment is the same in the two provinces, providing support to the argument that adjusters may have the incentive not to assign fault to their own insureds in a first-party recovery scheme. Alternatively, one could argue that perhaps the fault assignment is correct in Ontario and too high in Alberta. This seems unlikely because competitive forces cause insurers to have no incentive to declare their insureds at fault.

It is possible that this discrepancy can be ascribed to provincial differences. Therefore, as shown in Table 2, insurer C provided data for a third jurisdiction, Nova Scotia, which also operates under tort recovery. The proportions of at-fault claims for Nova Scotia were not statistically different from the proportions observed in Alberta.

Because of how individual firms manage their claims database, there is some difference in the statistics collected for the three insurers. For insurers A and B, the claims examined were PD claims only with no BI component. For insurer C, the claims recorded included accidents giving rise to both PD and BI claims. Because of the possibility of tort action, many BI claims require that adjusters from both companies agree on fault assignment. This is a possible explanation as to why insurer C has a larger percentage of at-fault claims in Ontario than do insurers A and B.

The data in Table 2 also raise an interesting question. How can the frequency of at-fault claims be less than 50%? Legally, fault should be assigned in every auto accident, and drivers in a single-vehicle accident are always deemed to be at fault; therefore the frequency should be greater than 50%. In accidents involving two vehicles, one or both drivers should be deemed at fault because, as noted, any level of fault assignment is viewed as an at-fault accident. In accidents involving multiple vehicles the fault assignment rules allow for at least one and up to all drivers to be assigned some degree of fault. Thus, in multiple-vehicle accidents it is possible to have multiple drivers filing at-fault claims. This implies that the ratio of at-fault to all claims should be greater than 50%.

[1] The standard auto policy is a statutory document in both provinces.

Table 2

Moral Hazard and Fault Assignment: Percentage of At-Fault PD Claims in First-Party and Third-Party Recovery Schemes for Insurers B and C

	Insurer B			Insurer C		
Year	Ontario	Alberta	Year	Ontario	Alberta	Nova Scotia
1998	36.5%	56.5%	2002	42.0%	54.6%	56.3%
1999	36.1	56.6	2003	42.3	52.5	56.0
2000	38.3	58.9	2004	42.4	53.4	52.5
2001	37.5	54.5	2005	42.4	54.8	50.6
2002	37.9	52.6	2006	41.8	52.3	52.8

Furthermore, because each insurer underwrites similar risks in both jurisdictions, the empirical evidence suggests that adjusters for insurer A misclassify at-fault claims 29% of the time, adjusters for insurer B misclassify at-fault claims 33% of the time, and adjusters for insurer C misclassify at-fault claims 22% of the time.

If one assumes that all single-vehicle accidents have correct fault assignment (all single-vehicle accidents are classified as at-fault accidents), then the level of incorrect assignment in multiple-vehicle accidents is startlingly high. In 2001, 24% of reportable collisions in Ontario were single-vehicle accidents (Road Safety Program Office 2003). If 24% of all PD claims for insurer B are single-vehicle accidents, then 40% of drivers in multiple-vehicle accidents are classified as at-fault drivers in Alberta, and 18% of drivers in multiple-vehicle accidents are classified as at-fault drivers in Ontario.[2]

When fault is not correctly assigned, the driving record class does not represent the true risk of some drivers. When a driver has an at-fault accident that the adjuster codes as not at fault, the driver is not moved to driving record class 0 or 5* in the next period, but instead moves to a higher driving record class (or stays in class 5* or 6, depending on the current driving record class). Therefore the overall impact of misclassification should be that there are more low-risk drivers in the first-party recovery scheme.

HYPOTHESIS 2

If fault is correctly assigned in a first-party recovery jurisdiction, then ceteris paribus, *there will be no difference in the distribution of drivers across driving record classes in the first- and third-party recovery jurisdictions.*

The distribution of drivers across driving record classes in Ontario and Alberta for insurer B and for all insurers is given in Table 3. Using a z-test of difference in two proportions, there is no evidence to support hypothesis 2. In Ontario more drivers are proportionally in lower risk classes than in Alberta. This is consistent with the argument that adjusters have the incentive not to assign fault to their own insureds in a first-party recovery scheme.

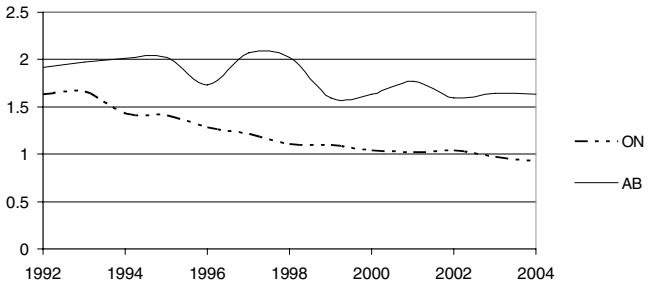
Table 3
Moral Hazard and Fault Assignment: Impact on Driving Record

	Distribution of DR for Insurer B		Distribution of DR for Industry	
Driving Record	Ontario	Alberta	Ontario	Alberta
6	76.9%	71.7%	79.7%	77.3%
5 and 5*	5.6	10.3	7.1	8.1
4	2.1	2.7	2.6	4.0
3[a]	9.9	11.7	5.2	5.8
2	2.4	1.5	1.8	1.6
1	2.0	1.4	2.0	2.0
0	1.2	0.8	1.6	1.2

[a] The bulge for driving record class 3 arises because of underwriting rules in place which state that new drivers who have taken a certified driver training course must be placed in driving record class 3, and not driving record class 0.

The driving record distribution could arise because drivers in Ontario have fewer accidents than drivers in Alberta. As shown in Figure 1, Alberta has a higher automobile fatality rate per licensed driver than Ontario.[3] In addition, Alberta also has more reported collisions per registered

Figure 1
Fatality Rates per 100,000 Licensed Drivers 1992–2004



Source: Annual number of road fatalities provided by Transport Canada. Licensed driver information was collected from CANSIM database.

[2] For insurer B in 2001, 37.5% of all Ontario accidents are coded at fault. Let x be the percentage of multiple-vehicle accidents coded at fault, then $0.24 + (1 - 0.24)x = 0.375 \rightarrow x = 17.8\%$. A similar calculation for Alberta percentages yields 40% for the fault assignment in multiple-vehicle accidents.

[3] An analysis of factors contributing to this difference is beyond the scope of this work. Factors that have been found to have explanatory power in fatality rates include demographic factors such as provincial wealth levels, education levels, percentage of young drivers, alcohol consumption rates, number of medical facilities, and police enforcement and geographic factors such as precipitation levels, urban concentration, and percentage of highways versus slower roadways.

vehicle than Ontario. Although this could help to explain the reason why more drivers are classified as low risk in Ontario, the data from Table 2 and Table 3 are also consistent with the existence of adjuster moral hazard resulting in incorrect fault assignment.

This incorrect assignment of fault has a long-term impact on the insurer's rate-making process: if fault is not assigned correctly, then the experience-rating component of automobile insurance becomes less accurate, and premiums charged to insureds will not reflect their individual risk. This has two important implications. First, when higher-risk drivers are rated as relatively low-risk drivers, their insurance premiums do not reflect their risk. Thus their moral hazard increases because they do not pay the expected cost of their driving. Second, insurance premiums for the entire portfolio of drivers must increase to cover the pooling effect caused by the misclassification.

Because the empirical data cannot be used to measure the impact of incorrect fault assignment on premium structures, we develop a theoretical model to assess these effects.

4. THEORETICAL MODEL

The previous section explains why company adjusters in a first-party recovery jurisdiction may have less incentive to find their own insured at fault, and it provides support for this argument. If fault is not assigned correctly, a distortion is created in the experience-rated component of the automobile insurance premium. This section presents a stochastic model of movement through driving record classes to assess the impact of this distortion. Because differences are found between the two provinces in both the statutory insurance product and road safety (as seen in Fig. 1) we cannot use industry data to examine the cost of misclassification.

The model has eight states, representing zero, one, two, up to six (and greater) years of at-fault-claims-free driving and state 5*. Drivers in the system are assigned a constant annual at-fault accident rate intensity and move between the states of the model according to their claims history. Transition probabilities between the states arise from the movement of drivers according to their at-fault claims histories and insurers' underwriting policies. The first model constructed analyzes the probability that a single driver is in a specific driving record class at any point in time assuming both correct and incorrect assignment of fault. The model is then expanded to allow for a portfolio of independent drivers. In the portfolio model, expected losses for the entire portfolio of drivers and for each cohort of drivers in each of the different driving record classes are calculated assuming both correct and incorrect assignment of fault.

4.1 Single-Driver Model

The focus of the single-driver model is the movement between the driving record classes and the impact of incorrect fault assignment on the probability that a driver is in any driving record class. Assuming that the at-fault accident rate is independent of adjuster incentives, moral hazard is introduced in the following manner. There exists a nonzero probability, μ, that once an at-fault accident is reported, the claims adjuster records the accident as not at-fault. In this case the insurer would still pay the claim if the accident was classified as not at-fault (via first-party recovery coverage), but the movement of the insured between states is different than if the claim is classified as at-fault. The probability that the insured is in a given driving record class for both the base model and the model with moral hazard can be calculated in equilibrium.

The following assumptions arise from the experience-rating mechanism previously presented:

- Insured classes: 0, 1, 2, 3, 4, 5, 5*, and 6
- If insured has j(j = 0, 1, 2, 3, 4, 5) years free of at-fault accidents, the insured is classified as being in state j
- If insured in class j(j = 0, 1, 2, 3, 4, 5) has an at-fault accident, the insured goes to class 0 in the next period
- If insured has 6 or more years of no at-fault accidents, the insured is classified as being in class 6
- When an insured in class 6 has an at-fault accident, the insured goes to class 5* in the next period and remains there for five years if they have no subsequent at-fault accidents in that period. At the end of this period the insured goes back to class 6.

- When an insured in class 5* has an at-fault accident, the insured goes to class 0
- The probability of an at-fault accident, λ, is constant over time
- The probability that an at-fault accident is classified as not at-fault by the insurance company, μ, is constant over time and independent of λ
- Let p be the probability that an insured moves to state 0 (from states 0, 1, 2, 3, 4, 5, and 5*) or from state 6 to state 5*. This will occur if the insured has an at-fault claim that is classified as at-fault. Therefore $p = \lambda(1 - \mu)$.
- $1 - p$ is the probability that no at-fault accident is recorded. In this case:
  - Insureds in state j move to state $j + 1$ (for $j = 0, 1, 2, 3, 4, 5$)
  - Insureds in state 6 stay in state 6
  - Insureds in state 5* either stay in 5* or move to state 6.

Let $X = \{X(n) : n = 0, 1, 2, \ldots\}$ denote the class of the insured in year n. Then the state space of X, E, is given by $E = \{0, 1, 2, 3, 4, 5, 6, 5^*0, 5^*1, 5^*2, 5^*3, 5^*4\}$. The original model is not a Markov chain because of the memory associated with class 5*; the probability that an insured is in class 5* in the following period depends partially on the years that a driver has been in that class. Therefore class 5* is judiciously separated into five distinct states to preserve the memory-less property. Class 5 * j denotes the fact that the person has already spent j years in class 5*. In this completely Markovian model, each time period is one year, and the states of the system are 0, 1, 2, 3, 4, 5, 6, 5*0, 5*1, 5*2, 5*3, 5*4. This is a discrete-time Markov chain describing the transitions of an insured between all possible classes.

The one-step transition probability matrix, P, of the discrete-time Markov chain is aperiodic and positive recurrent and has a finite number of states. As such a unique stationary distribution, $\{\pi(j), j \in E\}$, exists for $X = \{X(n) : n = 0, 1, 2, \ldots\}$. It is obtained by solving the system of equations $\pi(j) = \Sigma_E \pi(i)P(i, j)$ and $\Sigma_E \pi(j) = 1$, where $\pi(j)$ denotes the steady-state probability that an insured is in state j : $[j = 0, 1, 2, 3, 4, 5, 5^*, 6]$. Solving the above system of equations gives

$$\begin{aligned}
\pi(0) &= \frac{p[1 - (1 - p)^5]}{1 - p(1 - p)^5}, \\
\pi(j) &= (1 - p)^j \pi(0), j = 1, 2, 3, 4, 5, \\
\pi(5^*) &= [1 + (1 - p) + (1 - p)^2 \\
&\quad + (1 - p)^3 + (1 - p)^4]p\pi(6) \\
&= [1 - (1 - p)^5]\pi(6), \\
\pi(6) &= \frac{(1 - p)^6}{1 - p(1 - p)^5}.
\end{aligned}$$

4.2 Portfolio of Drivers Model

The single-driver model is expanded to consider a portfolio of independent drivers. Entry and exit of drivers is not allowed from the portfolio, allowing for a derivation of the steady-state equilibrium for a constant cohort of drivers. Because of the independence of drivers, the transition matrix and accident probabilities derived in the single-driver model hold for each individual driver in the portfolio.

The assumptions required to extend the single-driver model are the following:

- Each driver has a probability of an at-fault accident, $\lambda \sim Gamma(\alpha, \beta)$, that is constant over time and independent of other drivers.
- The probability that an at-fault accident is classified as not at-fault by the insurance company, μ, is constant over time and independent of each driver's accident probability. We acknowledge that in practice it could be the case that μ is affected by the personal characteristics of the claimant. Doerpinghaus, Schmit, and Yeh (2003) find that fault assignment is influenced by the age and gender of the claimant, with the young, elderly, and female drivers more likely to be assessed fault.

For each of the 10,000 drivers in the portfolio, an accident probability λ_k is chosen at random from the underlying risk distribution. The steady-state probability for each driver is derived, and by summing across all outcomes we are able to generate the insurer's portfolio of 10,000 drivers. In particular, the insurance company observes an at-fault accident rate for drivers in driving record class j, $\bar{p}_j$, which is given by

$$\bar{p}_j = \frac{\sum_{k=1}^{10,000} (1 - \mu)\lambda_{jk}\pi_{jk}}{\sum_{k=1}^{10,000} \pi_{jk}}.$$

The impact of adjuster misclassification on the premiums charged by insurers is constructed in the following manner. After assigning a constant severity per claim, expected losses for the entire portfolio of drivers and for drivers in each of the driving record classes are simulated. In this model it is assumed that all drivers carry collision coverage, and therefore the insurer pays the resulting claims. To simplify our discussion, we assume that the deductible on collision coverage is zero, and so the same amount is paid under first-party recovery whether or not the insured is at fault. This gives rise to the actuarially fair base premium that must be charged and the correct rate differentials for the driver rate class variable. This base model, absent moral hazard, provides the first-best outcome given the design of the driver rating classes. The observed at-fault accident frequency, the actuarially fair base premium, and the changes in rate differentials are then recalculated allowing for the incorrect assignment caused by moral hazard.

The assumption of constant claims severity is invalid if an adjuster, in practice, is more likely to investigate and assign fault for larger PD claims. To examine the validity of this assumption, we analyzed insurer B's at-fault and not-at-fault PD claims for Ontario for 2002 and found no statistically significant relationship between the size of loss and fault assignment. Insurer B has 11 classifications to describe claim type. No statistical difference is found between claim sizes for at-fault and not-at-fault losses for nine of the 11 claim types, and no statistical difference between average claim size of at-fault and not-at-fault claims for the entire sample of claims. For two claim types, not-at-fault claims paid were statistically higher than at-fault claims paid.

5. MODEL RESULTS

The average claims rate for third-party liability claims in urban Alberta for 2000–2003 is 3.5% as reported by the Insurance Bureau of Canada (2004). This is used to calibrate the single-driver model: λ is set to 0.035. Using data from Table 2, misclassification rates are calculated as $\mu = 0.33$ for insurer B and $\mu = 0.22$ for insurer C. The observed probability of an at-fault accident in the first-party recovery system is $p = \lambda(1 - \mu) = 2.35$ and 2.73 for insurers B and C, respectively. In the third-party recovery scheme, the insurer ''sees'' the true accident probability of 3.5%. Table 4 shows the probability that a single driver will be in a given driving record class without ($\mu = 0$) and with ($\mu = 0.30$) adjuster misclassification.

As expected, with adjuster misclassification, drivers look better to the insurance company than they really are. The probability of an individual belonging in class 6 goes up by approximately 5%. Correspondingly, for each of the lower driving classes, the probability has fallen by anywhere from 25% to 50%.

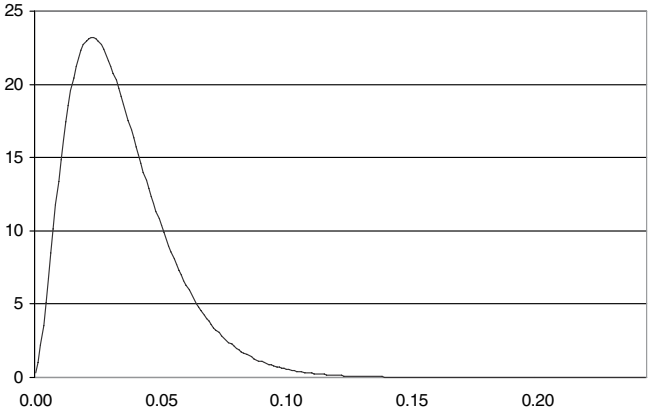
The gamma distribution used to simulate the at-fault accident probabilities for the portfolio of drivers is given in Figure 2, with parameters $\alpha = 0.035/3$ and $\beta = 3$. The model is calibrated to produce a mean accident rate of 3.5%, and so that the accident frequencies simulated for Alberta in Table 6 match the distribution of accident frequencies by driving record class for urban Alberta (Insurance Bureau of Canada 2004). Sensitivity analysis confirms that our results are robust to different parameter choices of α and β, which yield the average claim frequency of 3.5%. As noted earlier, μ is constant across all drivers and independent of λ_k, the risk level of each insured.

Table 5 presents the results for the portfolio of drivers model with adjuster misclassification equal to $\mu = 0.30$ and where there is no misclassification ($\mu = 0$). As in the single-driver model, drivers are more likely to be classified as low risk (driving record 6) in the presence of adjuster mis-

Table 4
Impact of Moral Hazard in the Single-Driver Model

Driving Record	$\mu = 0.30$	$\mu = 0$
6	88.08%	83.19%
5 and 5*	10.27	14.06
4	0.26	0.51
3	0.27	0.53
2	0.28	0.55
1	0.28	0.57
0	0.29	0.59

Figure 2
Gamma Distribution of Accident Frequencies for Portfolio of Drivers Model (α = 0.0167 and β = 3)



classification: 88.3% of drivers as compared to 83.6% of drivers. There is a smaller proportion of drivers in classes 0 to 5 and 5* under the assumption of adjuster misclassification. Similar to Table 4, the probability that the insured is in a lower driving class has fallen by 25–50% in the presence of incorrect assignment of fault.

We test the sensitivity of results to different misclassification rates and find some, but not large, economic sensitivity to changes in μ. For adjuster misclassification rates of μ = 0.1 and 0.5, the percentage of drivers in class 6 are 85.1% and 91.5%, respectively.

Our results have some significant implications that are explored further below. If fault is not assigned correctly then less heterogeneity exists between each driving record class and more heterogeneity exists within each driving record class. Also, driving record loses some of its predictive power in forecasting accident frequencies. This can be seen in Table 6, which gives the at-fault accident frequencies that will be observed by the insurer under the assumption of incorrect and correct assignment of fault.

The column with μ = 0 indicates the actual at-fault accident frequency for each class of driver. As anticipated, the low-risk drivers, those in driving record class 6, have an observed accident frequency less than the average accident frequency of 3.5%, and all other driving record classes have higher accident frequencies. Also, as anticipated, the accident frequencies increase for the higher-risk driving record classes.

The accident frequencies for the insurer with adjuster misclassification are lower for all driving records because 30% of the time (μ = 0.30) an at-fault accident is settled as a not-at-fault accident and therefore does not affect driving record. For driving record 6, the observed accident frequency with misclassification is 71.5% of the observed accident frequency without misclassification. For driving record 0, the observed frequency with misclassification is 70.4% of the observed accident frequency without misclassification.

We then examine the sensitivity of the observed accident frequency to changes in the misclassification rate. In the case when μ = 0.1, the observed accident frequency for classes 6 and 0 with misclassification are 87.8% and 88.1%, respectively, of the observed accident frequency without misclassification. In the case when μ = 0.5, the observed accident frequency for classes 6 and 0 with misclassification are 51.6% and 50.8%, respectively, of the observed accident frequency without misclassification.

To examine heterogeneity within each driving record class, we calculated the variance of driver

Table 5
Impact of Moral Hazard in the Portfolio of Drivers Model

Driving Record	μ = 0.30	μ = 0
6	88.3%	83.6%
5 and 5*	9.96	13.05
4	0.32	0.6
3	0.33	0.63
2	0.35	0.67
1	0.36	0.71
0	0.38	0.75

Table 6
Average Observed Accident Frequency in Portfolio of Drivers Model

Driving Record	μ = 0.30	μ = 0
6	2.33%	3.26%
5 and 5*	3.09	4.31
4	3.91	5.47
3	3.95	5.54
2	3.96	5.61
1	4.02	5.68
0	4.05	5.75

accident probabilities observed in each class. These results are tabulated in Table 7. As expected, the standard deviation of accident rates within each driving record class is lower when the fault is correctly assigned ($\mu = 0$), a result that holds for all driving record classes. Lower within-class standard deviations imply that the experience-rating model is more effective when fault is correctly assigned.

Insurance companies use differences in observed accident frequencies to develop rate class differentials. Following this practice, driving record class 6 is used as the base class to develop differentials (as this has the greatest proportion of drivers). Using the frequencies in Table 6, the rate differentials for the classes are obtained by dividing the accident frequency of each class by the accident frequency of class 6. Table 8 gives the rate class differentials for the models with and without misclassification.

For both schemes driving record 6 has a differential of 1.000 by design. What is of interest is the difference between driving record 6 and the other driving records under misclassification as opposed to correct assignment of fault. As predicted, in the presence of adjuster misclassification, there is less heterogeneity between driving records 6 and 0. The implied differential for driving record 0 with adjuster misclassification is 1.7419 compared to 1.7658 in the model without adjuster misclassification. There is less similarity between driving record classes 5 and 5* and class 6 with adjuster misclassification than if fault were correctly assigned.

We then alter the misclassification rate. When the adjuster misclassification is $\mu = 0.1$, the implied differential for driving record 0 with adjuster misclassification is 1.7564. When the adjuster misclassification is $\mu = 0.5$, the implied differential for driving record 0 with adjuster misclassification is 1.7247.

However, insureds are less interested in rate class differentials and more concerned about the absolute premiums they pay. In a first-party recovery scheme, fault assignment will not impact total claims paid; PD claims incorrectly coded as not-at-fault will be paid from first-party PD coverage and at-fault claims will be paid from collision coverage. In the third-party recovery scheme, all of the recorded accidents are properly coded as at-fault and will be paid by the insurer from collision coverage. Thus the total dollars paid by insurers in each model—with and without adjuster misclassification—are the same.

Given an average accident frequency of $\lambda = 3.5\%$, an assumed severity of \$3,500 per accident[4] and a portfolio of 10,000 insureds, the insurance company needs to collect \$1,225,000 in actuarially fair premiums to pay claims. Let r_0 be the premium or rate that must be charged to a driving record 6 driver. Therefore r_0 solves the following equation, $10{,}000 \times r_0 \times \Sigma_j (diff_j \times prop_j) = \$3{,}500{,}000$, where $diff_j$ is the differential for driving record class j as given in Table 8, and $prop_j$ is the proportion of drivers in driving record class j as given in Table 5. The premium then for an individual in driving record j is $R_j = r_0 \times diff_j$. Solving for premiums under both adjuster behaviors gives rise to the actuarially fair premiums in Table 9.

Under misclassification of fault, drivers pay more for insurance in most driving record classes.

Table 7
Standard Deviation of Accident Probabilities within Each Class

Driving Record	$\mu = 0.30$	$\mu = 0$
6	3.06%	1.89%
5 and 5*	3.86	2.17
4	4.73	2.48
3	4.77	2.52
2	4.82	2.55
1	4.86	2.58
0	4.91	2.63

Table 8
Implied Rate Differentials for Portfolio of Drivers Model

Driving Record	$\mu = 0.30$	$\mu = 0$
6	1.0000	1.0000
5 and 5*	1.3291	1.3242
4	1.6821	1.6797
3	1.6966	1.7003
2	1.7114	1.7215
1	1.7265	1.7433
0	1.7419	1.7658

[4] Kelly, Kleffner, and Tomlinson (2010) report that the average property damage claim that does not involve bodily injury is roughly \$3,500.

Table 9
Implied Rating Structure for Portfolio of Drivers Model for PD Claims

Driving Record	$\mu = 0.30$	$\mu = 0$
6	$117	$115
5 and 5*	156	152
4	197	193
3	199	195
2	201	198
1	202	200
0	204	203

The reason for this is twofold. First, there are substantially fewer drivers in the high risk classes in the presence of adjuster moral hazard. Second, the difference in differentials between the driving record class 0 and other drivers under misclassification of fault is smaller than if fault were assigned correctly. Thus the contribution of premium dollars from the higher risk classes is less than if adjusters correctly assigned risk.

If fault were assigned correctly, only 83.6% of drivers, not 88.3%, would be in class 6. Hence 5.3% of the drivers are wrongly assigned as being in class 6 under driver misclassification. The 5.3% are paying a premium well below what they should be paying. However, because we are analyzing the system in the steady state, we cannot say in which exact class these 5.3% of drivers should belong. For example, if one of these drivers who is wrongly classified into class 6 should really have been in class 4, the driver should pay $193 for insurance instead of the $117 that the driver is paying under the driver misclassification model. The misclassification for this driver results in a premium that is 39.2% lower than it should be.

Because the price of insurance is higher in most classes than it should otherwise be, all the drivers who have not been misclassified are the ones that ''lose'': they subsidize those wrongly classified. The difference in price of insurance for insureds in class 6 when fault is assigned correctly versus incorrectly is 2.13%: they are paying 2.13% more than they should be paying.

Thus, based on our numerical results, the people who are misclassified are paying a price far below what they should be paying, while the people who are assigned to classes correctly are paying a small percentage more than what they should be paying.

6. Discussion and Conclusion

This paper begins with the examination of the impact of first-party recovery schemes on adjusters' incentives in assigning fault. Using data from both an individual insurer and the automobile insurance market as a whole, it is shown that the distribution of driving records for insureds differs across two provinces: there is a greater proportion of low-risk drivers, as measured by past driving record, in Ontario (a first-party recovery scheme) than in Alberta (a third-party recovery scheme). Furthermore, for three insurers examined, fewer drivers in the first-party recovery jurisdiction are found to be at fault than in a traditional tort jurisdiction. This evidence is consistent with the notion of adjuster moral hazard and a tendency to underassign fault in a first-party recovery system.

A more exact test of adjuster moral hazard would be to examine whether the total assignment of fault is less than 100% on individual claims in the first-party recovery scheme. Although these data are not readily available, future work should attempt to use such data to conduct a stronger test of adjuster moral hazard.

Because differences in both road safety and the insurance product between the two provinces preclude an examination of the cost of this incorrect fault assignment, we develop a theoretical model of experience rating to examine the impact of incorrect fault assignment on driving record class. The results of the theoretical model show that if fault is not assigned correctly, then there will be less heterogeneity between each driving record class and more drivers rated as low risk (in higher driving record classes) than there should be. There is also more heterogeneity within each driving record class, suggesting that experience rating is less efficient when fault is not correctly assigned.

Because fault assignment will not impact total claims paid in a first-party recovery jurisdiction, the same amount of premium dollars must be collected regardless of fault assignment. We conjectured that in the first-party recovery scheme, low-risk drivers would pay higher premiums than they would in the absence of misclassification and high-risk drivers would pay lower premiums. However, this simulation suggests that drivers in almost all risk classes pay a higher premium be-

cause there are fewer drivers in the high-risk driving record classes and smaller rate differentials between classes.

This result has interesting implications for insurers from a competitive standpoint. If, in practice, an insurer could observe the moral hazard present in adjuster behavior, then it could gain a competitive advantage by designing adjuster contracts so that the misclassification did not happen. Although settlement costs would likely increase, the experience-rating component would once again classify insureds correctly. The result would be a reduction in premiums charged to low-risk drivers, and perhaps to drivers in all classes. Currently insurers' tendency to isolate claim settlement practices from pricing makes it less likely that they will identify this cost. Standard economic theory would also suggest that correctly classifying insureds would reduce moral hazard because the cost of insurance would be aligned with the risk of each insured. On the other hand, it could be argued that the misclassification is a relatively inexpensive way to ''grease the squeaky wheel,'' if indeed those insureds that are misclassified would otherwise give rise to the largest settlement costs. Our numerical results suggest that the insureds that are misclassified benefit greatly, whereas the cost to those classified correctly is quite small.

First-party recovery schemes for PD have been shown to provide benefits to insurers and insureds through lower expenses and shorter time to settlement. However, as this research illustrates, there are also costs related to adjuster moral hazard arising from a first-party recovery scheme. If insurers take a silo approach to claim settlement and pricing, then they will incur the costs of driver misclassification, which are shown to be significant.

7. Acknowledgments

The authors would like to thank Maureen Tomlinson for her research support. We also thank the Insurance Bureau of Canada and the insurance company executives for their data and valuable input. We also acknowledge the valuable comments of the associate editor and referees as well as seminar participants at the University of Western Ontario, the American Risk and Insurance Association annual meeting, and the University of Waterloo's Risk Management and Insurance Conference.

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