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Merging Automobile Insurance Regulatory Bodies: The Case of Atlantic Canada

Martin Boyer[*], *Jörg Schiller*[†]

Résumé / *Abstract*

La récente crise dans le Canada Atlantique au sujet de l'assurance de la responsabilité civile des automobilistes a contraint les gouvernements des quatre provinces (Terre-Neuve et Labrador, Nouveau-Brunswick, Nouvelle-Écosse et l'Île-du-Prince-Édouard) à mettre en place une commission pour étudier la possibilité de réorganiser, si nécessaire, leur système d'assurance automobile. Après avoir analysé les plus intéressantes modifications à la réglementation mises en place dans ces provinces, notre étude offre un nouveau terrain de discussion, soit la fusion des quatre réglementations provinciales afin de combattre la fraude à l'assurance. Notre étude se base sur le principe que les récentes augmentations dans les primes sont attribuables à une augmentation de la fraude à l'assurance dans ces provinces. En fusionnant les réglementations des quatre provinces, nous montrons que la fraude à l'assurance peut diminuer si la fusion permet d'épargner une partie du coût de vérification encouru par les assureurs lors de réclamations douteuses. Également, nous montrons qu'une telle fusion peut permettre de développer une meilleure technologie de vérification des réclamations. Nous terminons le papier en suggérant un système de taxation particulier qui non seulement peut financer les investissements nécessaires pour combattre la fraude, mais peut également réduire la fraude directement.

Mots clés : fraude à l'assurance, information asymétrique, taxation à l'assurance, politique publique

The recent automobile liability insurance crisis in Atlantic Canada has prompted the four provincial legislations (Newfoundland and Labrador, New Brunswick, Nova Scotia and Prince Edward Island) to setup a task force to redesign, if necessary, the personal automobile insurance system. After reviewing some of the most interesting new regulatory changes, our paper proposes a new area of discussion: The merger of the four provincial insurance regulatory bodies to combat insurance fraud. We base our paper on the principle that recent premium increases are mainly due to an increase in insurance fraud. We show that merging the regulatory bodies may reduce insurance fraud if the merger allows savings on the average audit cost and on the development of better fraud detection technology. Finally, we suggest a fraud reducing insurance taxation scheme to finance insurance fraud investigations.

Keywords: insurance fraud, asymmetric information, insurance taxation, public policy

Codes JEL : G22, D82, H21, C72

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1 Introduction

1.1 Motivation

In the past two or three years, major increases in insurance premiums in Canada's four Atlantic provinces, Newfoundland and Labrador, New Brunswick, Nova Scotia and Prince Edward Island, has prompted the four provincial legislations to set up a joint insurance task force to look at Atlantic Canada's latest automobile liability insurance crisis. The Atlantic Provinces are somewhat particular when it comes to automobile insurance in that they are the only ones, with Alberta, to have a pure tort system run by the private sector. In British Columbia, the government runs the tort system. Pure no-fault systems are in place in Québec and Manitoba. In Ontario claimants are allowed to sue if their injury is above a threshold. Saskatchewan operates a hybrid system with the government operation both the tort and the no-fault systems.

Although the insurance task force has recently (see The Globe and Mail, 3 October, 2003) rejected the idea of setting up a public automobile insurance system like the one in British Columbia, many other reforms are still being considered or have already been enacted, such as the $2,500 cap for pain and suffering as a result of minor injuries. Another important change to insurers doing business in Atlantic Canada is that insurers are no longer allowed to devise risk categories based on traditional and well known actuarial measures such as sex, age and marital status.

These changes came after large automobile premium increases in all four provinces. Statistics Canada reports average annual increases of 25% in Prince Edward Island and 40% in New Brunswick, Nova Scotia and Newfoundland and Labrador between April 2002 and April 2003. This compares to 30% in Québec and Ontario, and 50% in Alberta.[1]

One of the possible reasons why insurance premiums have gone up so much in the past few years is that automobile accidents have become more severe so that larger losses need to be paid, which means that premiums must increase. A second possibility is that the automobile insurance policies are covering more losses than before. A third possibility is that the number of bad drivers on the road is too high as a result of facility associations that are subsidizing bad drivers though implicit taxes on good drivers and the general population. A fourth possibility is that there are so many uninsured motorists on the road that policyholders who want to be fully covered need to pay for accidents with these drivers. A fifth possibility, and the one we shall address in this paper, is that policyholders have become more adept at insurance fraud so that indemnities are being paid

[1] The Insurance Bureau of Canada that collects and analyzes automobile insurance information in Alberta, Ontario, Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland and Labrador, contests these numbers. They find that the annual automobile insurance premium increases between March 2002 and March 2003 are more in the order of 15% for Alberta, 20% for Ontario, 23% for Nova Scotia, 27% for New Brunswick, 14% for Prince Edward Island and 25% for Newfoundland and Labrador.

to policyholders even though they are not entitled to them.

In the United States, automobile insurance fraud is a multi billion dollars industry. Brockett et al. (1998) report that insurance fraud in the United States represents about 20 billion dollars annually, of which 6 billion dollars may be attributed the excess injury payments (see IRC, 1996). In the state of Massachusetts in particular, Derrig et al. (1994) report that close to 50% of bodily injury claims contain some suspicion of fraud. This has prompted the state to set up an Automobile Insurance Fraud Bureau to investigate suspicious claims. By merging all insurer databases, Weisberg and Derrig (1991) were able to show that although only 10% of all claims were outright fraudulent (see Derrig et al., 1994), between 35% and 48% had some build-up aspect.

In Europe the Comité européen des assurances considers that insurance fraud represents between 5 and 10% of the total amount of indemnities paid by insurers.[2] The estimated extent of fraud in the Spanish automobile insurance market, as reported by Artis et al. (1999), ranges from 15 to 60%, depending on the estimating insurer. The estimated annual economic loss due to insurance fraud in the German auto insurance market is about 2 billion euros, which represents about 11% of all paid indemnities. In Canada, Medza (1998) estimates that insurance fraud adds close to 2 billion dollars to automobile insurance premiums in the country. For the province of Québec, Caron and Dionne (1997) evaluate that 10% of all claims have some fraud component.

The insurance bureau of Canada recognizes the importance of insurance fraud in the country. In 2000, the Canadian Coalition Against Insurance Fraud found that 25% of all personal injury claims contain elements of fraud - costing the industry 500 million dollars per year. For Atlantic Canada, specifically, the same report states that 28% of personal injury claims contained elements of fraud; this is the equivalent of between 40 million and 60 million dollars annually for the Atlantic Provinces alone.

Combating insurance fraud may take many forms. First, insurers can invest in personnel training so that claims adjusters are better able to identify fraudulent insurance claims. For example, a claim where there are no witnesses (an accident on a deserted country road) often raises doubts as to the validity of the claim (see Dionne and Gagné, 2001). A second possibility is for the insurers to invest in auditing claims more thoroughly. More thorough auditing is costlier; for example the insurer may send private investigators to verify that the claimant has indeed suffered the injuries he claims. Resorting to private investigations is also perceived in some circles to be an invasion of the claimant's privacy, which raises the possibility that the insurer will be sued for bad faith. A third possibility is to delegate fraud investigations to a body independent of the automobile insurance industry.

[2] See Alary and Besfamille (2000).

Setting up an investigating body, to which all suspicious automobile insurance claims are relegated for further inquiries, is no small feat. The publicly run investigating body must be such that the general population is better off than letting each insurance company conduct its own investigation. It also must be financed through some tax scheme, either on the insurance industry participants or on the general population. Moreover, such a body must not be a substitute to normal and efficient claims adjusting practices found in the industry. A suspicious insurance claims investigating body must complement other claims adjusting processes to increase the welfare of the population in general, not just the welfare of the insurance companies.

Merging investigating bodies from different regions or provinces may even be harder. However, there are increasing returns to scale in establishing a coordinated suspicious insurance claims (hereafter CSIC) investigating organization, especially for the four relatively small provinces in Atlantic Canada. We shall show in this paper that merging provincial insurance regulatory bodies and establishing a CSIC bureau will allow savings and reductions in the cost of insurance so that policyholder welfare may be increased. Moreover, we are able to suggest an efficient form of insurance taxation to finance the CSIC bureau.

1.2 Why Insurance Fraud?

A major question that was not addressed much in the different discussion papers distributed by the provincial legislations is the problem of automobile insurance fraud, in particular insurance claim build-up. In the Nova Scotia consultation paper, it is said that "insurance companies themselves are best able to assess the impact, if any, on premium increases[3]" of insurance fraud problems. We do not believe this to be the case. Research has shown (see Boyer, 2000) that the centralization of insurance fraud investigations increases the welfare of all. Moreover, having a centralized body may improve the commitment to verify suspicious claims as shown in Picard (1996).

Previous studies on insurance fraud, such as Weisberg and Derrig (1991) and Cummins and Tennyson (1992), argue that a good measure of the prevalence of insurance fraud is the ratio of bodily injury claims to other types of automobile insurance claims that are less subject to fraud, such as property, comprehensive or collision insurance.[4] The Canadian Coalition Against Insurance Fraud reports that the number of bodily injury claims has gone up from 75 claims per thousand collisions in 1991 to 163 per thousand in 1998. In Alberta, Nielson and Kleffner (2003) report that the frequency of bodily injury claims per insured vehicle has doubled between 1986 and 1999 when, at the same time, the frequency of property damage claims per insured vehicle has shrunk

[3] Nova Scotia Ministry of Environment and Labor (Financial Institutions Division), *The Road Ahead: A Planned Approach to Auto Insurance Solutions*, March 2003, page 5.

[4] See also Dionne and St-Michel (1991), Crocker and Tennyson (2002) and Tennyson and Salsas-Forn (2002).

by close to 40%. As a result, the bodily injury claims to property damage claims ratio has more than tripled in a decade. In Nova Scotia[5] the ratio of bodily injury insurance claims to collision and comprehensive insurance claims has more than doubled in the past ten years, even thought the number of accidents has dropped. Unless the number of persons per car has doubled, it is hard to imagine that these increases in bodily injury claims ratios does not contain an important part of false or exaggerated claims.

Will better insurance fraud investigation technology help reduce premium increases? It all depends what part of the automobile insurance contract is plagued with fraud. If fraud occurs in a very small proportion of the total premium, better technology will not do much good. On the other hand, if insurance fraud occurs on the part of the coverage that contributes most to the total insurance premium, then there is no doubt that better technology to investigate insurance fraud will reduce the overall automobile insurance premium and increase policyholders' well-being. As shown by Weisberg and Derrig (1991), Cummins and Tennyson (1992) and Nielson and Kleffner (2003), insurance fraud is most likely to happen, and most costly, on the third party liability portion of the coverage.

Automobile insurance in the Atlantic Provinces is divided into four sections, three of which are mandatory (third party liability, accident benefits and uninsured motorists) and one is optional (comprehensive and collision). 50% of the average automobile insurance premium is paid toward third party liability insurance. Comprehensive and collision insurance represent 37% of the average total automobile insurance premium. Another 12% goes toward accident benefits coverage and a mere 1% goes toward uninsured motorists insurance.

Because drivers do not have to purchase any comprehensive and collision insurance coverage (or they can decide to drive a less expensive car, or opt for a larger deductible), there is little reason why any government should need to regulate more tightly the premium paid for such coverage. This means that rate regulation is targeted to apply to 63% of the average premium, almost 80% of it (50/63) being paid toward third party liability. This is where all the savings will need to come from. It is also with respect to this third party liability insurance that most insurance fraud occurs.

1.3 Previous literature

Very little has been written on the coordination of insurance fraud investigating bodies because 1- these bodies are relatively new as evidenced by the recent literature on the subject (see Picard, 1996, Boyer, 2000, and Schiller, 2003), and 2- a large part of the literature has assumed away their role because the asymmetry problem between the insurer and the policyholder can be solved using

[5] See Nova Scotia consultation paper, op.cit.

the revelation principle (see Townsend, 1979, Mookherjee and Png, 1989, and Bond and Crocker, 1997).

The standard approach to insurance fraud, and the one we shall adopt, is known as the Costly State Verification (CSV) approach as pioneered by Townsend (1979). We will, however, assume that insurance companies are unable to commit to an auditing strategy when a claim is filed so that, in equilibrium, fraud may still exist in the economy. As a result, the principal-agent problem is not solved as in Khalil (1996). The CSV approach stands in contrast with the Costly State Falsification (CSF) approach, where no fraud is found in equilibrium and where auditing is useless. Boyer (2003) shows that the optimal contract using the CSF approach, as in Crocker and Tennyson (1999), is similar to the optimal contract using the CSV approach if the insurer is unable to commit to an auditing strategy.[6]

In contrast to Becker (1968) and Ehrlich (1972), we will not let the penalty for committing insurance fraud go to infinity so that the audit probability goes to zero and the first best allocation is achieved under insurer full commitment. Juries or courts typically choose the penalty so that their size is not explicit in the contract. Moreover, only a very small proportion of suspected fraudulent insurance claims (2.6%) are prosecuted as shown in Weisberg and Derrig (1991). As a result, combating insurance fraud is more efficiently done through the use of claims adjusting than through the prosecution of criminals. An efficient way to increase claims adjusting investigation would be to reduce its cost. The setting up of a CSIC in Atlantic Canada may allow doing exactly that.

The organization of the paper is as follows. In Section 2, we present the basic model and solve the insurance fraud game played by the insurer and the policyholder. Section 3 presents our main results where a coordinated suspicious insurance claims bureau helps in the investigation of claims. Section 4 offers an original way to finance the CSIC bureau. We discuss our results and conclude with a further avenue of research in Section 5.

2 The State of Automobile Insurance in Atlantic Canada

By the end of 2003, the governments of the four Canadian Atlantic provinces will have introduced legislation that modifies considerably the provision of insurance in these provinces. The purported goal of this legislation is to provide accessible, affordable and fair automobile insurance coverage to all consumers. Here are some of the new regulations

1. An insurer may not use a rating system based on: Age, sex, marital status, not at fault

[6] See Lacker and Weinberg (1989) and Crocker and Morgan (1998) and for more details on CSF.

claims, minor damage where no claim is paid and lapse in coverage.

2. An insurer cannot decline coverage for reasons of: Age, sex, marital status, not at fault claims, minor damage where no claim is paid, lapse in coverage, another insurer refused to insure, age of vehicle.

3. With respect to the regulation of rates, the Public Utility Board will only set a maximum benchmark for premiums, but will not set a minimum rate.

4. Capital requirements will be increased from 1 million to 3 million dollars.

5. The Property and Casualty Insurance Compensation Corporation (PACICC) will provide 100% coverage of unearned premiums up to $5000, or the government is to provide top up coverage and recover any payouts from the insurance companies.

6. If an insurance company goes out of business, its policyholders will get all of their unused premiums refunded up to $5000. Prior to the new regulations, policyholder would get back 70% to a maximum payout of $700.

7. Before renewing or obtaining a vehicle permit, drivers will be required to show proof of insurance, and uninsured drivers will face stiffer penalties.

Some of these new regulations have important drawbacks for competition between insurers and policyholder welfare. Three of these points have little economic and social reason to exist. We discuss them in turn.

2.1 Rating categories

For example, points 1 and 2 restrict the number of rating categories that an insurance company may use in determining the premium paid by a policyholder, even if said categories have been proven to be actuarially fair. Well known research in insurance (Cummins et al., 1983, Borenstein, 1989, Bond and Crocker, 1990, Harrington, 1991, Rea, 1992, and Harrington and Doerpinghaus, 1993) has shown that the limitation on the use of risk categories have little or no direct benefits, but that the indirect costs may be important. These higher costs are driven by the fact that the policyholder population changes as the individuals in the low risk categories start subsidizing individuals in the high risk categories, thus inducing more high-risks to participate in the market because it becomes relatively less costly for them. At the same time, some low risk individuals will chose to exit the market because they find the premium to be too high.

We can illustrate this using a quick example. Suppose that the insurance market is competitive, all agents in the economy are equality distributed according to two risk levels (expected loss of \$30 and \$60) and three willingness-to-pay for automobile insurance levels (the maximum willing to pay of \$30, \$50 and \$75) according to the following matrix

	Willingness to pay		
Expected loss	Small (\$30)	Medium (\$50)	Big (\$70)
Low (\$20)	1/6	1/6	1/6
High (\$60)	1/6	1/6	1/6

If the insurer is able to discriminate according to the risk categories, it will offer high-risk agents a contract with a premium of \$60 and low risk agents a contract with a premium of \$20. With a premium of \$20, all low risk agents choose to purchase insurance and drive because they are all willing to pay more than that. As for the high-risk agents, two-thirds of their population will prefer not to have insurance because the price of insurance is higher than their willingness-to-pay. Conditional on insurance being purchased, the average premium in the economy is \$30=(20+20+20+60)/4.

Suppose now that insurers are no longer allowed to discriminate between risk types. If there is no change in the insured population, the insurers will need to offer to all an insurance contract with a premium of \$30. The problem arises when the uninsured agents, the agents that were classified as high risk but whose willingness-to-pay was medium and small, now see an average premium smaller than their willingness-to-pay. As a result these high-risk agents enter the market, thus raising the average cost of insurance from \$30 to \$40=(20+20+20+60+60+60)/6. At \$40, however, the agents whose willingness-to-pay is small, regardless of their expected loss, prefer to exit the market. The only agents who are left are those whose willingness-to-pay is higher than \$40, regardless of their risk type. As a result, the average premium in the economy has jumped by 33%, from \$30 to \$40, as a result of this elimination of the possibility to classify risks.

Because incentives are distorted through the elimination of the rate classes, the number and the proportion of high-risk drivers on the roads increases at the same time as the number and the proportion of low risk drivers decreases. Overall the economic welfare in this economy is reduced.

Another well-known problem arising with the restriction of rating categories is that drivers who belong to an unprofitable group have great problems to get coverage, because insurance companies intentionally complicate the contracting process and/or recommend rival firms. For example, in Germany insurers are restricted by law to discriminate with respect to the nationality drivers. Therefore, some foreigners – that statistically cause higher expected losses – have great problems to get compulsory automobile liability coverage although insurers have to accept all drivers that want to buy such an insurance.

2.2 Capital requirements

Requiring that insurers operating in the proving have capital requirements 3 million dollars instead of 1 million dollars (point 4) will also have negative impacts on the welfare of policyholders in the Atlantic Provinces. Capital requirements are well known entry barriers in the insurance industry. Little other barriers exist. Although capital requirements are said to increase the solvency of insurers, it is not clear that this raises the welfare of personal automobile liability insurance policyholders. In fact, even if greater capital requirements reduce the risk of bankruptcy, they are not a panacea to forestall bankruptcies as shown in Kareken and Wallace (1978).

Moreover, solvency requirements may induce more premium volatility and lead to more frequent and/or abrupt underwriting cycles as shown in Winter (1991). As a result, more stringent capital requirements coupled with solvency regulations based on premiums written may exacerbate the volatility of insurance prices in Atlantic Canada.

2.3 Bankruptcy protection

Points 5 and 6 also raise interesting problems regarding the new legislation in place in Canada's Atlantic provinces. The fact that policyholders are now completely protected in case of a bankruptcy will reduce their monitoring of the financial health of their insurer. In other words, policyholders will no longer care with whom they are insured because they will no longer fear lapses in coverage in the event of a bankruptcy. This will undoubtedly result in more insurance company bankruptcies and government bailouts, thus costing the taxpayers resources that, presumably, would be better used elsewhere.

With less supervision by the policyholders, managers of insurance companies will be better able to defraud the system because they know that consumers no longer care about the financial well-being of their insurer. As a result, managers will be able to pay themselves larger salaries, make more aggressive and risky investments with the premiums collected and enter destructive price wars with their competitors without fear of losing clients. This is especially dramatics in the case of longer-tail insurance products like liability insurance. Take the following example.

Suppose an individual decides to incorporate himself as an insurer with a capital of one million dollars. Being the only shareholder, he decides to pay himself a salary of 250,000 dollars a year as the sole manager of the company. This insurer enters the liability insurance market where the average claim is paid, say, in two years (after court proceedings, claims adjustments, and other delays). Suppose for simplicity that the all premiums and claims are collected and paid on the first day of the year, along with the manager's salary. Because this is a new insurance company, it makes an aggressive marketing campaign such that the premium it collects are 25% lower than the

expected claims it will pay in two years. In other words, if the company collect 1 million dollars in premiums, it will need to pay 1.25 million dollars in two years.[7] Assuming an investment return of 0% for simplicity, the insurance company knows that the premium it collects this year will be nowhere near enough to pay for the claims, especially since part of the premium that is collected goes toward paying the manager's salary.

To summarize, at the beginning of year 0, the insurance company's assets are given by the initial one million dollars invested by the manager, plus the one million dollars collected in premiums minus the 250,000 dollars paid toward the manager's salary. This gives the company 1,750,000 dollars in assets at year 0. At year 1, no claims are yet made, but a new set of policyholders pay the insurer premiums of 1 million dollars. The manager's year 1 salary of 250,000 dollars is paid so that the company now has 1,750,000+750,000=2,500,000 dollars in assets. At year 2, another million dollars is collected in premiums, the manager's salary is paid, and 1,25 million dollars are paid to settle the claims. The company now has 2,500,000+750,000-1,250,00=2,000,000 dollars in assets. At year 3, the company has 2,000,000+750,000-1,250,000=1,500,000 dollars in assets; $1,000,000 in assets in year 4; and $500,000 in assets in year 5. The insurer goes bankrupt in year 6 as no more assets remain in the company even though it still will need to pay claims of $1,250,000 in both years 7 and 8. These unpaid claims are now the responsibility of the government, so that the policyholders do not suffer from the insurer's bankruptcy.

Let us see what is the return to the manager of such an investment. The manager investment 1 million dollars initially and collected $250,000 each year in years 0 to 6. The manager's annual rate of return on his investment is 25%... Not bad. Who ends up covering the policyholders who signed liability insurance contracts with the insurer in years 5 and 6? The provincial government and ultimately the taxpayers are the final claimants, of course.

Such full proof bankruptcy protection is not good for the insurance system as a whole since it eliminates the consumer's incentives to verify their insurer's financial health. As a result the new legislation will drive out good and efficient insurers that have too much to lose by going bankrupt and bring in fly-by-night insurers whose imminent bankruptcy will become a hardship for the province.

Tighter capital and investment regulations are not a low-cost viable solution either. As mentioned in the discussion on minimum capital requirements, these do not prevent bankruptcy as shown by Kareken and Wallace (1978). Moreover, Myers and Read (2001) show that too tight a regulation may drive out national companies, thus leaving room for local insurers that have higher

[7] Given that the province will not set a minimum premium level, there is not garantee that this will not happen. Moreover, the insurer could argue that it only needs to generate a 25% return over two years (12% per year) on the invested premium to be able to pay for the losses.

bankruptcy risk. They write:

> "If the regulatory squeeze is too long and too hard, the national companies gradually leave... The local companies' surplus has to be higher ... or default risk increases because of less effective diversification... But now the regulator has to face up to default risk: it is no longer spread out nationally, but internalized."[8]

As a result, the policyholders must expect, through the new legislation, that their premiums will be much higher in the future, as well as their taxes. Premiums will be higher because the good and efficient insurers will eventually and gradually leave Canada's eastern provinces and be replaced by less efficient ones. These less efficient companies will need to charge higher premiums to remain solvable given the little capital they have compared to the national insurers. And the companies that charge too small a premium will find themselves in bankruptcy, and their policyholders bailed out by the taxpayers. The current legislation will lead inexorably too lower welfare for all Atlantic Canadians.

2.4 Uninsured Drivers

The stiffening of regulations concerning the proof of insurance and penalties for not having insurance indicates that uninsured drivers are a serious problem in Atlantic Canada. Therefore, a high number of uninsured motorists may be an additional reason for the rising premiums in the past. In their study Smith and Wright (1992) show that premiums in the US automobile insurance market vary dramatically across cities and high premiums are connected with a high number of uninsured drivers.

In 2001, insurers in Nova Scotia have to pay indemnities of the order of 3.8 million dollars because of claims caused by uninsured motorists.[9] For comparison, compulsory automobile insurance premiums topped 177 million dollars in the Province for the same year.[10] This ratio (2.1%) is relatively high given what is observed in other parts of the world. For example, in Germany,[11] the annual cost of uninsured drivers is approximately 3.7 million euros on total premiums of 8 billion euros, a ratio of 0.05%.

The relatively high cost of uninsured motorist claims may be another reason why provincial legislations in Atlantic Canada are looking at revamping the automobile liability insurance system.

[8] Myers and Read (2001). Page 572.

[9] See Insurance Bureau of Canada (Novia Scotia Utility and Review Board), *Evidence of the Insurance Bureau of Canada*, August 2002, Tab. 2, Actuarial Evidence, pages 45 and 68.

[10] Including premiums for Third Liability, Accident Benefits, and Uninsured Motorist Coverage.

[11] In Germany, Verkehrsopferhilfe, a corporation funded by all automobile insurance companies, takes charge of nearly all claims that are causes by uninsured drivers.

To reduce the incidence of uninsured motorists, the province of Nova Scotia raised the fines of uninsured driving. In our view, however, relying on greater fines on uninsured motorists should not have as strong an impact than if proof of insurability was required to have a driver's license and to own a vehicle. Because of individual limited liability, uninsured drivers, who presumably earn a low income and/or have low wealth, will not be affected much by higher fines. As a result higher fines on uninsured driving will have no impact on poor drivers and they decide to drive uninsured as shown in Sinn (1982) and Shavell (1986). On the other hand, when drivers have to proof their coverage, poor drivers either have to buy insurance or will not be able to obtain a vehicle permit. The small impact of uninsured motorist impact on the total automobile insurance premium paid in Germany may be directly due to this insurance legislation aspect.

3 Government Intervention to Curb Insurance Fraud

Government intervention on the insurance market is not all bad, however. Government can become a partner of the insurance industry to help reduce the cost of insurance claims and, by the same token, the cost of automobile insurance. This can be achieved in three ways: 1- establishing a no-fault insurance system; 2- providing much needed capital to the insurers to soften capital surplus constraints; and 3- establishing a coordinated suspicious insurance claims (CSIC) bureau. We will mostly concentrate on the third aspect of government intervention in this paper.

No-fault systems as the one in place in Québec, Manitoba and many U.S. States reduce insurance premiums paid to the detriment of the services rendered by the insurance sector. No-fault legislation reduces the services to the policyholders and the general population through a limit on the right to sue. Nielson and Kleffner (2003) present a position paper on the topic and offers details and references on the ways auto insurance may be reformed by eliminating tort.

Government intervention in the insurance sector may be most needed as a purveyor of capital or a provider of better auditing technology. The automobile liability insurance crisis in Atlantic Canada coincided with the disappearance of most the industry's surplus following the events of 9/11. As a result, there was little capital left to back potential losses so that premium increases were inevitable. Because surplus will come back as the economy and the industry recover from 9/11, premiums will settle and go back down again, just as in any other underwriting cycle.[12] There is therefore room for governmental intervention as a provider of bridge financing. This may be done through the creation of a crown corporation that acts a reinsurer of last resort for local insurers.

Finally, government intervention may be warranted if better auditing technology is necessary

[12] See Cummins et al. (1991), Winter (1994), Cummins and Danzon (1997) for more details behind this argument.

to make sure that agents receive payments for losses they have incurred, and not for losses they have made up. We show in the following model how this may be achieved by merging the insurance regulatory bodies of Canada's four Atlantic Provinces.

3.1 CSIC: Basic Setup

The assumptions and the setup of the model are similar to Boyer (2000) and Schiller (2003). Policyholders are risk averse and have von Neumann-Morgenstern utility functions ($U' > 0, U'' < 0$) over final wealth W. They are endowed with initial assets A. The insurers are risk neutral. Policyholders may suffer a loss L with probability π. Whether a loss occurred is the policyholder's private information. The action space for the policyholder is file a claim (FC) and do not file (DF), whereas the action space for the insurer is audit the claim (AC) and do not audit (NA). Auditing a claim is costly to the insurer, but perfect. Before the insurer decides to audit the claim, we suppose that it receives an informative, but unverifiable signal (y) after which it decides to audit or not. The signal is informative in the sense that $p\left(x = x_i | y_1\right) > p\left(x = x_i\right)$. The signal can either be y_1 "suspicious" or y_0 for an "unsuspicious" claim. The contingent probabilities are:

	Claim is...	
Signal	fraudulent	honest
suspicious (y_1)	ϕ	δ
unsuspicious (y_0)	$1-\phi$	$1-\delta$

The insurance market is perfectly competitive in that premiums (denoted by α) are equal to expected benefits (denoted by β) plus expenses due to fraud. The agent caught committing fraud must incur some penalty $k > 0$.

The sequence of the game is displayed in figure 1. In stage one, the players sign a contract that stipulates a coverage (β) and a premium (α). In stage two, the policyholder learns whether he suffered a loss L or not. The policyholder then decides whether to file a claim. Upon hearing the policyholder's message, the insurer receives and informative signal and may audit. Finally in stage 6 the payoffs are paid and the game ends.

The game played in stages 2-6 yields an unique perfect Bayesian Nash equilibrium in mixed strategies so that no player has an incentive to deviate unilaterally from the set equilibrium. The

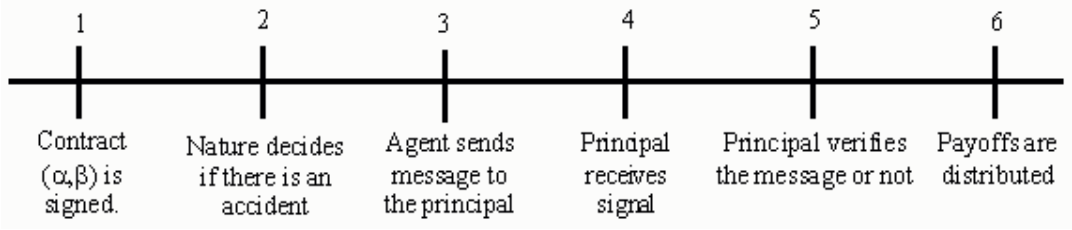

Figure 1: Sequence of play.

players' payoffs contingent on their actions and Nature's are displayed in Table 1.

Table 1. Monetary payoffs to the policyholder and the insurer: Payoffs contingent on their actions and Nature's

Actions			Monetary Payoffs	
Nature	Policyholder	Insurer	Policyholder	Insurer
No loss	*DF*	*AC*	$Y-\alpha$	$\alpha-c$
No loss	DF	NA	$Y-\alpha$	α
No loss	FC	AC	$Y-\alpha-k$	$\alpha-c$
No loss	FC	NA	$Y-\alpha+\beta$	$\alpha-\beta$
Loss	FC	AC	$Y-\alpha-L+\beta$	$\alpha-\beta-c$
Loss	FC	NA	$Y-\alpha-L+\beta$	$\alpha-\beta$
Loss	*DF*	*AC*	$Y-\alpha-L+\beta$	$\alpha-\beta-c$
Loss	*DF*	*NA*	$Y-\alpha-L$	α

Contingent states in italics represent actions that are off the equilibrium path.

Lemma 1 presents this equilibrium.

Lemma 1 *Assuming that the signal is uninformative, then, for a given set of parameters including the audit cost c, the unique perfect Bayesian Nash equilibrium in mixed strategies of this game is: 1-Policyholder plays FC Nature chooses Loss; 2-Policyholder plays FC with probability* η *and DF with probability* $1-\eta$ *when Nature chooses No loss; 3-Insurer plays NA when the policyholder played DF; and 4-Insurer plays AC with probability* ν *and NA with probability* $1-\nu$ *when the policyholder played FC.*

In equilibrium, η *and* ν *are given by*

$$\eta = \left(\frac{c}{\beta - c}\right)\left(\frac{\pi}{1-\pi}\right) \tag{1}$$

$$\nu = \frac{U(A-\alpha+\beta) - U(A-\alpha)}{U(A-\alpha+\beta) - U(A-\alpha-k)} \tag{2}$$

Proof: See Boyer (2000).•

The equilibrium audit probability from (2) corresponds to the critical detection probability κ_c, which keeps policyholders indifferent between their actions. When the signal is informative in the sense that $p(x = x_i|y) > p(x = x_i)$, the players will consider the informativeness of the signal when deciding their reporting and auditing strategies. As a result, the equilibrium changes and is given in lemma 2. In order to simplify the analysis, we assume that ϕ is greater than the crucial detection probability κ_c. When the fraction of fraudulent claims in the set of claims with the signal y_1 is higher than the critical detection probability, the insurer is always be able to make policyholders without a loss indifferent between their strategies by exclusively auditing claims with that signal. For a detailed analysis see Schiller (2003).

Lemma 2 *When the signal is informative and $\phi \geq \kappa_c$ holds, the unique perfect Bayesian Nash equilibrium in mixed strategies of this game is similar to that presented in lemma 1, but the insurer only audits suspicious claims with the signal y_1.*

The equilibrium strategies η and ν are then given by

$$\eta = \left(\frac{\delta c}{\phi(\beta - c)}\right)\left(\frac{\pi}{(1-\pi)}\right) \tag{3}$$

$$\nu = \frac{\delta\beta}{\phi\beta - [\phi - \delta]c}\frac{U(A - \alpha + \beta) - U(A - \alpha)}{U(A - \alpha + \beta) - U(A - \alpha - k)} \tag{4}$$

Proof: See appendix.•

In the following, we only consider the optimal insurance contract with an informative signal, because the case without the signal can be easily deduced by setting $\delta = \phi$. Given the different states of the world, the function to maximize is

$$\begin{aligned} EU &= \pi U(A - \alpha - L + \beta) + (1-\pi)(1-\eta)U(A - \alpha) \\ &\quad + (1-\pi)\eta[(1-\nu)U(A - \alpha + \beta) + \nu U(A - \alpha - k)] \end{aligned} \tag{5}$$

subject to the equilibrium constraints of lemma 2 and the players' participating constraints. The insurer's and the policyholder's constraints are respectively given by

$$\alpha = \pi\beta + (1-\pi)\beta\eta(1-\nu) + c\nu[\pi + (1-\pi)\eta] \tag{6}$$

and

$$EU^* \geq \pi U(A - L) + (1-\pi)U(A) \tag{7}$$

The per policy cost of fraud is given by $(1-\pi)\beta\eta(1-\nu)+c\nu[\pi+(1-\pi)\eta]$ so that the premium must be at least equal to it. This cost can be separated in two parts: $(1-\pi)\beta\eta(1-\nu)$ represents the expected cost of successful fraudulent claims, whereas $c\nu[\pi+(1-\pi)\eta]$ represents the expected cost of fraud detection. In a recent study, Dionne et al. (2003) showed that a large European insurer was able to save 43% (resp. 22 million euros) of its expected costs of successful fraudulent claims after the implementation of a fraud detection system.

Substituting for ν given in (3) and for η given in (2) simplifies the problem[13] to

$$\max_{\alpha,\beta} EU = \pi U(A-\alpha-L+\beta)+(1-\pi)U(A-\alpha) \tag{8}$$

$$subject\quad to\quad \alpha = \pi\beta\left[1+\left(\frac{\delta}{\phi}\right)\left(\frac{c}{\beta-c}\right)\right] \tag{9}$$

and finally

$$\max_{\beta} EU = \pi U\left(A-\pi\beta\left[1+\left(\frac{\delta}{\phi}\right)\left(\frac{c}{\beta-c}\right)\right]-L+\beta\right)+(1-\pi)U\left(A-\pi\beta\left[1+\left(\frac{\delta}{\phi}\right)\left(\frac{c}{\beta-c}\right)\right]\right) \tag{10}$$

The solution to this problem gives us lemma 3.

Lemma 3 *If the principal is making zero profit then the optimal coverage entails over-insurance with $\beta > L$ as long as the signal is imperfect $(\delta > 0)$.*

Proof: See Schiller (2003).•

The optimal insurance contract entails over-compensation because the slope of the zero-profit premium function is always smaller than that of a fair premium $\alpha = \pi\beta$ if the signal is not perfect $(\delta > 0)$. Hence, for $\beta < L$ an increase in coverage raises the expected payoffs and reduces the income risk of a policyholder. Because the marginal utility is positive when $\beta = L$, the optimal indemnity must be greater than the loss. In equilibrium, there exists a $\beta^* > L$, such that the trade-off between increasing the expected payoffs and risk taking are exactly offset. As a result policyholders choose to be over-insured, as in Boyer (2000) and Schiller (2003).

This result is driven by the insurer's impossibility to commit ex ante to an ex post auditing strategy. Consequently, the insurer must imbed in the insurance contract provisions that will induce her to audit with greater care. These increased incentives to audit are achieved by increasing the indemnity paid, β, when they do not audit. A policyholder reads this signal as meaning that insurers have greater incentives to audit so that he should reduce his likelihood of committing fraud. Khalil (1997) Mookherjee and Png (1989) and Bond and Crocker (1997) also have circumstances under which a policyholder may be over-compensated for his loss.

[13] The participation constraint is redundant since it is the equivalent to choosing $\beta = 0$.

3.2 Introducing a CSIC Bureau

3.2.1 Reducing uncertainty

In the following, we offer arguments to why the implementation of a coordinated suspicious insurance claims (CSIC) investigating organization may bring several benefits to Atlantic Canada. First, a CSIC bureau increases the welfare of all policyholders in the economy by eliminating auditing costs variability and uncertainty across jurisdictions. Second, a CSIC will allow to tap into increased returns to scale in the auditing process.

Let us firstly take a closer look at the problems of decentralized audits for fraud. Suppose there are N policyholders and two regions $i = H, L$ in the economy. The two regions' only distinguishing features are their audit costs c_i with $c_H > c_L$. In each region the amount of fraud is given by $F_i = N_i \eta_i$ where N_i is the number of policyholders in region i and η_i is the probability that a policyholder in region i commits fraud. Given the fraction of the population living in the low cost region is ξ (i.e., $N_L = \xi N$), the total number of fraudulent claims in the economy (F) is

$$F = \xi F_L + (1-\xi) F_H = \frac{\pi}{1-\pi} N \frac{\delta}{\phi} \left[\xi \left(\frac{c_L}{\beta_L - c_L} \right) + (1-\xi) \left(\frac{c_H}{\beta_H - c_H} \right) \right]. \tag{11}$$

Obviously, the regions where audit costs are higher experience more fraud, because audit are less likely being more costlier. Policyholders increase their fraud probability in order to keep insurers in the high cost region indifferent between his actions. If policyholders do not know where they will live eventually, they face some uncertainty regarding the provisions of the insurance contract.

The introduction of a CSIC increases the expected utility of all agents if it audits claims at a cost equal to the industry's average $\bar{c} = \xi c_H + (1-\xi) c_L$. To see why, consider what happens to the probability of committing fraud given in equation 3. Because $\eta(c)$ is increasing and convex in the cost of auditing c for a given indemnity payment (in other words, because $\eta'(c|\beta) > 0$ and $\eta''(c|\beta) > 0$), the likelihood of fraud is greater when policyholders in each region are audited at their respective cost instead of the average cost. Put differently, we have

$$\xi \eta(c_L) + (1-\xi)\, \eta(c_H) > \eta(\xi c_L + (1-\xi)\, c_H). \tag{12}$$

The same happens to the average premium since it is convex in the cost of auditing for a fixed benefit (i.e., $\alpha'(c|\beta) > 0$ and $\alpha''(c|\beta) > 0$).

In reality, however, the indemnity payment will vary as the cost of auditing varies. This means that the probability of committing fraud is not necessarily completely convex in the cost of auditing as shown in Boyer (2000). Nevertheless, as long as the indemnity is not too elastic with respect to the audit cost, the amount of fraud in the economy will be smaller when all policyholders are

audited a the same cost than when each policyholder is audited at his corresponding cost. Moreover, Boyer (2000) shows that, even if the amount of fraud increases because η is no convex in c, the policyholders' expected utility is greater when all are audited at the industry's average cost.

Consequently, by merging the four regulatory bodies, policyholders gain by reducing the uncertainty as to the cost efficiency of being audited in their region. The utility policyholders gain by this reduced uncertainty may be compounded by a reduction in the amount of fraud and by a lower average premium.

3.2.2 Spreading fixed costs

A CSIC bureau can also help to reduce the average costs of fraud detection. So far we have abstained from any costs of the informative signal y, but fraud detection systems and its resulting signals cause high development and implementation costs, because these systems are computer based and need a lot of know-how to be valuable. Due to the fixed costs of the system, the size of the insurance market or respectively the number of policyholders is crucial for its implementation. This may be the reason why fraud detection is only poorly developed in Atlantic Canada as the following analysis demonstrates.

Let us consider an insurance market with a number of N policyholders and a number of I completely homogenous insurers. We briefly compare two situations: a market with and one without a detection system. Suppose the development and implementation costs of a system are D. When insurers compete in contracts, the sustainable premium offer will correspond to the average costs of a contract. In a situation where some of the I insurers charge the same expected utility maximizing contract, they will split the market equally. In equilibrium, where all the companies have access to the same detection technology, all companies will offer the same premium. A detection system will only be implemented by all insurers, if the average costs of a contract with fraud detection are lower than those without fraud detection and

$$\left[1+\left(\frac{\delta}{\phi}\right)\left(\frac{c}{\beta-c}\right)\right]\left[\beta+\frac{D\cdot I}{N}\right]\leq\frac{\beta^2}{\beta-c} \tag{13}$$

holds.[14]

As we have shown before, the fraud probability decreases with an informative fraud detection system. Economies of scale play a crucial role, because the average costs of an insurance contract with fraud detection decreases in the market share of a company (I/N). Therefore, a cooperation of all insurers in the economy, which leads to $I=1$, causes to the lowest possible average costs of fraud detection.

[14] We refrain from any stratgic problems with the implemenation under fixed costs. See Schiller (2003) for these questions.

In the situation of the four provinces it seems appropriate to centralize fraud audits and the development and implementation of a fraud detection system, in order to enhance the fight against insurance fraud and to reduce the fraud costs per policy. As a possible strategy, all four provincial insurance regulatory bodies should set up a CSIC bureau which develops a system centrally that identifies suspicious claims. After its implementation the system assigns an informative signal to each claim and insurers can decide to refer the claim to the bureau, where all fraud audits in the economy take place.

3.2.3 Providing a better signal

A third way in which the CSIC can be beneficial to the economy is by providing a more informative signal to the insurers in terms of what suspicious claims are fraudulent and what are not. A signal y_1 is more informative about a claim being fraudulent when $\frac{\phi}{\phi+\delta}$ is close to 1. For example, when $\delta = 0$, the signal y_1 is perfectly informative so that no fraud occurs in equilibrium as in Schiller (2003).

Government intervention may be beneficial in this economy if it can increase the informativeness of signal y_1. Let us measure the quality of the signal by the ratio $\frac{\delta}{\phi}$. The smaller is this ratio, the more informative is the signal (i.e., at $\frac{\delta}{\phi} = 0$, the signal is perfect). When we look at equations 3 and 4, we find that the probability of committing fraud and the probability of auditing decrease as the signal becomes better. In other words, $\eta'\left(\frac{\delta}{\phi}\right) > 0$ and $\nu'\left(\frac{\delta}{\phi}\right) > 0$. As a result, the premium is reduced when the signal is more informative since $\frac{\partial \alpha}{\partial \frac{\delta}{\phi}} > 0$. Moreover, the impact of the signal's informativeness on the premium is linear as $\frac{\partial^2 \alpha}{\partial\left(\frac{\delta}{\phi}\right)^2} = 0$. Because the CSIC reduces the premium paid through a better signal on what claim is fraudulent, it is certain that policyholders will be ready to finance the creation of such a body if its cost is lower than the premium policyholders are able to save.

4 Financing the CSIC Bureau

For the three advantages of a CSIC bureau presented in the previous section of the paper, there were certainly costs associated with the setting up of such a coordinated suspicious insurance claims bureau. It therefore becomes imperative to see how the government is able to finance this regulatory.

One thing that we must bear in mind in the models presented in this paper is that insurance companies make zero expected profits so that policyholders have to bear all costs associated with insurance fraud. As Boyer (2001) shows, the efficient way to finance these expenditures is to tax

insurance indemnities instead of premiums because taxes have an impact on both the policyholder's decision to commit fraud and the insurer's decision to audit for two reasons. Firstly, the indemnity tax lowers the indemnity net of taxes that the policyholder receives in the event of a loss so that they have less to gain by a filing a fraudulent claim, all else being equal. Secondly, the indemnity tax increases the incentives for insurers to audit because a fraudulent claim becomes more costly for them.

Another important advantage of the benefit tax is that it causes a redistributive effect because only policyholders who file a claim finance the system and the auditing costs in the economy. As a result, proportionally more of the tax is paid by agents who file fraudulent claims. It is true that agents who had a true claim are paying more than their fair share, but as long as the indemnity net of the tax is greater than the loss, one could still argue that the indemnity tax allows to fully smooth the policyholder's income. In other words, if the indemnity tax (t) is set so that $t = 1 - \frac{L}{\beta}$ ex post, the policyholder's utility is $U\left(A - \pi\beta\left[1 + \left(\frac{\delta}{\phi}\right)\left(\frac{c}{\beta - c}\right)\right]\right)$ in every state of the world. As a result the policyholder is fully insured even if he must pay more than the fair price of insurance for this coverage since $\pi\beta\left[1 + \left(\frac{\delta}{\phi}\right)\left(\frac{c}{\beta - c}\right)\right] \geq \pi\beta$.

Consequently, a CSIC bureau financed by a tax on the insurance indemnity benefits that reduces the insurers' cost of auditing may considerably reduce the amount of fraud in the economy. This is true whether the CSIC takes care of all the insurance investigation or just offers guidance to the insurance industry as to what claim should be audited.

5 Final Remarks and Conclusion

A great shortcoming of the proposed reform of the automobile insurance system in Atlantic Canada is that it exclusively tackles the insurance market. The insurance market in only one side of the raising premium coin, the second side being the rising cost for medical services used by car accident victims. Although all Atlantic Canadians are covered by some minimum provincial public health system coverage, not all services are covered, including some that are the most costly in the event of an automobile accident. For example, physical therapy is not included in the Canadian Health Act so that provinces do not need to offer such coverage universally.

The fact that customers are insured, would by itself not cause economic problems as long as insurance companies are able to write complete contracts assigning indemnity payments directly to any possible state of nature. The first problem in a third party liability insurance system is that there is not any direct contractual relationship between the insurer and the customer of medical services. But even in a no-fault system, where this is not the case, the set of potential states of

nature is rather complex implying that complete contracts would either be impossible or cause disproportionate transaction costs (see Melumad et al., 1997, and Segal, 1999 for more details on the complexity topic). For example, a complete contract in auto insurance would have to precisely define the indemnity payable in case of any possible damage to the insured person.

Since writing a complete contract is usually not a realistic option, most property and casualty insurance policies base indemnity payments on the claimants' actual expenses. In other words, policyholders are typically compensated for the purchase of certain goods and services designed to alleviate the pain of their loss. As a result, their price elasticity for these goods and services declines. In perfect markets the policyholders' reduced price elasticity would have no impact on the actual prices, since prices correspond to marginal cost. In imperfect competitive market where supply is slow to respond, such as in the case of the medical services market, the policyholders' low price elasticity plays a crucial role in determining the cost of the service. As shown by Feldstein (1970, 1973), Frech and Ginsburg (1975), insured customers excessively seek medical treatments so that the price level for medical services increases.

If only the demand side of the market were affected, it would not be too bad for insurers who would be able to under-pay in years where there are few claims since the medical services market would be in a situation of over-capacity. Unfortunately for insurers, however, the market power in the medical services market leads to an increasing number of suppliers. As Nell et al. (2003) show, market power acts as a ratchet so that pricing problems on insurance markets are intensified. Additionally, Alger and Ma (2003) show that suppliers and costumers partly collude and misreport the extent of injuries to claimants in order to collect insurance payments.

Third party insurance fraud may also play an important role for the actual auto insurance crisis and the rising bodily injury claims. As a consequence, an insurance reform that only tackles the insurance markets turns a blind eye to some major causes of premium increases. As a result, these reforms may lead to no substantial improvements. The new $2,500 cap for pain and suffering awards for minor injuries will have a limiting effect on the costs but further intervention will presumably be necessary. Instead, lump-sum indemnities for certain injuries and more a intense supervision of insurance companies concerning the some covered medical treatments may lead to a significant reduction in the amount paid for bodily injury claims.

Tighter supervision may also come in the form of better auditing technology for insurers. We presented a model whereby merging many segmented insurance markets into one may lead to significant improvements in the amount of insurance fraud encountered on the automobile liability insurance market. These improvements came about because the fixed cost of setting up a coordinated suspicious insurance claims (CSIC) bureau could be spread over more policyholders, therefore

reducing the cost that each policyholder must incur. Moreover, fraud and premiums may decrease provided that some conditions hold regarding the elasticity of the demand for insurance coverage with respect to the insurers' cost of auditing. Nevertheless, even if fraud increases, the average policyholder's expected utility will be greater with a CSIC than without.

Although we have modelled the CSIC as taking care of all insurance fraud investigations, another way to improve the expected utility of the policyholders in the economy is if the CSIC can improve the quality of the signal received by the insurers. In other words, by giving CSIC access to more information regarding claims made to and paid by insurers, better expert systems may be developed so that the signal received by insurers is clearer. This will reduce insurance fraud in the economy as well as the premium paid by the policyholders. As a result, the policyholders' expected utility would increase if the four Provincial governments in Atlantic Canada would coordinate their effort to fight insurance fraud in the automobile liability insurance market.

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7 Appendix

7.1 Proofs

Proof of lemma 2. In the perfect Bayesian Nash Equilibrium beliefs are determined from Bayes' rule whenever possible. Therefore, the ex ante fraud belief μ of the insurer is

$$\mu = \frac{(1-\pi)\eta}{\pi + (1-\pi)\eta} = \frac{\delta c}{\phi\beta - [\phi - \delta]\, c}. \tag{14}$$

The posterior fraud belief $\mu\,(y_1)$ of the insurer after the observation of the signal y_1 is

$$\mu\,(y_1) = \frac{\phi(1-\pi)\eta}{\delta\pi + \phi(1-\pi)\eta}. \tag{15}$$

The equilibrium fraud probability η must solve the indifference condition of insurers, which is given by

$$-\beta = \mu(s_1)\,[-c] + (1 - \mu(s_1))\,[-\beta - c]\,. \tag{16}$$

Substituting $\mu(y_1)$ in (16) by (15) and rearranging the term yields

$$\eta^* = \left(\frac{\delta\pi}{\phi\,(1-\pi)}\right)\left(\frac{c}{\beta - c}\right). \tag{17}$$

After the observation of the signal the posterior fraud belief $\mu(y_1)$ is

$$\mu\,(y_1) = \frac{\phi(1-\pi)\eta^*}{\delta\pi + \phi(1-\pi)\eta^*} = \frac{c}{\beta}. \tag{18}$$

The equilibrium audit probability $\nu(y_1)$ satisfies the following indifference condition of policyholders

$$\begin{aligned} U(A-\alpha) \;&=\; \phi\nu(y_1)U(A-\alpha-k) \\ &\quad + (1 - \phi\nu(y_1))\,U(A-\alpha+\beta). \end{aligned} \tag{19}$$

After some manipulations one obtains

$$\nu(y_1) = \frac{1}{\phi} \frac{U(A-\alpha+\beta) - u(A-\alpha)}{u(A-\alpha+\beta) - u(A-\alpha-k)} = \frac{\kappa^c}{\phi}. \tag{20}$$

The overall audit probability is given by proportion of audited claims to all received claims, which is

$$\nu = \frac{\delta\pi + \phi(1-\pi)\eta}{\pi + (1-\pi)\eta} \nu(y_1). \tag{21}$$

By using (17) and (21) the overall probability simplifies to

$$\nu^* = \frac{\delta\beta}{\phi\beta - c\,[\phi - \delta]} \frac{U(A-\alpha+\beta) - U(A-\alpha)}{U(A-\alpha+\beta) - U(A-\alpha-k)}. \tag{22}$$

QED•