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Three Essays on Insurance

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Dedication

This thesis is dedicated to my wife, Kafieh, my son Soran-Ryan and also to my family: my father, mother, brothers and sisters.

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Abstract

The thesis consists of three research projects on the insurance market, both health insurance and car insurance in Canadian economy.

First essay, *Effectiveness, Severity, Prevalence and the Scope of Public Health Insurance Coverage*, focuses more on the breadth of coverage for health services and is motivated by the idea that some "medically necessary" services are covered 100% while other services are not covered at all by the public insurer: we ask where should this frontier between total coverage and no coverage lie. Interestingly, while attempting to address this latter concern we are able to provide further insight on the optimal depth of public coverage: it is not typically appropriate to have a fixed top-up rate, which is usually is the case. The appropriate amount of public coverage depends upon both the severity of conditions and the effectiveness of treatments. The model by dealing with both of the severity and effectiveness of any given condition is able to provide insights into issues concerning breadth and depth.

First, we find that in the absence of horizontal equity restrictions on the taxation of personal income, a publicly-funded health care system replicates the pattern of spending that would be chosen by individuals if health care services were privately funded: in other words, if individuals were given an equivalent amount of cash, they would spend all of these dollars on health care. In this setting, if there is low therapeutic benefit to treatment, the public sector will redistribute cash to these individuals, rather than paying for treatment. Second, if redistribution is constrained by a horizontal equity requirement with respect to income taxation, then this has consequences for the design of the publicly-funded health care insurance system. This results in a situation where individuals who are relatively healthy receive less care than under a privately-funded system whereas individuals who are in poor health receive more care than they would otherwise. If sick people were given an equivalent

amount of cash, they would not choose to spend all of it on health care. This pattern is consistent with casual empiricism. An important implication of the result on the impact of horizontal equity on health-care coverage is that primary health care policies which deliver services - such as homecare - to sick people are likely to be highly efficient, particularly as compared to providing additional health care services to these individuals: they do not need yet another diagnostic examination or test, what they need is services-in-kind which increase the value of consumption thus relaxing the horizontal equity constraint.

In second essay, *The Effects of No-fault Insurance System on Accident Measures Across Canadian Provinces*, we investigate whether or not switching from liability compensation systems to no-fault regime across four Canadian provinces, including Quebec, Manitoba, Saskatchewan and Ontario has had influenced three accident measures, fatality, personal injury and property-damage-only accidents, compared to three liability-based provinces, British Colombia, Alberta and New Brunswick.

The results are consistent with the existing literature on this issue, implying that no-fault has actually led to more accidents for both fatality and property-damage-only accidents. Using Mills ratio and conventional IV to take into account the possibility of endogeneity of decision to switch to no-fault, we even get stronger effect, implying that the existing papers on this issues have under-estimated the actual effect. The effects, also, are different among various provinces with different regimes; Quebec and Manitoba with pure no-fault regime have had stronger adverse effect for all three measures of accidents, Saskatchewan with monetary no-fault in place has had the positive impacts of no-fault on fatal and property-damage-only accidents, while the effect for Ontario with verbal no-fault are not significant for fatal and property-damage-only accidents and negative for personal injury accidents.

In third essay, *The Effects of No-fault and Choice Systems on Severity in Saskatchewan: A Micro Level Data Analysis*, I examine the possible impacts of two different compensation regimes on the severity of accidents. Grace to the daily detailed information on the characteristics of the drivers, the type of the vehicle, and the environmental factors influencing the severity of the accidents, I was able to disentangle the effects of choice and no-fault systems on five level of injuries, minor, moderate incapacitating, major incapacitating, major unconsciousness and fatality.

According to the results, no-fault has resulted in more serious injuries by shifting the distribution of the accidents from minor to major injuries. The result on choice is not significant for whole sample; however it showed the increasing impact on severity of accidents among male compared to female drivers.

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Introduction

The role played by government in health care provision is a question that has intrigued researchers for decades. In this paper, we are interested in the both the breadth and depth of publicly-provided health care. For the most part, the literature on the interactions between private and public health insurance has focused on the depth of public insurance by examining the optimal top-up rate: i.e., what proportion of healthcare costs should the government insure and what proportion is left for private individuals (insurers) to cover. The approach taken here allows us to show that it may be optimal to provide full coverage for some sorts of health care problems, but no coverage at all for other conditions, thus providing some insight into the question of determining the optimal scope of a public health insurance system. An interesting feature of the model developed here is that in the absence of horizontal equity restrictions on the taxation of personal income, a publicly-funded health care system replicates the pattern of spending that would be chosen by individuals if health care services were privately funded: in other words, if individuals were given an equivalent amount of cash, they would spend all of these dollars on health care. In this setting, if there is low therapeutic benefit to treatment, the public sector will redistribute cash to these individuals, rather than paying for treatment. However, if redistribution is constrained by a horizontal equity requirement with respect to income taxation, then this has consequences for the design of the publicly funded health care insurance system. This results in a situation where individuals who are relatively healthy receive less care than under a privately-funded system whereas individuals who are in poor health receive more care than they would otherwise. If sick people were given an equivalent amount of cash, they would not choose to spend all of it on health care. This pattern is consistent with casual empiricism. An important

implication of the result on the impact of horizontal equity on health-care coverage is that primary health care policies which deliver services - such as homecare - to sick people are likely to be highly efficient, particularly as compared to providing additional health care services to these individuals: they do not need yet another diagnostic examination or test, what they need is services-in-kind which increase the value of consumption thus relaxing the horizontal equity constraint.

The second chapter of the thesis develops a unique data set over seven Canadian provinces to examine the impact of no-fault automobile insurance on accidents in four provinces: Quebec, Manitoba, Ontario and Saskatchewan. This research is the first to examine empirically the link between no-fault and accidents in Manitoba, Ontario and Saskatchewan, and contributes to the very small literature that looked at this link for Quebec. The Canadian experience is interesting because in two provinces, the no-fault regime is "pure" in the sense that liability rules never come into effect irrespective of the magnitude of the bodily-injuries sustained (Quebec and Manitoba), while the other two provinces are more similar to the US experience in that thresholds exist above which liability rules come into play (Ontario has a verbal threshold while Saskatchewan's is monetary). This chapter takes two main approaches to treating the no-fault variable. First, the no-fault regime is treated as an exogenous independent variable while the second specification allows the possibility that the no-fault variable is endogenous. For taking into account the endogeneity of no-fault two approaches, a Heckman two-stage approach and conventional Instrumental variable (IV) are followed. The results of the analysis of chapter two indicate that no-fault rules have led to an increase in fatal accident compared to provinces with tort rules in place. The overall effect is about 5 percent, but this figure differs dramatically across the different type of no-fault regimes. Quebec and Manitoba have experienced much higher fatal accident increases, at

6.29 percent, while for Saskatchewan the number is 4.11 and for Ontario surprisingly it is not significant. The effect on property-damage-only accidents is also positive and significant. Interestingly, while no-fault rules increase the number of personal injury accidents in the pure regimes, the effect is not statistically significant in the other two regimes, suggesting that the type of no-fault rule matters when it comes to influencing driving behaviour. The impact of no-fault on accidents is estimated to be larger when endogeneity is taken into account suggesting that some of the earlier work in this area has understated the influence of no-fault rules on driver behavior.

Third chapter of the thesis using a unique micro-level dataset on Saskatchewan drivers who involved in accident examines the impacts of two distinguished compensation regimes, no-fault and choice, on the severity of the accidents over 1988 to 2005. No-fault and choice regimes came into effect on January 1995 and January 2003, respectively. Under choice system, the drivers can opt out of the default regime, which is no-fault, in favor of liability regime. After controlling for other factors capable of influencing the severity of the accidents, the existing of significant variations among the individual drivers of the available dataset allows us to more deeply disentangle the effects of these two systems on five level of severity of accidents; minor, moderate non-capacitating, major incapacitating, major non-consciousness and fatal. The econometric method used is ordered probit technique with unique feature. According to the results of the ordered probit model, no-fault regime has been associated with shift in injuries from minor to more serious injuries and fatal accidents. The highest shift is observed for moderate injuries. However, the result on choice system does not provide any significant sign of decreasing the level of severity of accidents among the involved drivers, even though is negative. Based on the theoretical background on this regime, choice is assumed to lead to less risky pool of the drivers as a whole, and therefore it

is expected that it would have negative impact on the severity of the accidents. One possible reason can be the existing of small proportion of the drivers who switched to liability regime which was less than 1 percent of the licensed drivers' population. The chapter also provides the marginal effects of the other variables existing in the models by showing how the distribution of the accidents' severities changed due to the changes in those variables.

Chapter One

Effectiveness, Severity, Prevalence and the Scope of Public Health Insurance Coverage

1.1. Introduction

The role played by government in health care provision is a question that has intrigued researchers for decades. The current climate of increasing demand for health care services and its attendant pressure on the government's purse, has brought this question back into the limelight. In this paper, we are interested in the both the breadth and depth of publicly-provided health care. As Stabile (2005) notes, under the current Canadian health care financing arrangement, provincial governments are mandated to fund only a partial list of "medically necessary" services universally – hospital and doctors services, – while other services that by any medical definition would be considered "medical necessity" such as insulin for diabetics or ventolin for asthmatics, are not mandated to be publicly insured under the Canada Health Act . But what are "medically necessary" services? And is it the appropriate criterion on which to be basing the decision to

provide public health insurance coverage? Should relatively inexpensive but prevalent treatments be insured (because of medical necessity), or should some of these therapies be paid for directly by patients? These questions are the principal themes of the present paper.

For the most part, the literature on the interactions between private and public health insurance has focused on the depth of public insurance by examining the optimal top-up rate: i.e., what proportion of health-care costs should the government insure and what proportion is left for private individuals (insurers) to cover (Blomqvist and Johansson, 1997, Blomqvist and Christiansen, 1998). Typically, these proportions are found to be fixed for the population. This paper, however, focuses more on the breadth of coverage and is motivated by the idea that some "medically necessary" services are covered 100% while other services are not covered at all by the public insurer: we ask where should this frontier between total coverage and no coverage lie. Interestingly, while attempting to address this latter concern we are able to provide further insight on the optimal depth of public coverage: it is not typically appropriate to have a fixed top-up rate. The appropriate amount of public coverage depends upon both the severity of conditions and the effectiveness of treatments.

This chapter contributes to the literature in several ways. First, the theoretical model developed in this paper contrasts with the existing models in that, rather than dealing with either the severity of the health condition facing an individual (e.g., Chernew et al., 2000, T.Stroupe et al., 2000) or the effectiveness of the treatment for any given condition, it deals with both of these concerns. In this way, the model is able to provide insights into issues concerning breadth and depth.

Individuals' utility depends upon income and health state. A central concern of our paper is equity: in particular, the model explores the impact on health care spending of horizontal equity restrictions with respect to taxation of income. The analysis yields two important insights. First, we find that in the absence of horizontal equity restrictions on the taxation of personal income, a publicly-funded health care system replicates the pattern of spending that would be chosen by individuals if health care services were privately funded: in other words, if individuals were given an equivalent amount of cash, they would spend all of these dollars on health care. In this setting, if there is low therapeutic benefit to treatment, the public sector will redistribute cash to these individuals, rather than paying for treatment. Second, if redistribution is constrained by a horizontal equity requirement with respect to income taxation, then this has consequences for the design of the publicly-funded health care insurance system. This results in a situation where individuals who are relatively healthy receive less care than under a privately-funded system whereas individuals who are in poor health receive more care than they would otherwise. If sick people were given an equivalent amount of cash, they would not choose to spend all of it on health care. This pattern is consistent with casual empiricism. An important implication of the result on the impact of horizontal equity on health-care coverage is that primary health care policies which deliver services - such as homecare - to sick people are likely to be highly efficient, particularly as compared to providing additional health care services to these individuals: they do not need yet another diagnostic examination or test, what they need is services-in-kind which increase the value of consumption thus relaxing the horizontal equity constraint.

This chapter is organized as follows. The next section reviews the pertinent literature

on publicly-funded health care. Section 3 develops a simple theoretical model which is expanded in sections 4 and 5. Section 6 concludes.

1.2. Literature Review

There is a striking dearth of literature in economics dealing directly with the issue of the appropriate scope of publicly-funded health care insurance. However, there are large literatures dealing with a number of closely related issues, some of which are germane to the model developed in this paper. One of the key issues is the way in which the provision of public health insurance interacts with other instruments for the redistribution of welfare. A classic examination of this issue is Usher (1977) who shows that a commodity is more likely to be socialized the greater is the inequality of income and the less diverse are the taste of individuals for that commodity. He notes that, abstracting from redistribution, most people are made worse off by socialization because they are constrained to consume some given level of goods. He concludes that, because of taste parameters, everyone will be better off if the proceeds of taxation are redistributed equally to everyone rather than using these funds to provide one of the goods publicly.

More recently, papers such as Besley and Coate (1991), Blackorby and Donaldson (1988) and Boadway and Marchand (1995) investigate the role of imperfect information in influencing the public provision of goods in kind versus cash redistribution of income. These papers draw attention to the fact that governments may often be limited in their capacity to distinguish between those individuals who are needy, and those who are not, and that this fact circumscribes the capacity of the government to undertake

redistributive activity. By providing some redistributive services in kind, and ensuring that the goods provided are valued only by the needy, the limits on redistribution can be somewhat attenuated. Whereas there is no problem of asymmetric information in the economy studied here, the analysis developed here can be compared to these papers to the extent that the driving force behind public provision of health insurance is the limit on redistribution that arises when the income tax system must respect the principle of horizontal equity.

Gouveia (1997) is one of the few researchers to directly tackle the issue of the scope of public health insurance, but from a positive perspective. He uses a political economy framework to examine the public provision of private good (health), and concludes that voters with very high and very low income levels both prefer lower levels of public provision of health care, as long as there is a supplementary private market. An important feature of Gouveia is that health care is a continuous variable, and there is no distinction between the different possible risks that are insured. In contrast, the framework used in this paper is normative. Moreover, there is an explicit distinction drawn between, say, the risk of getting prostate cancer and the risk of getting flu.

Hindriks (2001) uses Yaari's dual theory (rather than expected utility theory) to analyze political support for a compulsory public insurance with a uniform insurance policy versus privately-provided insurance with individually-tailored policies. An important result is that for any distribution of risk in the population, mixing public with private insurance is politically non-sustainable in the sense that there is always a majority that would like to push this supplementary system toward either less pure public insurance or less private insurance. As the author notes, however, one limitation of this framework is

that it does not allow for the health insurance system to play any broader redistributive role; in the analysis developed below, the potential redistributive role of the health care system is recognized explicitly. Hindriks and De Donder (2003) take a similar approach but introduce elements of asymmetric information which mean that the market for private insurance is faced with problems of adverse selection. The majority support for uniform public provision can still be demonstrated in this context, as well as the non-sustainability of "top up" provisions that allow for supplementation of public insurance with additional private insurance. As in the earlier work of Hindriks, the interaction between the redistributive role of the health care system and of the income tax system is not fully captured.

The issue of the interaction between the redistributive roles of the health care financing system and the income tax system is addressed directly by Breyer and Haufler (2000). They argue that shifting redistribution through the financing of the health care system (redistribution between different health risks) entirely to the income tax system (income redistribution) results in two types of efficiency gains. Firstly, this facilitates the adoption of more incentive-compatible insurance contracts (e.g., introduction of copayment schemes) and, secondly, this reduces the shadow price of public funds associated with income redistribution. As compared to Breyer and Haufler (2000), the paper here shows that when there are restrictions on income distribution (in particular, if the income tax system cannot be conditioned on health status), then their results on the superiority of pursuing redistributive objectives through the income tax system are no longer valid.

Petretto (1999) investigates the optimal social and private health insurance by taking into account their interaction. In order to facilitate the study of a mixed system he

proposes to merge two streams of literature, the classical problem of trade off between gain from risk sharing and dead weight loss associated to ex post moral hazard and combining the redistributive roles of income taxation and social insurance. Regarding the optimal social insurance coverage, he concludes that the optimal rate of social insurance should be higher if the distributional characteristics be higher. He also notes that the social insurance rate may be justified on the basis of equity and efficiency considerations.

Delipalla and O'Donnell (1999) address a political support to public provision of a private good (health care) with adverse selection within an environment of market failure. They show that Majority Voting Rule (MVR) exists and under weak assumptions about the income distribution and tax function, equilibrium public provision is positive. They conclude that under asymmetric information public provision is more likely to be positive and will not be lower. In their model the low risk individuals despite facing a relative tax price greater than one, prefer a mixed public private health care system, and that political support derives from slackening of the self selection constraint on the private insurance market equilibrium (Delipalla and O'Donnell, 1999).

1.3. A simple two individual, two illness model

Much insight into the interaction of prevalence, severity and effectiveness can be gleaned from studying a very simple model with only two individuals, two health conditions and uniform incomes. Although the model is extremely stylized, results in the more general analysis developed below are easier to understand once this simple model has been examined.

We assume that both individuals have identical concave utility functions, and that utility depends on two arguments: consumption (C) and health (H):

$$U = U(C_i, H_i) \tag{1}$$

where $i = 1, 2$ denotes the agent's type, and where we assume that the utility function is concave, and that both consumption and health are normal goods. An agent's type is determined by their state of initial health. We assume that all citizens have an identical income Y and that they face a uniform, lump-sum tax T . Tax collected by the government is used to provide lump-sum transfers of the consumption good (τ_i) and these must be chosen while respecting the public sector budget constraint:¹

$$2T = \sum_{i=1}^2 \tau_i. \tag{2}$$

Initially we assume that health care services must be purchased privately: consumers divide their after-tax income between consumption and health care (z_i) so that the consumer's budget constraint is

$$Y - T + \tau_i - z_i = C_i. \tag{3}$$

A crucial role is played by H . Each individual is assumed to be characterized by a

¹Observe that the public sector budget constraint could also be formulated as $\sum_{i=1}^2 \tau_i = 0$. The separate recognition in the budget constraint of the revenue from the income tax and expenditure in the form of lump-sum transfers of the consumption good is useful in subsequent sections when examining optimal fiscal policy.

given initial state of health Ψ_i , where $\Psi_i > \Psi_j$ if $i < j$. However, that initial state of health can be increased if there is access to health care, so that

$$H_i = \Psi_i + \phi_i z_i \quad (4)$$

where ϕ_i is a parameter describing the effectiveness of health care and $\phi_i > \phi_j$ if $i < j$. These assumptions imply that the less severe condition has the more effective treatment. This may be interpreted as meaning that there are effective treatments available for relatively minor problems, but that the marginal productivity of health care dollars spent on major problems is low². In this very basic setting, the optimisation problem solved by the individual is:

$$\max_{z_i} U^i = U(Y - T + \tau_i - z_i, \Psi_i + \phi_i z_i), z_i \geq 0$$

A solution to the individual's optimisation problem requires that z_i^* be chosen so that:

$$\frac{dU^i}{dz_i} = -U_c + \phi_i U_h \leq 0 \quad (5)$$

$$\text{and } z_i^* \frac{dU^i}{dz_i} = 0. \quad (6)$$

Observe that individuals with a more severe health problem will not necessarily choose to allocate funds to health care: treatment must be effective before a sick individual will choose to spend money on caring for their own health; notice also that a sufficient (but

²Whereas this is obviously a strong assumption, it is more or less plausible depending upon how broadly we interpret health conditions. For example, if we were to interpret the different conditions as more-or-less incurable cancers, then arguably the assumptions that are made here are reasonable.

not necessary) condition for the second-order conditions to be satisfied is that $U_{CH} \geq 0$. Moreover, if $U_{CH} \geq 0$ it is straightforward to check that $dz_i^*/d\Psi_i < 0$. In contrast, $dz_i^*/d\phi_i \leq 0$. If utility is separable in consumption and health ($U_{CH} = 0$) then $dz_i^*/d\Psi_i < 0$ and $dz_i^*/d\phi_i > 0$. Similarly, one can show that $dz_1^*/dT < 0, dz_1^*/d\tau_1 > 0$ if $U_{CH} \geq 0$.

The government's problem is to choose both a level of tax and lump-sum redistributions to ensure that social welfare is maximized. If the government is Benthamite, then this problem can be expressed as:

$$\max_{T, \tau_2} W = U(Y + T - \tau_2 - z_1^*, \Psi_1 + \phi_1 z_1^*) + U(Y - T + \tau_2 - z_2^*, \Psi_2 + \phi_2 z_2^*) \quad (7)$$

$$\text{subject to } z_i^* \text{ solves (5), } i = 1, 2; \tau_i \geq 0; \text{ and } T \geq 0 \quad (8)$$

The Kuhn-Tucker conditions for the government's problem are:

$$T : +U_{C1} - U_{C2} + (-U_{C1} + \phi_1 U_{H1}) \frac{dz_1^*}{dT} + (-U_{C2} + \phi_2 U_{H2}) \frac{dz_2^*}{dT} = 0 \quad (9)$$

$$\tau_2 : -U_{C1} + U_{C2} + (-U_{C1} + \phi_1 U_{H1}) \frac{dz_1^*}{d\tau_2} + (-U_{C2} + \phi_2 U_{H2}) \frac{dz_2^*}{d\tau_2} \leq 0 \quad (10)$$

$$\tau_2^* \left[-U_{C1} + U_{C2} + (-U_{C1} + \phi_1 U_{H1}) \frac{dz_1^*}{d\tau_2} + (-U_{C2} + \phi_2 U_{H2}) \frac{dz_2^*}{d\tau_2} \right] = 0 \quad (11)$$

where U_{C_i}, U_{H_i} denote the marginal utility with respect to consumption and health for individuals of type i . Using (5) and assuming an interior solution with respect to z_i , we can rewrite the first-order conditions as:

$$T : +U_{C1} - U_{C2} = 0 \quad (12)$$

$$\tau_2 : -U_{C1} + U_{C2} = 0$$

or, in other words, the government chooses (T, τ_2) to equalize the marginal utility of consumption across citizens. Using (5) and (12) we obtain that, at any solution in which $z_1^*, z_2^* > 0$:

$$\frac{U_{C1}}{\phi_1 U_{H1}} = \frac{U_{C2}}{\phi_2 U_{H2}} \quad (13)$$

which implies that $\phi_1 U_{H1} = \phi_2 U_{H2}$; since $\phi_1 > \phi_2$, this requires that $U_{H1} < U_{H2}$ at the optimum.

Remark 1. *Suppose that $U_{CH} = 0$. Then $C_1 = C_2$ and $H_1 > H_2$.*

Observe that this follows directly from (13). Notice also that, in an economy in which individuals finance their own health care, the government's only role is to redistribute purchasing power between the two individuals to ensure that - after taking account of the impact of private health care spending and of the differences in the health outcomes for each citizen - the marginal utility of additional consumption is equalized across consumers. Since there is no social aversion to inequality, at the social welfare optimum the type 1 individual is strictly better off than the type 2 person. As the government does not 'rob Peter to pay Paul', there is no reason to collect higher T in order to finance a positive level of transfer τ_i for both individuals. To verify this claim, suppose that $\tau_1^* < \tau_2^*$ and let $2T - \tau_1^* - \tau_2^* = 0$. Clearly, $\tau_2^* = 2T - \tau_1^* = T'$. In other words, we can define a new tax, $T' = 2T - \tau_1^*$ and thereby implement the same allocation as was previously found to be optimal.

Proposition 2. *Suppose that $U_{CH} \geq 0$. Then $H_1 \geq H_2$ and $C_1 \leq C_2$.*

Proof. This follows directly from (13) and (12). To jointly satisfy the requirements that

$U_{C1} = U_{C2}$ and $U_{H1} < U_{H2}$ when $U_{CH} \geq 0$, consumption and health must be inversely related, and the individual with the higher level of health must have the lower level of consumption, e.g., $H_1^* > H_2^*$ and $C_1^* < C_2^*$. It remains to establish that it is person 1 who has the higher level of health. But this follows immediately from the fact that $\phi_1 > \phi_2$: if H_2 were greater than H_1 at the optimum, then an infinitesimal reallocation of resources from individual 2 to individual 1 will increase social welfare. ■

The intuition for this result is simple: since individual 2 is in poorer health, and health care expenditure is less effective, i.e., $\phi_2 < \phi_1$, the government provides a positive transfer τ_2^* to this individual ($\tau_1^* = 0$), and in equilibrium $C_1^* < C_2^*$ because this compensates in part for the relatively poor state of health of this individual.

We now modify this simple economy to consider the impact of providing health care services through a publicly-funded system. To capture the institutional realities of the Canadian health care system, we assume that health care expenditures must be entirely financed by the public sector and that supplementary private health care is prohibited. In this case, the individual citizen has no decision to take, and so the only decision-maker is the government. The government's optimization problem can be expressed as:

$$\max_{T, \tau_2, z_1, z_2} W = U(Y - T, \Psi_1 + \phi_1 z_1) + U(Y - T + \tau_2, \Psi_2 + \phi_2 z_2)$$

subject to

$$2T = \tau_2 + z_1 + z_2.$$

This can be re-written as:

$$\max_{T, \tau_2, z_1, z_2} W = U(Y - T, \Psi_1 + \phi_1 z_1) + U(Y + T - z_1 - z_2, \Psi_2 + \phi_2 z_2)$$

The first-order conditions are:

$$T : -U_{C1} + U_{C2} = 0 \quad (14)$$

$$z_1 : \phi_1 U_{H1} - U_{C2} \leq 0 \quad (15)$$

$$z_2 : -U_{C2} + \phi_2 U_{H2} \leq 0 \quad (16)$$

$$\hat{z}_1 [\phi_1 U_{H1} - U_{C2}] = 0. \quad (17)$$

$$\hat{z}_2 [-U_{C2} + \phi_2 U_{H2}] = 0. \quad (18)$$

Denote a solution to (14)-(17) as $(\hat{T}, \hat{\tau}_2, \hat{z}_1, \hat{z}_2)$.

Remark 3. When income redistribution can be differentiated according to an individual's state of health, $T^* = \hat{T}, \tau_2^* = \hat{\tau}_2, z_1^* = \hat{z}_1, z_2^* = \hat{z}_2$.

Proof. Follows directly from the first-order conditions. ■

For a given distribution of after-tax income there is no difference in the level of health care chosen by the government or by the individual, so when the government can redistribute across consumers on a lump-sum basis, taking into account differences in states of health, the equilibrium outcomes under a private health care system and under a public health care system are identical. There is no positive reason to prefer a private system to a public one, nor any reason to fear public provision. However, what

must be underscored is the fact that the actual pattern of redistribution - under both public and private health care systems - depends upon the relative states of health of consumers. The type 2 individual receives a positive income transfer, τ_2^* , even though pre-tax incomes are the same.

1.4. Two individual, two illness model with horizontal equity

The results above - in particular, the fact that there is no difference between the level of health care spending chosen by the individual under a private health care system or by the government under a publicly-run system - turn crucially on the assumption that the government is able to provide personalized transfers of the consumption good, τ , and that these transfers can therefore be differentiated according to the health state of the consumer. In the real world, of course, tax/transfer systems are subject to horizontal equity constraints: to a very real extent, individuals with the same gross-of-tax income must be left with the same after-tax income, regardless of any other differences in personal circumstances³. In an economy in which the government is constrained by the requirement of horizontal equity on the income tax front, health care spending becomes a second-best tool for pursuing broader redistributive objectives. In this context, the government's problem can be reframed as:

$$\begin{aligned} \max_{T, z_1, z_2} W &= U(Y - T, \Psi_1 + \phi_1 z_1) + U(Y - T, \Psi_2 + \phi_2 z_2) \\ \text{subject to} & \quad 2T = z_1 + z_2. \end{aligned}$$

³Although medical expenses (z_i) may be partially deducted from taxable income in Canada, this is in no way equivalent to make the income tax schedule dependent on H .

with first-order conditions:

$$T : -U_{C1} - U_{C2} + 2\lambda = 0$$

$$z_1 : U_{H1}\phi_1 - \lambda \leq 0$$

$$z_1 (U_{H1}\phi_1 - \lambda) = 0$$

$$z_2 : U_{H2}\phi_2 - \lambda \leq 0$$

$$z_2 (U_{H2}\phi_2 - \lambda) = 0$$

$$\lambda : 2T - z_1 - z_2 = 0.$$

Rewriting, and assuming that $z_1, z_2 > 0$ we have:

$$U_{H1}\phi_1 - U_{C1} + U_{H2}\phi_2 - U_{C2} = 0 \tag{19}$$

$$\Leftrightarrow -(U_{H1}\phi_1 - U_{C1}) = U_{H2}\phi_2 - U_{C2}$$

$$2T - z_1 - z_2 = 0 \tag{20}$$

In interpretation, the net marginal benefit of an additional dollar of health care spending on individual 2 (the less healthy individual) has to be equal to the net marginal cost of one dollar less of health care spending on individual 1 (the healthier individual). We define $(\tilde{T}, \tilde{z}_1, \tilde{z}_2)$ as the solution to (19)-(20).

It is interesting to compare $(\tilde{T}, \tilde{z}_1, \tilde{z}_2)$ with $(T^*, \tau_2^*, z_1^*, z_2^*)$. In particular, we want to examine the way in which the constraint on the capacity of the government to redistribute resources changes the pattern of expenditures on health care.

Proposition 4. *Under horizontal equity, $\tilde{H}_1 \leq H_1^*, H_2^* \leq \tilde{H}_2$, that is, less is spent on the relatively healthy and more on the relatively sick than when health care is purchased privately (or, equivalently, than when policy makers can tie redistributive tax policy to health status).*

Proof. *Under horizontal equity, consumption is equalized for both individuals. Suppose initially that $\tilde{C}_1 = \tilde{C}_2 < C_1^* < C_2^*$. Observe that the lower level of consumption expenditure implies that the government has a larger budget for health care than in the unrestricted case. Then, assuming that H is a normal good, it must be true that $\tilde{H}_1 \geq H_1^*, \tilde{H}_2 \geq H_2^*$. This implies that $U_{C_1^-} \geq U_{C_1^*}$ and $U_{C_2^-} \geq U_{C_2^*}$. From the first-order conditions under the assumption of horizontal equity we know that $2\phi_2 U_{\tilde{H}_2} = 2\phi_1 U_{\tilde{H}_1} = U_{\tilde{C}_1} + U_{\tilde{C}_2} \geq U_{C_1^*} + U_{C_2^*} = 2\phi_1 U_{H_1^*} = 2\phi_2 U_{H_2^*}$ and therefore $U_{H_1^-} \geq U_{H_1^*}$ and $U_{H_2^-} \geq U_{H_2^*}$. But this is impossible because $\tilde{H}_i > H_i^*$ and $\tilde{C}_i < C_i^*$.*

Secondly, suppose $C_1^* < C_2^* \leq \tilde{C}_1 = \tilde{C}_2$. Then, similarly, since government has less resources to spend, and as long as H is a normal good, this implies that $\tilde{H}_i < H_i^*$ and therefore $U_{C_i^-} \leq U_{C_i^*}$. Again since $2\phi_i U_{H_i^-} = U_{C_1^-} + U_{C_2^-} \leq U_{C_1^*} + U_{C_2^*} = 2\phi_i U_{H_i^*}$ then this implies that $U_{H_i^-} \leq U_{H_i^*}$ which contradicts the fact that $\tilde{H}_i < H_i^*$ and $C_i^* \leq \tilde{C}_i$.

The third case is that $C_1^* \leq \tilde{C}_i \leq C_2^*$. Observe that if $\tilde{H}_1 > H_1^*$ then $U(\tilde{C}_1, \tilde{H}_1) > U(C_1^*, H_1^*)$ which implies that individual 1 has been made better off by the imposition of the constraint, which is a contradiction with the fact that $U(C_1^*, H_1^*)$ is the solution for person 1 when there is no horizontal equity restriction. Consequently, it must be true that at the constrained optimum $\tilde{H}_1 \leq H_1^*$. Next observe that if $\tilde{H}_2 < H_2^*$ then, since $\tilde{C}_2 < C_2^*$ it would necessarily be true - via the government's budget constraint - that $\tilde{C}_1 \geq C_1^*$ and $\tilde{H}_1 \geq H_1^*$, which we have just shown is impossible. Therefore it must be

true that if $C_1^* \leq \tilde{C}_i \leq C_2^*$ that $H_1^* > \tilde{H}_1$ and $\tilde{H}_2 > H_2^*$. Note that this in turn implies that $\tilde{z}_1 \leq z_1^*, z_2^* \leq \tilde{z}_2$. In other words, under horizontal equity the gap between health outcomes is reduced. ■

This result can be compared to the results of authors such as Besley and Coate (1991), Blackorby and Donaldson (1988) and Boadway and Marchand (1995), who have drawn attention to the role of imperfect information constraints in justifying public sector involvement in the provision of private goods. In this case, there is no informational asymmetry, but there is an ethical or legal constraint – similar to those, perhaps, that are embedded in the Canadian *Charter of Rights and Freedoms* — that limits the capacity of the government to redistribute resources. The response of the government to this constraint is to seek to make additional effort to redistribute resources to the less healthy individual through the provision of health care.

This result is striking because it suggests - on the one hand - that a publicly-funded health care system is willing to finance ‘heroic treatment’, which individuals would not be willing to pay for themselves. At the same time, the publicly-funded system does not allocate as many resources to ‘well person care’ as these individuals would choose to spend on themselves. This is certainly consistent to some degree with casual empiricism - many patients are offered expensive treatments which are often known to be ineffective, but ‘better than nothing’, while at the same time relatively healthy people are denied publicly-funded treatments that generate greater health benefits than these heroic measures. Notice that this result also provides support for the view that providing ‘in-kind benefits’ - such as home care, housekeepers, or personal care assistants - rather than

additional medical services may be a far more efficient use of public tax dollars because this is in effect a way of redistributing resources via increased consumption rather than via relatively ineffective health care treatment.

1.5. Many individuals, many conditions: A general analysis

Although the results derived above provide important insights into the way in which a welfarist government will use health care spending to pursue redistributive objectives, it is evident that these results are of only limited interest: what is needed is insight into how health care spending will be structured when there are many individuals, many different conditions, and when incomes may differ. As the analysis below shows, however, many of the insights gleaned from the simple two person, two condition model extend naturally to the general case.

In the general setting, the type of an individual will be denoted by i . Individuals with the same type have the same condition and the same income; however, it is possible that individuals of different incomes have the same health condition or, equivalently, that individuals with different health conditions have the same income. As before, however, we require that $\Psi_i \geq \Psi_j$ and $\phi_i \geq \phi_j$ if $i < j$.

To analyze the general case, we start by characterising the outcome if individuals were to finance their own health care out of their after-tax income, and assume that tax revenue is used to finance lump-sum redistribution. In this simple setting, the optimisation problem solved by the individual is identical to that considered in the simple

model:

$$\max_{z_i} U^i = U(Y + \tau_i - z_i, \Psi_i + \phi_i z_i), z_i \geq 0$$

which τ_i is now to be interpreted as a net transfer and can be either positive (transfer) or negative (tax). At a solution to the individual's optimisation problem z_i^* is chosen so that:

$$\frac{dU^i}{dz_i} = -U_c + \phi_i U_h \leq 0 \quad (21)$$

$$\text{and } z_i^* \frac{dU^i}{dz_i} = 0. \quad (22)$$

Turning to the government's problem, this can be reframed as:

$$\begin{aligned} \max_{\tau_1, \dots, \tau_m} W &= \sum_{i=1}^m n_i U(Y_i + \tau_i - z_i, \Psi_i + \phi_i z_i) \\ &\text{subject to } \sum_{i=1}^m n_i \tau_i = 0. \\ &\text{and } z_i^* \text{ solves (21).} \end{aligned}$$

where, in fact, n_i is the number of individuals of type i , and $n_1 + n_2 + \dots + n_m = N$, and N is the total number of people in the economy. The ratio n_i/N is defined as the prevalence of type i individuals. From the problem above we derive the first-order conditions:

$$\begin{aligned} \tau_i &: n_i U_{ci} + n_i (-U_{ci} + \phi_i U_h) \frac{dz_i^*}{d\tau_i} - \lambda n_i = 0 \\ \lambda &: - \sum_{i=1}^m n_i \tau_i = 0. \end{aligned}$$

Using (21), i.e., assuming $z_i > 0$, we obtain that:

$$\tau_i : U_{ci} - \lambda = 0 \quad (23)$$

$$\lambda : \sum_{i=1}^m n_i \tau_i = 0. \quad (24)$$

Denote by $(\tau_1^{**}, \dots, \tau_n^{**})$ the solution to (23)-(24). Observe that, as before, $\lambda = U_{Ci} = U_{Cj} = \phi_i U_{hi} = \phi_j U_{Hj}$ for all i, j for whom health care expenditures are strictly positive: the marginal benefit of an additional unit of health care equals the marginal benefit of an additional unit of consumption, and this is equalized across all individuals. Notice that if individuals i and j differ with respect to their initial income Y but not with respect to their initial state of health, then these first-order conditions require the equalization of both consumption and health for each of these two individuals. In other words, after taxes and transfers, all individuals with the same health conditions achieve the same outcomes. By a straightforward extension of our earlier argument, it is evident that if $U_{CHi} \geq 0$ then health and consumption must be inversely related, and that type 1 individuals must have the best health outcomes: therefore $H_1^{**} \geq H_2^{**} \dots \geq H_n^{**}$ and $C_1^{**} \leq C_2^{**} \dots \leq C_n^{**}$.

1.6. Many individuals, many conditions: Impact of horizontal equity restrictions

As in the two individual, two condition model, it is illuminating to study the impact of horizontal equity restrictions on redistributive policy. By forcing the government to

treat individuals who have identical incomes, but different states of health, as identical for income tax purposes, the government is forced to make greater use of health care expenditures for redistributing welfare. Under horizontal equity the optimisation problem of the government can be reformulated as:

$$\begin{aligned} \max_{T, z_i, i=1 \dots n} W &= \sum_{i=1}^m n_i U(Y - T, \Psi_i + \phi_i z_i) \\ \text{subject to } \sum_{i=1}^m n_i z_i &= NT. \end{aligned}$$

from which we obtain the first order conditions:

$$Z_i : n_i \phi_i U_{h_i} - \lambda n_i = 0 \quad (25)$$

$$T : - \sum_{i=1}^m n_i U_{ci} + \lambda N = 0. \quad (26)$$

Using (25)-(26):

$$\sum_{i=1}^m \frac{n_i}{N} U_{ci} = \phi_i U_{h_i}, \text{ for } i = 1, 2, \dots, n. \quad (27)$$

This relationship indicates that the social marginal benefit of allocating an additional dollar of resources to health care spending on an individual of type i (the right-hand side) must be equated with the social marginal cost of reducing consumption by that same amount.

Proposition 5. *Under horizontal equity, $C_1^* \leq \tilde{C}_1$ and $C_n^* \geq \tilde{C}_n$; similarly, $\tilde{H}_1 \leq H_1^*$*

and $\tilde{H}_n \geq H_n^*$. In other words, the gap between healthiest and least healthy individuals is diminished.

Proof. Suppose that $n = 3$. (The argument can easily be extended for $n \geq 3$). As with two individuals, suppose initially that $\tilde{C}_1 = \tilde{C}_2 = \tilde{C}_3 < C_1^* < C_2^* < C_3^*$. Observe that the lower level of consumption expenditure under horizontal equity implies that the government has a larger budget for health care than in the unrestricted case. Then, since we have assumed that H is a normal good, it must be true that $\tilde{H}_1 \geq H_1^*$; $\tilde{H}_2 \geq H_2^*$; $\tilde{H}_3 \geq H_3^*$. This implies that $U_{\tilde{C}_1} \geq U_{C_1^*}$, $U_{\tilde{C}_2} \geq U_{C_2^*}$ and $U_{\tilde{C}_3} \geq U_{C_3^*}$. From the first-order conditions we know that $3\phi_3 U_{\tilde{H}_3} = 3\phi_2 U_{\tilde{H}_2} = 3\phi_1 U_{\tilde{H}_1} = U_{\tilde{C}_1} + U_{\tilde{C}_2} + U_{\tilde{C}_3} \geq U_{C_1^*} + U_{C_2^*} + U_{C_3^*} = 3\phi_1 U_{H_1^*} = 3\phi_2 U_{H_2^*} = 3\phi_3 U_{H_3^*}$ and therefore $U_{\tilde{H}_1} \geq U_{H_1^*}$, $U_{\tilde{H}_2} \geq U_{H_2^*}$ and $U_{\tilde{H}_3} \geq U_{H_3^*}$. But this is impossible because $\tilde{H}_i > H_i^*$ and $\tilde{C}_i < C_i^*$.

Secondly, suppose $C_1^* < C_2^* < C_3^* \leq \tilde{C}_1 = \tilde{C}_2 = \tilde{C}_3$. Then, similarly, since government has less resources to spend, and given the assumption that H is a normal good, this implies that $\tilde{H}_i < H_i^*$ and therefore $U_{\tilde{C}_i} \leq U_{C_i^*}$ for $i = 1, 2, 3$. Again since $3\phi_i U_{\tilde{H}_i} = U_{\tilde{C}_1} + U_{\tilde{C}_2} + U_{\tilde{C}_3} \leq U_{C_1^*} + U_{C_2^*} + U_{C_3^*} = 3\phi_i U_{H_i^*}$ this then implies that $U_{\tilde{H}_1} \leq U_{H_1^*}$ which contradicts the fact that $\tilde{H}_i < H_i^*$ and $C_i^* \leq \tilde{C}_i$.

The third case is that $C_1^* \leq \tilde{C}_i \leq C_2^* \leq C_3^*$. Observe that if $\tilde{H}_1 > H_1^*$ then $U(\tilde{C}_1, \tilde{H}_1) > U(C_1^*, H_1^*)$ which implies that individual 1 has been made better off by the imposition of the constraint, which is a contradiction with the fact that $U(C_1^*, H_1^*)$ is the solution for person 1 when there is no horizontal equity restriction. Consequently, it must be true that at the constrained optimum $\tilde{H}_1 \leq H_1^*$. Next observe that if by normality $\tilde{H}_2 < H_2^*$ and $\tilde{H}_3 < H_3^*$ then, since $\tilde{C}_2 < C_2^*$ and $\tilde{C}_3 < C_3^*$, it would neces-

sarily be true - via the government's budget constraint - that $\tilde{C}_1 \geq C_1^*$ and $\tilde{H}_1 \geq H_1^*$, which we have just shown is impossible. Therefore it must be true that if $C_1^* \leq \tilde{C}_i \leq C_2^* \leq C_3^*$ that $H_1^* > \tilde{H}_1$. Note, however, that this does not allow us to conclude that $\tilde{H}_2 > H_2^*$ and $\tilde{H}_3 > H_3^*$; using essentially the same argument, it can also be shown that $C_1^* \leq C_2^* \leq \tilde{C}_i \leq C_3^*$ also implies that $H_1^* > \tilde{H}_1$.

Turning now to health expenditure on the least-healthy individual. Suppose that $C_1^* \leq C_2^* \leq \tilde{C}_i \leq C_3^*$. By similar reasoning to that used above, it can be shown that $C_1^* \leq C_2^* \leq \tilde{C}_i \leq C_3^*$ then $\tilde{H}_3 > H_3^*$, and likewise if $C_1^* \leq \tilde{C}_i \leq C_2^* \leq C_3^*$. Therefore, as the result of horizontal equity, the gap in health condition among the individuals decreases, at least for the two individuals on the extreme points. ■

The above result provide an explanation of why it appears to often be the case that publicly-funded health systems "waste" resources. In the real world, income tax systems are to a very large degree insensitive to differences in health status of citizens with otherwise equal incomes. In this sort of policy environment, it is welfare-maximising to overspend on the treatment of individuals in poor health, and to underspend on those in good general health: the fact that the marginal productivity of health care dollars is not equalized across the population should not be interpreted as evidence of poor policy making, but instead as demonstrating that governments understand the connection between the limits to redistribution through the income tax system and the optimal provision of health care services.

An analysis of the comparative statics results with 3 types demonstrates that these are in fact a fairly straightforward generalisation of the results with two individuals and

two conditions. These results are presented in the table below⁴:

$$\begin{array}{cccccc}
\frac{dz_1}{d\Psi_1} < 0 & \frac{dz_1}{d\phi_1} =? & \frac{dz_2}{d\Psi_1} > 0 & \frac{dz_2}{d\phi_1} > 0 & \frac{dz_3}{d\Psi_1} > 0 & \frac{dz_3}{d\phi_1} > 0 \\
\frac{dz_1}{d\Psi_2} > 0 & \frac{dz_1}{d\phi_2} > 0 & \frac{dz_2}{d\Psi_2} < 0 & \frac{dz_2}{d\phi_2} =? & \frac{dz_3}{d\Psi_2} > 0 & \frac{dz_3}{d\phi_2} > 0 \\
\frac{dz_1}{d\Psi_3} > 0 & \frac{dz_1}{d\phi_3} > 0 & \frac{dz_2}{d\Psi_3} > 0 & \frac{dz_2}{d\phi_3} > 0 & \frac{dz_3}{d\Psi_3} < 0 & \frac{dz_3}{d\phi_3} =? \\
\frac{dz_1}{d(\frac{n_1}{N})} > 0 & \frac{dz_1}{d(\frac{n_2}{N})} < 0 & \frac{dz_2}{d(\frac{n_1}{N})} > 0 & \frac{dz_2}{d(\frac{n_2}{N})} < 0 & \frac{dz_3}{d(\frac{n_1}{N})} > 0 & \frac{dz_3}{d(\frac{n_2}{N})} > 0
\end{array}$$

We note that $\frac{dz_i}{d\Psi_i} < 0$. This result follows because when the initial state of health improves, but there is no change in the effectiveness of treatment, the point at which the marginal benefit of an additional unit of treatment equals the marginal benefit of an additional unit of consumption is achieved at lower levels of health care expenditure. Similarly, $\frac{dz_i}{d\phi_i}$ is always ambiguous: an increase in the effectiveness of treatment for condition i means that individuals of type i derive more benefit from a given dollar of health care expenditure, which will tend to increase z_i (substitution effect). However, the fact that treatment has become more effective means that the marginal benefit of additional units of health care services falls more quickly than initially, and it may be that the level of health care expenditure at which the marginal benefit of more units of health care is equated with the marginal benefit of additional units of consumption is achieved at a lower level of z_i than initially the case (income effect). In effect, the impact of an increase in ϕ_i on the demand for z_i can be compared to the impact of the change in the wage rate on the supply of labour.

We note that $\frac{dz_1}{d\Psi_2} > 0$, $\frac{dz_1}{d\Psi_3} > 0$, $\frac{dz_2}{d\Psi_3} > 0$. In each case, an increase in the initial health stock of individuals who are less healthy than person i (or, equivalently, a reduction in

⁴Complete derivations of these expressions are found in the appendix.

the gap in the initial health stock of person i and person $i + j$) leads to an increase in health care expenditure for person i . The reduction in the gap in health care stock reduces the need to redistribute resources across individuals, and therefore leaves person i with greater after-tax wealth. Since health is a normal good, this increases the demand for health care services for those individuals who are ‘relatively healthier’. Analogously, $\frac{dz_j}{d\Psi_i} > 0, i < j$: as the gap between the healthy and the sick increases, it is more socially useful to provide health care services to those in relatively poor health.

The most interesting results are with respect to prevalence. The analysis shows that as the proportion of relatively healthy individuals increases, $\frac{dz_i}{d(\frac{n_i}{N})} \geq 0$, for all i : in other words, when you have a population that is relatively healthier, you do a better job of caring for both the sick and the healthy. This is because a more healthy population is intrinsically a wealthier population: there are relatively fewer sick individuals requiring care, and therefore the existing resources can do a better job of looking after everyone. However, and for the same reasons, if the proportion of relatively sick individuals increases, then $\frac{dz_i}{d(\frac{n_i}{N})} \leq 0, j \geq i$.

1.7. Discussion and conclusions

This paper contributes to our understanding of the role, the optimal scale, and the scope of public health insurance. As might be expected, the analysis shows that in the absence of any constraints on redistribution, the optimal choice of spending on health care in both publicly and privately funded health care regimes is the same. In other words, if individuals were given an amount of cash equal to what the public sector was spending

on health care services, they would spend all of these dollars on health care. However, the interesting lesson to emerge from this case is that there is no optimal top-up rate: the proportion of health care expenditure which a government would choose to fund for an individual may be more or less than 100%. In particular, if there is low therapeutic benefit to treatment, the public sector will redistribute cash to these individuals, rather than paying for treatment.

Unlike much recent research which has argued that asymmetric information is a key reason for public provision of private goods such as health insurance, the analysis presented here demonstrates that when the capacity to redistribute resources through the income tax system is constrained – for example, due to a horizontal equity constraint – then publicly-provided health insurance may emerge as what is in effect a second best solution for redistribution. As a result, individuals who are relatively healthy receive less care than under a privately-funded system whereas individuals who are in poor health receive more care than they would otherwise. From the resource allocation point of view, a further implication of the analysis is that the provision of what is often referred to as primary health care services - such as homecare - to sick people is likely to be highly efficient, particularly as compared to providing additional health care services. These individuals don't need yet another diagnostic examination or test. What they need is services-in-kind which increase the value of consumption thus relaxing the horizontal equity constraint.

There are some interesting implications to be drawn with respect to the impact of prevalence on the funding of health care services. Specifically, if the proportion of the population which is relatively healthy increases, then health care spending of all types

of individuals will increased, which is consistent with observed patterns of spending: countries with healthier populations appear to provide higher levels of health care services to all sections of the population. Similarly, if the prevalence of more serious conditions increases, then spending on all categories of health care services decrease.

There are two interesting avenues for future research. Firstly, the case under which the individuals have different incomes can be analysed. Under the latter, the horizontal equity constraint will be relaxed and the model will be more realistic. Preliminary analysis suggests, however, that this will have little impact on the flavour of the results presented here. A second extension would be to reformulate the characterisation of individual health states as a vector of conditions. Such a reformulation would allow for more insight to be generated into the optimality of funding the treatment of specific pathologies.

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Appendix 1.A

The comparative statics for case 3 conditions, 3 individuals:

$$\frac{dz_1}{d\Psi_2} = \frac{\phi_2 U_{hh2} \left(\frac{n_2}{n} A - \frac{n_2}{n} \phi_2 U_{Ch2} \right) \left(-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3} \right)}{B}$$

$$- \frac{\frac{n_2}{n} U_{Ch2} \left(\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2} \right) \left(-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3} \right)}{B}$$

which is positive unambiguously.

$$\frac{dz_1}{d\phi_1} = \frac{\phi_1 z_1 U_{hh1} \left(\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2} \right) \left(\frac{n_3}{n} A - 2 \frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3} \right)}{B}$$

$$- \frac{\frac{n_1}{n} z_1 U_{Ch1} \left(\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2} \right) \left(-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3} \right)}{B}$$

$$- \frac{\phi_1 z_1 U_{hh1} \left(-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3} \right) \left(\frac{n_2}{n} A - \frac{n_2}{n} \phi_2 U_{Ch2} \right)}{B}$$

which is negative unambiguously when $U_{Ch} = 0$. B is the coefficient matrix of endogenous variables, z_1, z_2, z_3, T .

$$\frac{dz_1}{d\phi_2} = \frac{\phi_2 z_2 U_{hh2} \left(\frac{n_2}{n} A - \frac{n_2}{n} \phi_2 U_{Ch2} \right) \left(-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3} \right)}{B}$$

$$- \frac{\frac{n_2}{n} z_2 U_{Ch2} \left(\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2} \right) \left(-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3} \right)}{B}$$

which is positive unambiguously.

$$\frac{dz_1}{d\Psi_1} = \frac{\phi_1 U_{hh1} (\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2}) (\frac{n_3}{n} A - 2 \frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3})}{B}$$

$$- \frac{\frac{n_1}{n} U_{Ch1} (\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2}) (-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3})}{B}$$

$$- \frac{\phi_1 U_{hh1} (-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3}) (\frac{n_2}{n} A - \frac{n_2}{n} \phi_2 U_{Ch2})}{B}$$

which is negative unambiguously when $U_{Ch} = 0$.

Where $A = \frac{n_1 U_{CC1} + n_2 U_{CC2} + n_3 U_{CC3}}{n} < 0$.

$$\frac{dz_1}{d(\frac{n_1}{n})} = \frac{(z_1 A - U_{C1}) (\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2}) (-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3})}{B}$$

which is unambiguously negative under $U_{Ch} = 0$.

$$\frac{dz_1}{d(\frac{n_2}{n})} = \frac{(z_2 A - U_{C2}) (\frac{n_2}{n} \phi_2 U_{Ch2} - \phi_2^2 U_{hh2}) (-\frac{n_3}{n} \phi_3 U_{Ch3} + \phi_3^2 U_{hh3})}{B}$$

which is negative, as well.

Chapter Two

The Effects of No-fault Insurance System on Accident Measures Across Canadian Provinces

2.1. Introduction

One area where public policy has important effects on individual choices is with respect to the legal liability rules for automobile insurance. An important feature of the liability regime is whether or not the fact that you as the driver of the car that caused the accident can be sued for damages, and what sorts of ceilings (if any) exist to the damages that may be awarded. Fault-based regimes use the courts to determine which party caused the accident (or the relative contributions of both drivers), and the appropriate damages to be awarded. The major drawbacks to reliance on the tort system are the inconsistency of awards made, the cost of using the court system, and the timeliness of judgments. In contrast, pure no-fault regimes do not seek to determine fault, but award damages based on a

uniform schedule. Although no-fault regimes do eliminate court costs, and deliver consistent awards, and seem designed to be more timely than tort-based systems, the major drawback to the no-fault approach is that individuals who suffer severe or catastrophic injuries will typically receive smaller awards for damages under no-fault rules than would be the case under tort.

For the economist interested in the impact of institutions on individual choices, a key question then becomes: How do rules concerning legal liability affect driver behavior? Are drivers in a tort-based system more or less likely to drive carefully than under a no-fault regime? Does switching from a fault-based system to a no-fault one actually have a measurable impact on accident rates? These are important questions – particularly if it can be demonstrated that fatalities are significantly higher under one legal regime than the other.

Over the last twenty years, a significant body of literature has sought to gain insight into the influence of legal liability rules on automobile accident rates. This literature is reviewed below in greater detail. Most of this literature uses data from the US, where there is considerable heterogeneity in the liability rules governing automobile accidents. In contrast, only a couple of studies have examined this question empirically in Canada, and both of them focused on the experience in Quebec (Devlin (1992) and Gaudry (1992)), which introduced pure no-fault insurance in 1978. However, since Quebec introduced no-fault rules in 1978, three other Canadian provinces have followed suit: Ontario, Manitoba and Saskatchewan. Interestingly, the no-fault rules in these three provinces differ substantially: Ontario has a partial no-fault regime with a so-called verbal threshold. In practice, this means that in cases where damages are severe enough, injured parties have the

capacity to resort to the court system to obtain greater compensation. Saskatchewan⁵ also has a partial no-fault regime, but with a monetary threshold and drivers also have the option of choosing whether to purchase insurance that provides them with access to the tort system or whether to continue to be covered under the no-fault regime. Manitoba, like Quebec, has a pure no-fault regime.

In view of the greater heterogeneity that now exists in liability regimes in Canada, and in view of the fact that many more years of data now exist than was the case when the original studies on the Quebec experience were published, it is clearly useful to take a fresh look at the impact of liability regimes on accident rates in Canada. In particular, to the extent that it can be demonstrated that the partial no-fault regimes which exist in Manitoba or Ontario lead drivers to behave differently than they do under pure no-fault or pure tort, this may provide important insights into how best to balance concerns for timeliness and fairness in damage awards against the need to protect lives by encouraging drivers to take appropriate care. It should also be noted that another important difference between the USA and Canada is the existence of publicly-funded health insurance in Canada. All Canadian drivers who are injured in car accidents – whether at fault or not – will have access to care, whereas this is not the case in the United States. This means that the magnitude of the impact of the liability rules in Canada may differ substantively from in the USA, and it is therefore interesting to see whether the empirical evidence suggests that this is true.

This paper undertakes to contribute to the literature on the impact of changes in liability rules on accident rates by looking at the impact of introducing no-fault automobile insurance in Canada . To this end, the paper uses a unique data set spanning seven provinces

⁵ According to the existing literature, e.g. see Schwartz (2000), Saskatchewan's no-fault system is pure. However, there is a slight difference between the no-fault regime that is in place in Saskatchewan and that in Quebec and Manitoba.

and upwards of 30 years. This data set was constructed specifically for this paper, from a variety of primary sources; these are described in greater detail below.

The organization of the paper is as follows: in the second section a review of the literature on the impact of legal liability rules is presented. Section three reviews the various insurance systems across the Canadian provinces. The possible relationship between no-fault and accidents is discussed from a theoretical point of view in section four. Section five describes the data set used for this study, and this is followed by a discussion of the empirical methodology in section six. Section seven presents the different specifications used in the paper. The results are reported and analyzed in section eight, and some post estimation tests are discussed in section nine. Section ten concludes.

2.2. A review of the empirical literature

A significant body of research has examined various aspects of the impact of legal liability rules embodied in auto-insurance policies on the likelihood of accidents. The probability that any given driver is involved in an accident is at least partially a function of the care that they take while behind the wheel. As tort-based and no-fault based auto insurance regimes differ in important ways with respect to the incentives which they provide to drivers to avoid accidents, it is reasonable to predict that the observed accident rates should differ under these regimes. In examining this issue theoretically, the challenge is to adequately model how individuals respond to incentives. If the cost of having an accident increases as a result of a change in insurance regime then, *ceteris paribus*, the individual has an incentive to invest

more in care in order to reduce these accident costs. However, it turns out to be difficult to derive sharp predictions about the impact of the change in the insurance regimes on driver behavior: the theoretical literature has concluded that the net effect of no-fault regimes on expected accident costs can only be determined empirically.

Most of the empirical literature has focused on the U.S. system – which makes sense because there is a great deal of variation in legal regimes across states and jurisdictions, and because of the availability of data. Between 1970 and 1975 various forms of no-fault were enacted by 24 states. Florida, Michigan, New Jersey, New York, and Pennsylvania have verbal⁶ no-fault, while Hawaii, Kansas, Kentucky, Minnesota, North Dakota and Utah have monetary⁷ no-fault. Recently New Jersey, Pennsylvania and Kentucky switched to choice no-fault. Colorado reverted back to the tort liability regime in July 2003⁸. Kochanowski and Young (1985) and Zador and Lund (1986) found that the implementation of no-fault had no effect on the number of fatal accidents, while Landes (1982) found that adopting no-fault led to more fatalities.

Early papers looking at this question using data from jurisdictions other than the US found clearer, although not unambiguous, evidence regarding the consequences of no-fault laws on accidents. Two countries examined in this regard were New Zealand and Canada. In New Zealand after 1978, anyone involved in a traffic accident was indemnified at a rate determined by the state; law suits for additional compensation were prohibited, regardless of who was responsible for the accident. McEwin (1989) conducted an empirical study of this

⁶ Under this regime a victim is eligible to sue for pain and suffering if she crosses a severity line pre-described in the statute.

⁷ Under a monetary regime, lawsuits for non-economic injuries are precluded unless medical bills exceed a pre-determined dollar threshold.

⁸ See the Insurance Information Institute website: <http://www.iii.org/media/hottopics/insurance/nofault/>, Nov. 15, 2008.

system using pooled cross sectional and time series data for New Zealand and Australia for the period 1970 to 1981. He found that switching to no-fault measures increased the number of fatal accidents per capita by 16 percent, all other factors held constant.

In Canada, the Province of Quebec overhauled its automobile insurance regime in 1978. One of the main changes implemented at that time was the switch from a liability-based automobile insurance regime to a purely no-fault one for all accidents involving bodily injuries. Devlin (1992) examined the impact on accidents arising from the switch to pure no-fault insurance adopted in Quebec. She used data from Ontario and Quebec over the 1966-84 period and found an increase in fatal accidents of 9.6%, in bodily-injuries of 26.74% and in property damages of only 5.33%. Gaudry (1992) also examined this change in regime but using different methodology. He concluded that adopting pure no-fault in Quebec increased fatalities, injuries and property damages by 7 %, 24 % and 9 %, respectively.

Several more recent papers examining the impact of no-fault in the United States have also generally concluded that no-fault regimes increase accidents. Sloan et al. (1994) studied the effect of various policies, including tort and no-fault insurance, on motor vehicle fatalities per 1000 population for three age groups (18-20, 21-24, and 25-64) using data from the US Fatal Accident Reporting System (FARS) over the period 1982-90. Unlike earlier research, this study used a broader sample of tort and no-fault insurance systems. More specifically, the tort liability insurance includes three variables: dram shop liability⁹, compulsory liability insurance, and compulsory liability insurance drinking under the influence (DUI) surcharge. Moreover, no-fault insurance is measured by four variables: the fraction of claims barred from tort liability, compulsory personal injury insurance, pure

⁹ “A typical dram shop law provides that a commercial server of alcoholic beverages may be found liable for accident costs from injuries caused by their patrons” (Sloan, 1994, p. 55).

comparative negligence¹⁰, and modified comparative negligence¹¹. They found that the fatality rate for drivers above the age of 21 increased by 18 % if the fraction of claims barred from tort liability (proxy for no-fault indicator) rises from 0 to 0.25. Also, the motor vehicle fatality rate of adults increased when individuals were required to purchase first-party personal insurance protection policies without barring claims from tort liability. In contrast, moving from contributory to various forms of comparative negligence rules¹² was not found to have any significant effect on accidents. However, if the fraction of automobile claims barred from tort liability and compulsory personal injury insurance were used as proxies, Sloan et al. found significant and positive effects on fatal accidents for adults and for the population age above 64, but not for youth.

Using a US closed-claims accident survey data set, Devlin (1999) examined whether or not no-fault insurance measures affect the severity of accidents. Eight classes of severity were used in this paper, which employed an ordered probit procedure. The author concluded that no-fault measures in the US have led to an increase in the severity of accidents of about two to four percent.

Cummins et al. (2001) investigated the effect of no-fault insurance on fatality rates, for all US states over the period 1968-94. The authors controlled for the potential endogeneity of no-fault laws by using the Mill's ratio method and also by using the claims ineligibility ratio in an IV estimation. The predicted value from a reduced-form Tobit

¹⁰ "The pure comparative negligence rule is identical to negligence with a defense of contributory negligence when only the injurer is at fault, but when both injurer and victim fail to satisfy the due care standard, accident costs are divided according to each party's relative contribution to the accident" (Sloan, 1994, 57).

¹¹ Under the comparative negligence rule, an injurer will not be liable for accident losses he causes if he takes due care (Shavell, 1987). Liao and White (2002) treat the comparative negligence rule as equivalent to a pure tort system. "Under modified comparative negligence in some states a plaintiff is barred from recovery if the injurer's degree of negligence is greater than or equal to the defendant's, while in some other states the plaintiff is not compensated if the injurer's negligence is greater than the defendant's" (Sloan, 1994, p. 57).

¹² "Under contributory negligence rule an injurer is required to compensate victims for the full amount of their losses if the injurer is found negligent and the victim is not" (Liao and White 2002, p. 263).

regression with the proportion of ineligible claims that are refused by the insurance companies as the dependent variable was used as instrument for the no-fault variable in the IV procedure. The authors also accounted for the stringency of the no-fault laws by using an IV estimation technique and multinomial logit model. In almost all of the models estimated, they found that the estimated coefficient on the no-fault indicator is positive and statistically significant, i.e., adopting no-fault liability insurance led to a higher fatal accident rate. The increase in the fatality rate was estimated to fall in the range of 13-14 percent using the no-fault indicator variable regressions, and was found to be around seven percent when using the claims ineligibility ratios.

Loughran (2001) used quite a different method to investigate the relationship between no-fault insurance and accident fatality rates as well as the driver care level. He employed a difference-in-difference approach using US data in 16 states between 1971 and 1976 and found that there was no significant relationship discernible between having no-fault rules in place and higher accident rates (or lower driver care).

Cohen and Dehejia (2004) examine the effect of two types of laws, compulsory insurance laws and no-fault liability laws, on driver behavior and traffic fatalities across the fifty U.S states and the district of Columbia over the period 1970-98. This paper is the first to take into account the fact that all states that adopted no-fault insurance also adopted compulsory insurance requirements. They employed an instrumental variables (IV) approach and use compulsory insurance as an instrument for the proportion of uninsured motorists on the road. Among other things, they demonstrated that having automobile insurance was associated with significant moral hazard from the perspective of the driver. They also concluded that no-fault liability insurance had a significantly positive relationship with

traffic fatality rates. Based on their calculations, the adoption of no-fault rules increased fatality rates by six percent.

In addition to looking at accidents, a number of researchers have examined other facets of the liability-insurance question. Carroll and Kakalik (1993) examined whether or not the compensation received under no-fault insurance is actually any different from that which would have been received under a liability system. Using data on compensation received by people injured in automobile accidents during the late 1980s they developed a simulation model relating accident victims' injuries and losses to their expected automobile insurance compensation under specified no-fault plans in tort states. They also simulate the compensation under 21 different no-fault plans and then compare this to the actual compensation received. These simulations allowed these authors to measure the effect of shifting from the traditional tort plan to a no-fault one on transaction costs, economic and non-economic losses and on the timelines of compensation took place. They concluded that although the effect of a specific no-fault plan will not be the same across all states, transaction costs clearly fell in no-fault states. No-fault liability insurance favored economic losses over non-economic losses (e.g., pain and suffering), and it paid compensation, on average, two months sooner than the traditional plans. These findings led Carroll and Kakalik (1993) to conclude that no-fault plans generated considerable transactions cost savings as compared to the traditional tort system.

Other researchers have tried to explain the factors behind the adoption of the tort or no-fault legal systems. In order to deal with the endogeneity of the decision to implement no-fault, Cummins and Weiss (1992) estimated a probit model and found that the political stripes of the governor of the state matters meaning that democrats favored one system while republicans favored the other. Devlin (2002) used data from 1972-90 for all US states to

examine the factors influencing the adoption of different types of no-fault regimes. She concluded that the structure of the insurance industry and the type of rate regulation were among the most influential determinants of the types of no-fault insurance regime adopted.

Some jurisdictions in the United States have introduced a so-called “choice” system whereby drivers may opt for no-fault or liability coverage. New Jersey, Pennsylvania and Kentucky implemented “choice” in 1989, 1990 and the 1975, respectively (Schmit and Yeh 2003), enabling motorists to reject the lawsuit threshold and retain the right to sue for any auto-related injury.¹³ Carroll and Abrahamse (1998), by using simulations, looked at the impact of this choice on insurance premiums and administrative costs. They found that choice could reduce automobile insurance premiums by 24 percent in relation to the tort system and also results in more consistent reimbursement of the injured.

Using claims data from New Jersey and Pennsylvania for two specific years, 1987 (pre-choice) and 1997 (post-choice), Schmit and Yeh (2003) examined the effect of adopting choice on three dependent variables: attorney usage (which they interpret as administrative waste), settlement duration (speed of payment) and variability in payments (equity). New Jersey switched in 1989 from a no-fault to a choice system, while Pennsylvania switched from a tort to a choice system in 1990. The results showed that attorney involvement, settlement duration and variability in payments have increased in New Jersey. In contrast, they found weak evidence of decreased attorney usage and lower settlement duration in Pennsylvania, but strong evidence of increased variability in payments relative to loss. Further analysis of tort versus no-fault (after the introduction of choice) did

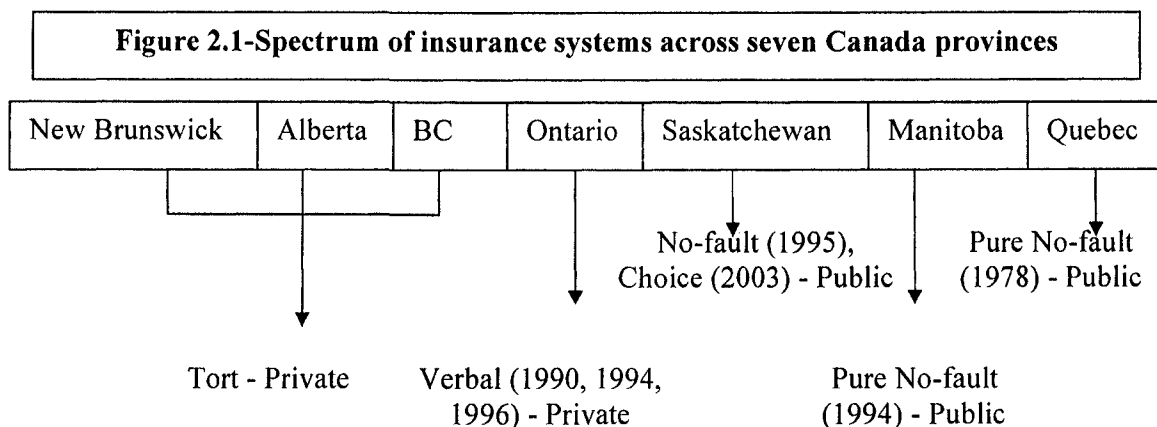
¹³ See the Insurance Information Institute website: <http://www.iii.org/media/hottopics/insurance/nofault/>, Nov, 15, 2008.

not provide clear evidence of lower administrative costs, or of speedier or more equitable payments for those who chose no-fault in New Jersey and Pennsylvania.

Aside from the early research looking at the Quebec experience, not much research has been undertaken with the Canadian data. This is a bit surprising given the large changes that have occurred in the Canadian automobile insurance landscape in recent years. Over the past decade or so, three other provinces have implemented no-fault measures: Ontario first introduced partial no-fault measures in 1990, and then modified them in 1994 and 1996; Saskatchewan introduced no-fault in 1995 and added a 'no-fault choice' system on 2003, while Manitoba introduced pure no-fault rules in 1994. Therefore, one open question that this paper attempts to answer is that how implementing those new compensation regimes influenced the accident measures. Also, how the no-fault's impacts have been different across different provinces. In addition, how the other determinants of the insurance market reinforced or dampened the effect of no-fault on accidents. We turn now to a detailed description of the automobile insurance systems in the seven Canadian provinces under investigation in this paper.

2.3. A review of insurance systems across Canada

The analysis of this paper uses data collected from seven provinces. Four of these provinces have some form of no-fault insurance (Ontario, Saskatchewan, Manitoba and Quebec), while three are strictly liability based (New Brunswick, Alberta and British Columbia). In addition, four provinces have publicly-run insurance systems (British Columbia, Saskatchewan, Manitoba and Quebec). We depict the different types of insurance regimes in figure 2.1.



Under a pure no-fault system, as exists in Quebec and Manitoba, all accidents involving bodily injuries are subject to no-fault provisions and there is no right to sue for additional damages. In a verbal system, there is a verbal threshold that must be met in order for the tort rules to apply. The verbal threshold in the Ontario insurance system is that a person who sustains “permanent serious disfigurement” or a “permanent serious impairment of an important physical, mental or psychological function” (Ministry of Finance, 2003, p.19) has the right to sue for non-economic losses. A monetary threshold specifies the monetary loss that must be sustained by a victim of an accident before he or she may sue for additional damages.¹⁴ In what follows, key features of the insurance regimes in each of the provinces included in this study are presented, and changes that each regime has undergone are also discussed.

2.3.1. New Brunswick

The New Brunswick insurance system is tort-based and is operated by the private sector. Standard insurance coverage includes medical payments to a limit of \$50,000 per person

¹⁴ For more detailed information on insurance legal systems and their characteristics refer to Tables 2.A1, 2.A2 and 2.A3 in the appendix.

including rehabilitation, excluding health insurance plans per year for a four year period. New Brunswick experienced a rapid escalated insurance cost claims during 2001-2003, leading the government to implement some reforms. The most important reform, in 2003, was the introduction of a cap of \$2,500 on court awards for pain and suffering with respect to minor, non-permanent injuries sustained in car collisions.¹⁵ A “No Frills” policy (IBC, 2005, p.13) was recently introduced whereby a driver has the option of selecting reduced accident benefits coverage for a lower premium. Under this option medical, funeral, death, income replacement and home support benefits are cut in half.¹⁶

2.3.2. Alberta

Private insurers operate the car insurance market in Alberta. Accident victims may sue for pain and suffering, but damages for non-pecuniary losses related to all minor personal injuries are limited to \$4,000. The compulsory minimum third-party liability is \$200,000 for any accident. However, if a claim involving both bodily injury and property-damage reaches this figure, payment for property damage is capped at \$10,000 (IBC, 2005, p.15)

Alberta also experienced rising insurance costs over the last 5 years, which led the government to implement a number of reforms to the system. In October 2003 a freeze was placed on premiums, and this was followed by comprehensive reforms on October 1, 2004, when the Alberta government implemented legislation that introduced a Maximum Benchmark Premium Grid. The grid imposes a ceiling on premia for mandatory private passenger automobile insurance coverage.¹⁷ This Grid ties the premia for mandatory coverage (Third Party Liability and Accident Benefits) to the driver’s record of at-fault auto insurance claims, the driver’s driving record (tickets, etc.) and the records of other licensed

¹⁵ http://www.ibc.ca/en/car_insurance/nb/reforms.asp. Nov. 3, 2008.

¹⁶ Public Utilities Board, (2005) p. 15.

¹⁷ <http://www.airb.gov.ab.ca/gridrate/> Nov. 3, 2008.

drivers in the household.¹⁸ The reform package also set up the Automobile Insurance Rate Board, and mandated the Board with setting premiums for basic coverage, monitoring premiums for optional coverage, and reviewing and approving rating programs for new insurers entering the Alberta market.¹⁹

2.3.3. British Columbia

The Insurance Corporation of British Columbia (ICBC) is a provincial Crown Corporation established in 1973 to provide universal auto insurance to BC motorists. It also has responsibility for driver licensing, and vehicle registration and licensing.²⁰ All motorists in BC must take out a basic package of insurance. The basic Autoplan is “the minimum amount of insurance any vehicle must carry to legally operate in British Columbia.”²¹ This package is only provided by ICBC but it can be bought from any Autoplan brokers. The basic package of ICBC provides third party liability coverage accident benefits, underinsured motorist protection, hit-and-run and uninsured motorists protection and inverse liability. However, it does not include coverage outside Canada and the USA.²²

Since 1976 property-damage coverage has also been provided by private insurers. ICBC competes with other automobile insurance companies by offering extended third-party liability and other optional insurance coverage such as collision and comprehensive coverage. Third party liability coverage provides protection for bodily injury, death or property-damage up to \$200,000 (\$1 million for taxis and buses) as well as legal, investigative and court-ordered interest in the claim. Compensation for medical payments is subject to a

¹⁸ <http://www.autoinsurance.gov.ab.ca/consumers.html>, Nov. 3, 2008.

¹⁹ <http://www.airb.gov.ab.ca/about.html>, Nov. 3, 2008.

²⁰ http://www.icbc.com/inside_icbc/corpinfo.asp, Nov. 3, 2008.

²¹ http://www.icbc.com/insurance/insura_getsta.asp, Nov. 3, 2008.

²² http://www.icbc.com/inside_icbc/corpinfo.asp, Nov. 3, 2008.

ceiling of \$150,000 per person; this includes rehabilitation but excludes amounts payable under surgical, dental, hospital plans or received from other insurers (IBC, 2005, p. 13).

2.3.4. Ontario

Automobile insurance, which is provided by private insurers, has been mandatory for Ontario drivers since 1979. At that time a modest benefit schedule was introduced for automobile accident victims, regardless of who was at fault (Ministry of Finance, 2003, p. 5). However, an accident victim's access to any meaningful compensation required going to court. Following publication of the Osborne Report (1988), and in searching for a balance between no-fault benefits and access to the court, the government of Ontario reformed the system by introducing a partial no-fault scheme, with a so-called "verbal threshold".²³ The new rules were announced in 1990, and came into effect on June 21, 1990 (Brown 1998, 414). In 1994 and 1996 the eligibility rules for suing in tort (along with benefit levels) were changed. Bill 164, promulgated in 1994, lowered the tort threshold for non-economic losses (pain and suffering), changed the verbal threshold of "permanently injured and serious conditions" to just "seriously injured", and also eliminated the right to sue for economic losses (Brown 1998).

By 1995, medical and rehabilitation claims costs had risen to 800 million dollars annually, up from 200 million dollars in 1990 (Ministry of Finance, 2003, p. 7) resulting in rapidly rising premiums. Under pressure from insurers, lawyers and claimants the government introduced Bill 59, "*The Automobile Insurance Rate Stability Act*" (AIRSA) which restored access to tort damages for economic losses. In the case of economic loss in excess of no-fault benefits, an injured person has the right to sue for 80% of net income loss

²³ The verbal threshold that one must meet to sue for pain and suffering is that a person has sustained a "permanent serious disfigurement" or a "permanent serious impairment of an important physical, mental or psychological function" (Ministry of Finance, 2003, p. 19).

before trial, 100% of gross after trial; also injured persons can sue for medical, rehabilitation and related costs when the injury is catastrophic (IBC, 2005, p.14). In general, these changes in the system can be viewed as returning to the 1990 version of no-fault in terms of tort rights. More recently, in 2004, the Government of Ontario made a significant change to its liability insurance provisions by increasing the deductible for pain and suffering awards from \$15,000 to \$30,000 (Public Utilities Board, 2005, p. 15).

2.3.5. Saskatchewan

The Saskatchewan Government Insurance Corporation (SGI) was created in 1945 and has evolved into two distinct operations, the Saskatchewan Auto Fund and SGI.²⁴ The former is the province's compulsory auto insurance program and also manages the driver licensing and vehicle registration system, while the latter is a competitive entity, selling insurance products and operating in seven Canadian provinces: Saskatchewan, Alberta, Manitoba, Ontario, Prince Edward Island, Nova Scotia and New Brunswick.

In 1981 SGI increased liability coverage from \$35,000 to \$100,000 and then to \$200,000 in 1985 (The Council of Atlantic Premiers, 2003 p. 65). The SGI experienced an increase in claims costs over the period of 1988-1993. According to the 'Annual Report' of SGI, because of the high cost of injury claims in 1994, the Auto Fund suffered a loss of \$93.8 million, compared to \$18.9 million of 1993. In 1995 Saskatchewan abolished fault-based coverage except for the right to take legal action for economic loss whenever the injured person's gross earnings exceed \$50,000 per year²⁵. "No-fault measures were introduced in 1995 as part of the SGI's cost cutting strategy" (The Council of Atlantic Premiers, 2003 p. 65).

²⁴ http://www.sgi.sk.ca/sgi_pub/about_sgi/corporate_structure.htm. Nov. 3, 2008.

²⁵ This number is indexed such that this threshold changes over time with inflation. In 2008, the number is \$67,762.

On January 1, 2003, the Saskatchewan government introduced a choice no-fault system under which residents can opt out of the no-fault Personal Injury Protection Plan (PIPP) in favor of a tort plan. Under the tort option some benefits regardless of accident circumstances are provided, and there is the right to sue for pain and suffering for those who opt in to the liability system, subject to a \$5,000 deductible (IBC, 2005, p.14). Everyone is covered by the no-fault insurance plan unless they choose to opt into the tort coverage. In the Saskatchewan's public insurance market, government and private insurers compete for optional and excess coverage (IBC, 2005).

2.3.6. Manitoba

Manitoba Public Insurance (MPI) was established in 1970 and is a non-profit provincial Crown Corporation that has provided basic automobile coverage since .²⁶ It offers a variety of automobile insurance options, including Basic Autopac (introduced in 1971), Optional Autopac²⁷ and Special Risk Extension coverages.²⁸ The Basic Autopac coverage is mandatory in Manitoba and covers personal injury, all perils collision or third party liability claims.²⁹ Due to a considerable increase in injury claim costs for the years prior to 1994, and based on the recommendations of the Kopstein Report, Manitoba implemented a pure no-fault compensation scheme similar to that in the province of Quebec (The Council of Atlantic Premiers, 2003). The system is run by the government; however government and private insurers compete for optional and excess coverages (IBC , 200).

²⁶ http://www.mpi.mb.ca/english/about_us/about.html. Nov. 3, 2008.

²⁷ "Basic all-perils coverage insures vehicle and any permanently attached equipment against accidental loss or damage in Canada or the U.S. the insured pays the deductible and any depreciation —the Autopac coverage pays the rest. It covers damage from collision, "upset" (car or truck tips or rolls over), other causes (the insurance term is "comprehensive"), such as vandalism, theft, hail, and fire" (http://www.mpi.mb.ca/english/insurance/basic/ap_what_is_it.html), Nov. 3, 2008..

²⁸ Special Risk Extension Coverage is an optional extensions to basic Autopac and some other coverages like primary coverages for vehicles exempt form Autopac (<http://www.mpi.mb.ca/english/sre/sre.html>).

²⁹ <http://mpi.mb.ca/english/insurance/insurance.html>. Nov. 3, 2008..

2.3.7. Québec

Following the publication of the Gauvin Report on the Quebec automobile insurance system in 1974, the Quebec Government introduced a pure no-fault system for bodily injuries in 1978. A public monopoly, now called the SAAQ (Société de l'Assurance Automobile du Québec), was established to provide bodily-injury coverage. In 1992, in order to make more incentives for road safety, the rate-setting scheme for bodily injuries was modified to include a bonus-malus system based on demerit points obtained from drivers' violations of the Road Safety Code (Dionne 2001). As a pure no-fault insurance regime, there is no right to sue for pain and suffering, nor for economic losses in excess of no-fault benefits. The 1978 reform made liability insurance compulsory but kept the right to compensation for vehicular damages under the traditional liability regime, which is administered by the private sector (Dionne, 2001). The amount of compulsory third party liability is \$50,000.

2.4. Theoretical framework: linking no-fault insurance and accidents

It has long been recognized that individual behavior changes when there is access to insurance. A rich theoretical literature has been developed which models this moral hazard within a variety of contexts. The literature linking the legal regime to insurance and automobile accidents stems back at least to Calabresi's (1970) and Posner's (1972) important work on law and economics, and has been subsequently enriched by Shavell (1980), Polinsky (1980), Boyer and Dionne (1989) among others. The literature is reviewed in Danzon and Harrington (1991).

The basic idea is as follows: risk-averse individuals want to minimize the cost of having an accident, subject to the constraint that they gain sufficient utility out of driving. As a result, the coverage in the event of an accident and the price per unit of coverage crucially influence how carefully they drive. Clearly, one of the factors influencing the level of care is the legal regime under which the victim is compensated. Under a liability-based scheme, coverage is based on whether or not the individual takes appropriate driving care, whereas under a no-fault based scheme, it does not. In both schemes, premia usually depend upon the driving record.

Accordingly, after choosing the level of care by maximizing expected utility, the effect of the legal regime on the level of care can be examined. Typically, the final effect on accidents of having no-fault system is ambiguous: on the one hand, expected accident costs fall because the individual is indemnified irrespective of fault (which leads to a lower level of care, *ceteris paribus*), but on the other hand, because the individual cannot sue for pain and suffering and other losses above the no-fault cap (or cannot sue at all in pure no-fault regimes), this may encourage individuals to drive more carefully (e.g., Cummins et al. 2001, Cummins and Weiss, 1992, and Devlin, 1992).

The following model illustrates the relationship between the legal regime and the level of care.³⁰ The level of care is assumed to be observable. In addition, no time dimension is considered in order to avoid complexity.

A typical driver minimizes the expected costs by solving

$$\text{Min } ETC = \lambda(x)(x + \pi(x) + \ell - q(x)) + (1 - \lambda(x))(x + \pi(x)) \quad (1)$$

Where:

x : level of care (it can be interpreted as cost of care)

³⁰ This model is adopted partly from Devlin (1992); see also, Cummins and Weiss (2001, 1999, and 1992).

$\pi(x)$: insurance premium as a function of level of care (risk classification system), where

$$\pi_x < 0,$$

ℓ : total loss associated with accident, including economic and non-economic losses,

$q(x)$: total amount of compensation where $q_x > 0$ under liability regime and $q_x = 0$ under no-fault regime,

$\lambda(x)$: probability of occurring an accident, where $\lambda_x < 0$.

$TC = x + \pi(x) + \ell - q(x)$ denotes the total cost associated with being a driver who has an accident, and $TC = x + \pi(x)$ denotes the total cost associated with being a driver who does not have an accident.

Depending on the level of care and the liability regime, three cases can be identified. The first case arises under the liability system when $x < \bar{x}$, and where \bar{x} is the minimum level of care that the court determines must be met in order to be deemed to not be at fault and hence eligible for compensation under liability rules. In this situation, the first order condition becomes:

$$\lambda_x (\ell - q) + \pi_x - \lambda q_x = -1 \quad (2)$$

In contrast, when $x \geq \bar{x}$, then the first order condition becomes:

$$\pi_x = -1 \quad (3)$$

whereas under a no-fault system the first order condition is:

$$\lambda_x (\ell - q) + \pi_x = -1 \quad (4)$$

The left hand sides of (2)-(4) show that the marginal benefit of taking one extra unit of care is equal to -1, which is the marginal cost of one extra unit of care. The differences on the left-hand side of these expressions show how the marginal benefit of an extra unit of care

depends upon the regime in place. In the case that $x < \bar{x}$, the term $-\lambda q_x$ exists on the left hand side. This term represents the decrease in compensation under liability system when the required minimum level of care determined by court is not met by the driver in the case of accident. λ_x is the decrease in the probability of an accident associated with taking one more unit of care; $(\ell - q)$ is the uncompensated amount of the loss; π_x is the decrease in the insurance premium arising from one extra unit of care and q_x is the increase in the level of coverage as a result of taking one extra unit care.

As can be seen from the above relations, the level of care under no-fault will be lower than that under tort when $x \geq \bar{x}$. However, whether or not care is higher under tort when $x < \bar{x}$ depends upon q_x , which reflects how sensitive the coverage is with respect to care. As pointed out by Dionne (2001), a comparison of (2)-(4) reveals that one way to dampen the negative impact of no-fault insurance on care is by introducing a more sensitive risk classification system, i.e., $\pi_x^{NF} > \pi_x^{Tort}$. In particular, if the total loss is covered by the no-fault insurance regime, i.e., $l = q$, then the level of care under no-fault and tort is the same.

From a more practical perspective, the impact of no-fault rules on driving behavior clearly depends upon how premiums respond to the accident experience of individuals.³¹ Cummins and Weiss (1992) showed that the negative impact of a no-fault regime on the level of care is mitigated with the tort threshold – a smaller threshold means that more claims are eligible for the tort system; and is further mitigated with the implementing of an appropriate risk classification system.

³¹ Note that while a no-fault regime compensates individuals regardless of fault, insurance premiums typically react to the accident proclivity of individuals – and this is usually undertaken by assigning fault among the parties based on the circumstances of the accident.

2.5. Data

The data used in this paper were collected from a wide variety of sources, as described in appendix B of this chapter. The data set spans seven Canadian provinces: Quebec, Manitoba, Saskatchewan, Ontario, British Columbia, Alberta and New Brunswick. The choice of provinces and the length of the period under investigation were dictated primarily by the availability of the data. It is important that the data be comparable across all of the jurisdictions in order to facilitate pooling together the information. All provinces with no-fault measures are present in the data set. The final data set constitutes an unbalanced panel, with the data running from 1975 to 2005 for Quebec, from 1982 to 2004 for Manitoba, from 1977 to 2004 for Saskatchewan, from 1978 to 2004 for Ontario, from 1982 to 2004 for British Columbia from 1982, from 1982 to 2005 for Alberta and from 1980 to 2004 for New Brunswick.³²

The dependent variables in this study are the number of fatal, personal injury and property-damage-only accident rates by province and by year, defined as fatal, personal injury and property-damage-only accidents per 100,000 licensed drivers. A detailed description of the data is presented in table 2.1 which defines all the variables used in the analysis, and table 2.2 presents descriptive statistics for the variables by province.

The main variables of interest to this paper concern the number of accidents over time and across provinces. The data distinguish between three types of accidents: fatal,

³² The data on personal injury and property-damage accidents for New Brunswick are available for 1984-2004.

personal-injury and property-damage-only accidents. As detailed later on, the most pertinent accident variable is fatal accidents as these are not subject to the type of reporting biases which may arise for the other kinds of accidents.

The first three variables in table 2.2 indicate the average number of fatal, personal injury and property-damage-only accidents that occurred over the period under study – for the sample as a whole, and by province. These figures are not very meaningful, however, because of the large differences in size across the various provinces: the average population in Ontario was 10.4 million individuals, while it is less than one million individuals in New Brunswick. Thus, these accident figures are normalized by dividing through by the number of licensed drivers in the province (suffix “l”).

If we look, for instance, at fatal accidents per licensed drivers, we see that there is quite a bit of variation in this figure across the jurisdictions: it varies from a low of 15.4 fatal accidents per 100,000 licensed drivers in Ontario, to 25.9 in Quebec. The largest personal injury accident rate is found in Manitoba, with 1,229 per 100,000 licensed drivers, while the lowest is in Alberta, with 759 personal injury accidents per 100,000 licensed drivers. Saskatchewan distinguishes itself with having the highest property-damage-only accident rate, at 4,376 per 100,000 drivers, while the lowest rate is found in Ontario with 2,300 accidents per 100,000 drivers.

Looking at the average over the period of study, however, paints only a partial picture. Figure 2 presents the number of fatal accidents per 100,000 licensed drivers by province by year. It is interesting to observe that these accident rates appear to be falling over time and converging to the same rate. The data on personal injury accidents are presented in figure 3, and on property-damage-only accidents in figure 4. In these cases, while the trend is negative, convergence across the provinces is certainly not evident.

Figure 2.2: Number of fatality accidents per 100000 licensed drivers across Canadian provinces

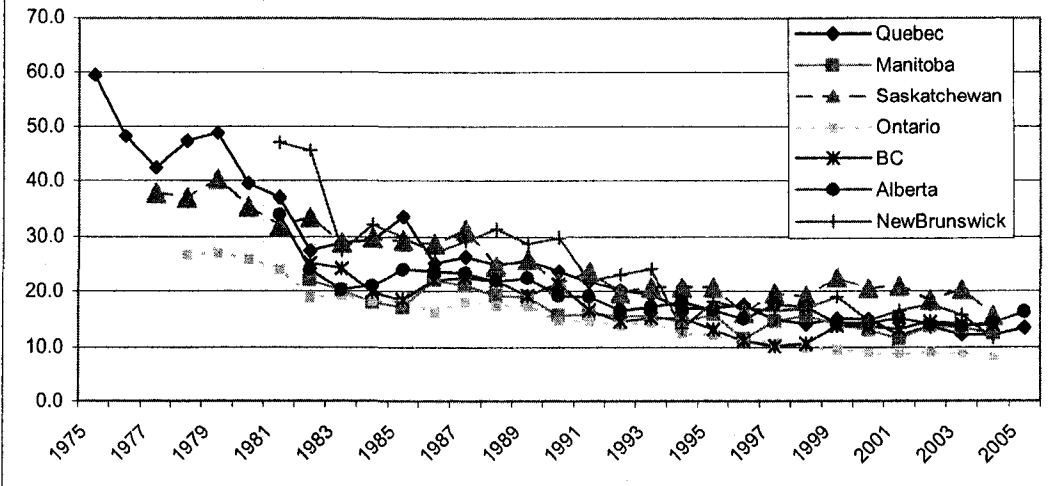
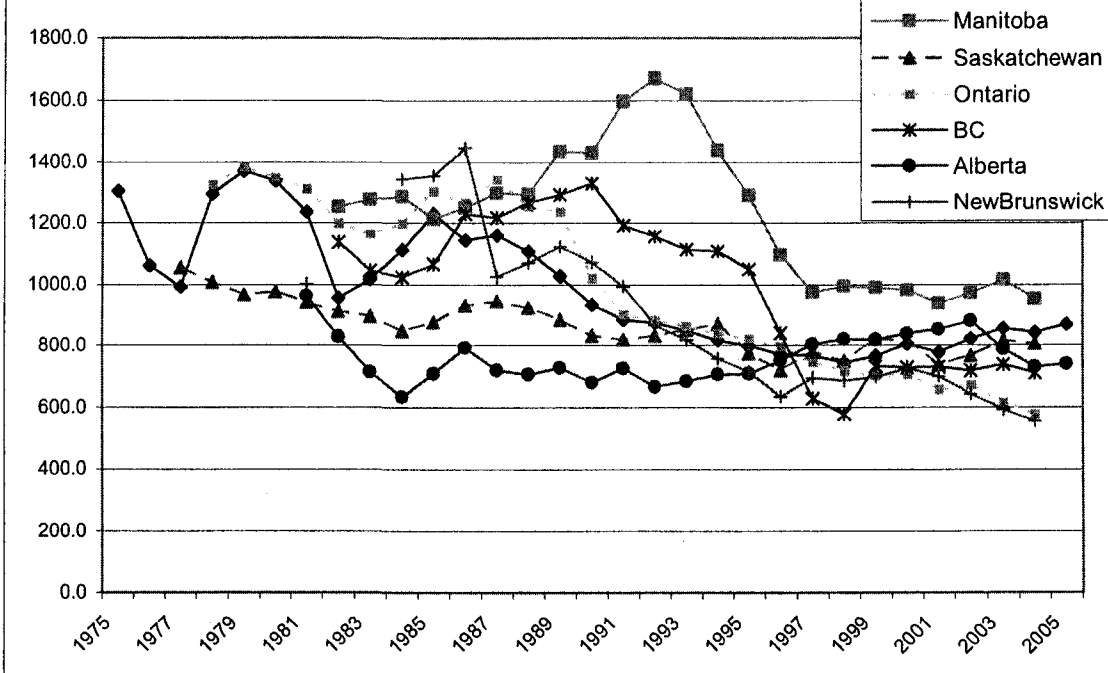


Figure 2.3: Number of personal injury accidents per 100000 licensed drivers across Canadian provinces



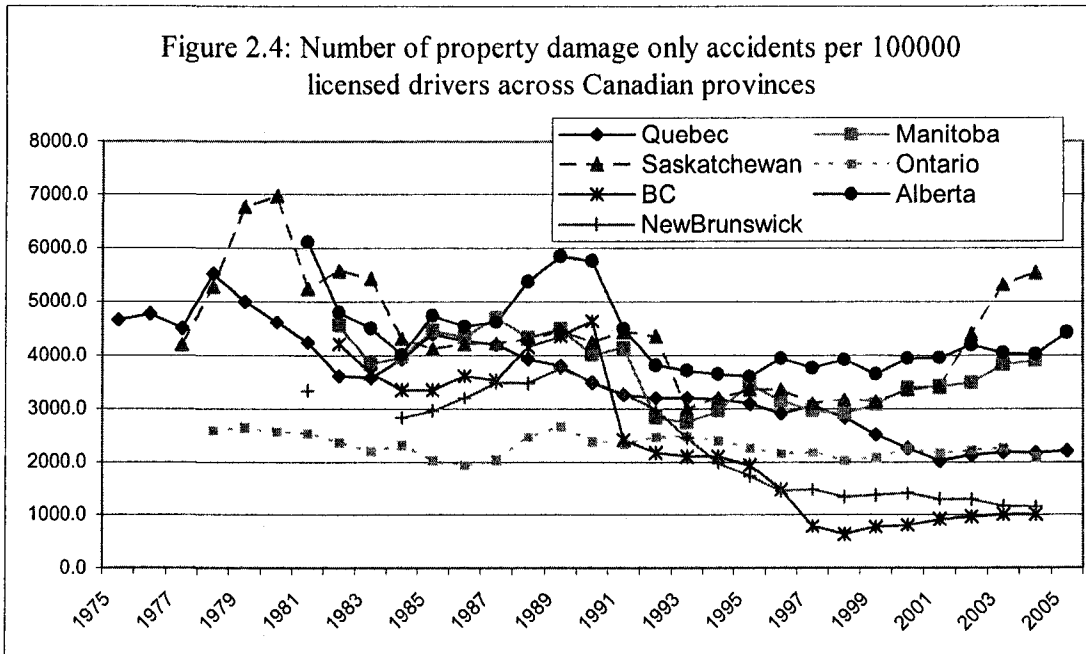


Table 2.2 also reveals quite a bit of variation across the variables that will help to explain the accident rates. The variable YOUNG represents the proportion of the population made up of individuals who are in the age range 16 to 24 years. We see, for instance, that British Columbia has the lowest proportion of young individuals – at 14.3% of the population – as compared to 16.2% in Saskatchewan. POPULATION65+ shows the proportion of the population with age 65 and over with Saskatchewan with the highest proportion, 13.4%, and Alberta with the smallest proportion, 9.1 percent. The number of criminal code traffic offenses plus impaired traffic offenses per 100,000 populations (OFFENCE) varies from a low of 547 in Manitoba to a high of 1,454 in Saskatchewan. The number of police officers per 100,000 populations goes from 168.3 in Alberta to 207.1 in Saskatchewan. Average provincial income is highest in Ontario and lowest in New Brunswick. Based on an index of insurance premiums, Ontario has the highest value among those seven provinces. Table 2.3 shows the correlation among the variables that have been used in this study.

2.6. Empirical model

The main objective of this study is to examine how switching from negligence rule to no-fault rule affected driver care in the provinces of Quebec, Manitoba, Saskatchewan and Ontario. We do this by examining fatality, personal injury and property-damage-only accidents. The basic model that is estimated has the following specification:³³

$$A_{it}^j = \beta' X_{it}^j + \varepsilon_{it}^j, \quad i = 1, 2, \dots, 7 \quad \text{for } j = 1, 2, 3 \quad (5)$$

where:

A_{it}^j = the measure of accident rate (accidents per licensed driver) for province i , at time t , for category j which j = fatal (fatal accident), pi (personal injury) and pd (property-damage only),

X_{it}^j = the vector of explanatory variables including no-fault dummy variable³⁴,

β = the vector of parameters of interest, and

ε_{it}^j = the error term for the equation.

The variables included in the models follow, as much as possible, the empirical work in the literature. The model includes demographic variables: the proportions of the population aged 16-24 and also 65 and more, the population (in 100,000s), real disposable income per capita; five policy variables: the presence of a Graduated Driver Licensing system, risk-classification system, Administrative Driver License Suspension (ADLS), enacting mandatory seat belt law, and Short-term Administrative Suspension (SAS) program;

³³ See, for instance, Devlin (1992), Cummins et al. (2001, 1999), and Cohen and Dehejia (2005).

³⁴ For some specifications, three different variables are used to represent pure, verbal and semi-monetary no-fault.

number of criminal code offences and police officers per 100,000 population under study; and variables capturing the driving environment, including data on the total rainfall and snowfall observed during the year.³⁵ Dummy variables to capture any time invariant heterogeneity across the provinces and effects specific to particular calendar years are included in all of the panel data models in this paper. These province dummy variables are included to control for heterogeneity across provinces, like province-specific policies and driving behaviors, not being picked up by the other explanatory variables in the equations. Time variables capture time-variant influences not being picked up by the other regressors in the model. For example, we would expect these time effects to pick up the increased safety of automobiles and other vehicles over time; similarly, advancements in the construction of roads may also be captured through these variables. We expect these variables to have negative estimated coefficients.

Economic theory predicts, on one hand, that individuals with a higher level of income are less likely to have an accident, *ceteris paribus*, because of tendency of positive correlation between income and level of education (Cummins et al., 2001), and the fact that a higher level of schooling is associated with having fewer accidents. On the other hand, a higher income can be associated with more accidents because the opportunity cost of time is greater for the affluence, and this will therefore lead to more risk-taking (Cummins et al., 2001)). While older individuals are expected to have fewer accidents because they are more mature, more experienced and more risk-averse than are younger ones, the decreasing reaction time of older drivers can also lead to more accidents. We expect that the higher the population and the more vehicles on the road, the more congested the road system will be, and the more accidents that will be observed.

³⁵ http://www.climate.weatheroffice.ec.gc.ca/climateData/monthlydata_e.html, Nov. 3, 2008.

The impact of the number of traffic criminal code offenses on accidents per 100,000 population is ambiguous, ex-ante. On the one hand, this may reflect a tightening up of traffic vigilance and hence could be associated with fewer accidents; on the other hand, it may indicate a greater prevalence of riskier driving behavior. The same ambiguity exists for the sign of the variable indicating the number of police officers per 100,000 populations.

The effect of adverse weather conditions on traffic accident rates can be mixed. It can encourage drivers to proceed more carefully, hence reducing accidents (or their severity); it could also increase accidents because drivers are not making the appropriate adjustments.

Public policies also affect accidents. Overall, five variables are captured by dummy variables: the presence of a risk classification system, the presence of a Graduated Driver Licensing program (GDL), enacting mandatory seat belt laws, adopting Administrative Driver's License Suspension (ADLS) and Short term Administrative Suspension (SAS) program system and any changes in the maximum speed limit that occurred over the period of study.

Graduated Driver Licensing systems are designed to help reduce accidents caused by young drivers. Therefore we expect to find a negative relationship between the GDL policy and accident rates; however the effect of this variable depends partly on the proportion of young drivers to all drivers as well.

Most of the provinces have made some changes to the different indicators (especially age, gender and marital status) used for classifying the risk category of drivers. The risk classification variable is a dummy variable which is intended to capture changes to the risk classification system of the different provinces. In British Columbia age, gender and marital status were eliminated as rating variables in 1979 and a program called FAIR was

introduced.³⁶ In 1988, ICBC implemented changes which tie premia to the value and age of the vehicle, the territory where the insured vehicle is principally operated, the purpose for which the vehicle is used, the claims record of the owner and the individual's driving record.³⁷ In Saskatchewan, the individual's at-fault accident history and driving record over the previous three years have determined the level of surcharges levied on the driver since 1988. In Manitoba prior to 1986, rating variables were age, gender and marital status. Since then premiums have been based on the type and principal use of the vehicle with surcharges levied in accordance with a schedule of demerit points (The Council of Atlantic Premiers, 2003 p. 30). In 1992 in Quebec, the SAAQ modified the rate-setting scheme for bodily injuries to include a bonus-malus system based on demerit points resulting from drivers' violations of the *Road Safety Code* (Dionne, 2002). Alberta introduced a grid system in 2005 obliging insurance companies to compare the premium charged any given driver under their current rating program to the premium indicated on the grid; drivers are then charged the lesser of the two premiums. The other two provinces, Ontario (see Brown, 1998) and New Brunswick, have not implemented any significant changes to their risk classification systems over the periods covered by the data in this study. The dummy variable for changes in the risk classification system is assigned a value of one whenever any changes are made in the rating variables.

The Short-term Administrative Suspension (SAS) program deals with the so called "DWI" (driving while impaired) drivers. Police checkpoints, more severe penalties for offenders, and preliminary breath testing were among the many measures implemented to

³⁶ This program treated all motorists as safe drivers until proven otherwise.

³⁷ Also, the ICBC implemented a bonus/malus system with factors including value, use of and garage location of the vehicle along with annual surcharges ranging from \$115 to \$3000 based on drivers' accumulated penalty points (www.icbc.com/inside_icbc/pdf/bcuc/icbc_final_reply_submission_rate_design.pdf), Nov. 3, 2008..

increase general deterrence by using this program (Beirness and Singhal, 2007). In contrast, the Administrative Driver's License Suspension (ADLS) deals more with cases of driving-related violences, e.g., driving while disqualified, speeding, and driving unregistered vehicles. Table 2.4 shows the years that different policies have come into effect for each province. Based on these explanations, table 2.5 provides the expected signs of the coefficients to be estimated.

Of course, having too many dummy variables in the model due to not having enough independent variation can be problematic in terms of interpretation of the results. A specific example is the graduated licensing system in Ontario which was adopted in 1995; however, Ontario also changed key features of the liability rules for auto insurance in 1990, 1994 and in 1996. Therefore, we need to interpret the findings with respect to the 1994 and 1996 liability changes with some caution – knowing that they may include the impact of the GDL change as well. Another partial issue is the adoption of the choice system in Saskatchewan on June 1, 2003 - the same year that its maximum speed limit changed from 100 km/h to 110 km/h on rural highways. We need, again, to exercise caution when interpreting the results from the choice variable.

2.7. Specifications

The paper examines the relationship between no-fault insurance and accident rates by estimating equation (5). One important question is how to measure the presence of no-fault. The simplest way to capture the no-fault regime is to include a dummy variable which takes on the value of one when this regime is in place, and zero otherwise. Using this specification,

we estimate the basic accident equation (equation 5) using two approaches. The first approach treats no-fault adoption as an exogenous decision and uses the Feasible Generalized Least Squares (FGLS) procedure for panel data that includes provincial and time effects. FGLS automatically corrects for possibility of heterogeneity of cross-section time-series (CSTS) data. The second approach recognizes the possibility that the adoption of no-fault is endogenous, and is related to the accident rate. In effect, jurisdictions with particularly high accident rates, especially personal injury accidents, are more likely to introduce a no-fault regime in order to control costs and premiums.

Another issue that arises is that not all no-fault regimes are the same. In particular, as shown in figure 1, there are three main types of regimes: pure no-fault (as is the case in Quebec and Manitoba), a semi-monetary threshold regime (Saskatchewan), and a verbal threshold regime, Ontario. A fourth regime can also be defined: in 2003 Saskatchewan introduced a “choice” system whereby drivers can decide whether to be covered under its no-fault or liability regimes.

2.7.1. No-fault as an exogenous variable

The analysis of this paper pays close attention to the impact of introducing no-fault insurance on the fatality rate: the fatality rate is not subject to reporting errors and hence provides a good indicator of how driving care is affected by the regime in place. When the no-fault regime is categorized into three groups - pure, verbal and semi-monetary - it is not possible to address the potential endogeneity of the regime using the Mill's ratio approach. Thus, only

one estimating strategy, i.e., treating no-fault as exogenous, is used when no-fault is measured in this way.³⁸

For all of the models estimated in this paper, the province of New Brunswick is the reference province. To capture the modifications that were made to the no-fault regimes in Ontario and Saskatchewan, three dummy variables - including two for Ontario 1994 and 1996 and one for Saskatchewan 2003 - are included into the model. The expected effect of the Ontario 1994 changes is ambiguous: on the one hand, the verbal threshold in relation to non-economic losses was decreased, leading to the possibility of more tort actions for non-economic losses, and hence fewer accidents, *ceteris paribus*. On the other hand, the right to sue for any economic loss was eliminated, which as we mentioned before can lead to fewer or more accidents. In 1996, “even though the right to sue for some economic loss was restored, likely exerting a negative effect on accidents, but it did tighten up the threshold returning” (Brown, 1998, p. 417), in effect, to the 1990 no-fault version.

After implementing the choice system in Saskatchewan, drivers could opt out of the no-fault plan (which is the default plan) and chose a tort-based one instead. The origin of the choice system goes back to the O’Connell-Joost proposal on 1986.³⁹ Going from a no-fault system to a choice system should, *ceteris paribus*, lead drivers to be more careful. In effect, one would expect more low-risk drivers to opt into the tort option because of the possibility to pursue the drivers at fault. Most of the existing literature on choice system deals with the financial implications of the system, ignoring its impact on driving care and accidents.⁴⁰

³⁸ We also applied a multinomial procedure to take into account the possibility of endogeneity of no-fault decision by different types (pure, semi-monetary and verbal). Due to insufficient variation in the data, the results were not reliable.

³⁹ “A system in which motorists would have the option to select either traditional liability or no-fault insurance.” (O’Connell and Joost 1986, 63).

⁴⁰ However, in the next chapter, which uses a micro-level dataset for Saskatchewan drivers involved in accidents, it is shown that an increase in severity of accidents followed the adoption the no-fault system in 1995.

2.7.2. No-fault as an endogenous variable

It may be that governments choose to switch to a no-fault regime because of high premiums (related to more personal injury claims), or discontent with the current insurance regime. Thus, the policy decision to go to a no-fault regime is endogenous, depending upon the prevailing insurance conditions. From an econometric perspective, one can account for the endogeneity of the no-fault decision using an instrumental variable technique, but appropriate instruments have to be found. In my model, the insurance premium index and whether or not the insurance regime is public or private are both used as instruments.

An examination of the history of those Canadian provinces that switched to no-fault shows that most of them adopted no-fault after experience rapid increases in premia, usually because of paying considerable amounts for injury claims (e.g. see Cummins 2001). If higher premia are the result of higher accidents rates, then the premium index is not an appropriate choice of instrument: the premium index should be used as an instrument only if there is zero correlation between accident measures and insurance premium. However, the relationship between accident rates and increases in the premium index is unlikely to be contemporaneous. Also, the switch to no-fault insurance usually happens after increases in claims in bodily injury accidents, rather than in fatal and property-damage-only accidents (e.g., see Cummins et al. 2001).

Whether or not the insurance system is publicly or privately operated arguably affects the probability of a no-fault regime as it has been explained in Devlin (2002) and Cummins et al. (2001), but is not related to accident rates – particularly not the fatal accident rate. The first reason is that the three principal players in the insurance market, namely consumers, insurance companies and lawyers, can lobby the government to affect the making decision

regarding the insurance legal system, and the response of public and private government to each of these lobbies may differ. Devlin (2002) provides a comprehensive list of variables that are most likely affect the decision on adopting no-fault regime. Among those variables there is “political affiliation”. Devlin argues that since no-fault insurance is a kind of government intervention in the market, some provincial governments may be more inclined in this direction than are other ones. A second reason why some provincial governments are likely to be more supportive of a specific type of insurance regime is that provinces where the insurance scheme is publicly operated are already involved in the insurance market, and consequently switching from a negligence-based regime to a non-negligence-based regime is be easier for the these provinces as compared to those where insurance is provided by private firms. Lastly, provinces with publicly-provided insurance presumably are more reluctant to incur the costs associated with the long process of determining fault that typifies a tort-based regime.

Two separate approaches are used to take into account the possibility of endogeneity of no-fault decision; a Mill’s ratio technique and an IV methodology. The former procedure introduced by Heckman (1976) and Lung-Fei Lee (1978) and applied by Cummins and Weiss (2001) in the insurance context, which assumes that there is an unobserved effect in the error term that affects the dependent variable differently across the no-fault and liability provinces. Following this procedure we endogenize the no-fault variable by estimating a probit model for the decision to switch to a no-fault regime and then calculating the Mill’s ratio from the estimated error structure of this regression. The underlying model is thus:

$$NF_{it} = \alpha' Z_{it}^f + \omega_{it} \quad (\text{Probit model, first stage}) \quad (6)$$

$$A_{it} = \delta' X_{it} + NF_{it} \varepsilon_{nit} + (1 - NF_{it}) \varepsilon_{pit} + \eta_{it} \quad (\text{Second stage}) \quad (7)$$

Where

NF_{it} = dummy variable presenting the adoption of no-fault insurance system (1) or not (0) of province i at time t ,⁴¹

A_{it} = is the measure of accident rate (here, accidents per licensed driver)⁴²,

X_{it}, Z_{it} are the vector of explanatory variables (RHS variables) for accident rate and no-fault equations, respectively, in which the latter includes all variables in the former vector plus two extra variables as instruments,

$\varepsilon_{nit}, \varepsilon_{fit}$ = are random error terms for no-fault states and tort states, respectively, in equation (7).

α, δ = the parameters of interests for no-fault and fatal accident, respectively, and

ω_{it}, η_{it} = the error term associated with those two models.

For (6) and (7), the endogeneity problem arises if ω_{it} in equation (6) is correlated to ε_{nit} or ε_{fit} in equation (7). In other words, if having no-fault regime in place is systematic rather than random, then the parameters estimates would be inconsistent. X_{it}, Z_{it} vectors are the same except for at least one extra variable which exists in no-fault but not in the accident rate equation.

For the Mill's ratios methodology, we use the predicted probability that province i has a no-fault law in place as an instrument for no-fault, based on a reduced-form probit equation. The Mill's ratio is calculated in the following way:

$$\text{Inverse - Mills - ratio} = \frac{f(\alpha'Z_{it}^f)}{F(\alpha'Z_{it}^f)}, \quad (8)$$

⁴¹ The no-fault variable is actually a latent variable which can be defined as the sentiment to adopting no-fault insurance by the province.

⁴² The analysis was also undertaken with accidents per registered vehicle; the results were not affected.

Where $f(\cdot)$ and $F(\cdot)$ are standard normal density and distribution function. Incorporating these two ratios into the accident model yields:

$$A_{ii} = \delta'X_{ii} + \gamma(NF_{ii} * \frac{-f(\alpha'Z_{ii}^f)}{F(\alpha'Z_{ii}^f)}) + \lambda((1 - NF_{ii}) * \frac{-f(\alpha'Z_{ii}^f)}{(1 - F(\alpha'Z_{ii}^f))}) + \eta_{ii}' \quad (9)$$

As can be seen, the no-fault Mills ratio is interacted with the no-fault dummy variable, and the tort Mills ratio is interacted with one minus the no-fault dummy variable.

For the instrumental variable (IV) methodology, based on a reduced form probit equation that was used to calculate the Mill's ratios (equation 6)), the predicted probability that province i has a no-fault law, i.e. $F(\alpha^f Z_{ii}^f)$, is calculated and used as the instrument for no-fault.

There is a slight difference in the interpretation of the results obtained using the Mill's ratio (or Heckit) versus those obtained using IV techniques.⁴³ When we use the Heckit approach, it is assumed that the endogeneity enters through the sample selection process, and does not affect the behavioral equation directly: we are not likely to observe all of the provinces that could make the switch. In contrast, for the IV approach, although the estimating equation is affected by the endogeneity, it is assumed that the sample is selected randomly: in theory, all provinces can be observed.

2.8. Results

2.8.1. Impact of no-fault on accidents: single variable

From the results reported in table 2.6, it is interesting to note that regardless of the specification and empirical model employed, the presence of no-fault insurance measures

⁴³ I am grateful to Professor David Gray for drawing my attention to this difference in interpretation.

appears to be associated with an increase in fatal accidents.⁴⁴ For Ontario, the changes made to the original no-fault regime in 1994 and 1996 did not have any additional impact (over and above the effect of the introduction of no-fault in 1990) on fatal accidents or on personal injury accidents, whereas both of the subsequent changes seem to have increased property-damage-only accidents. However, we should keep in mind that the changes in the no-fault regime on 1994 and 1996 may also reflect the impacts of two other policy variables, namely the effect of Graduated Driver Licensing on 1994, and the ADLS (administrative driver's license suspension) law, which came into effect on Nov. 29, 1996.⁴⁵

The move to a choice regime in Saskatchewan in 2003 appears to have had a positive impact on just property-damages and, in some specifications, on personal injury accidents but not on fatalities. One reason why the move to the choice system did not have much of an impact on accidents is that very few people switched to tort. According to Saskatchewan Government Insurance (SGI), the total number of individuals that chose the tort program was 4187, 4993, 5327 and 5585, respectfully, over the 2003-2006 period – numbers which are very small relative to the 670,000 licensed drivers (less than 1 percent) in that province but increasing. We expected that any move toward more liability, like the choice option, should decrease accidents. However, the fact that the maximum speed limit changed from 100 km/h to 110 km/h in 2003 may also be wiping out any effect from the introduction of choice.

The impact of no-fault on personal injury accidents is positive but insignificant; suggesting that the introduction of the no-fault regime has not increased the personal injury

⁴⁴ As it is shown in appendix C2, and based on the Wooldridge test of serial correlation of order one, there is no first-degree autocorrelation in the underlying model (the first specification without taking into account any endogeneity). The Wooldridge test for serial correlation in panel data does not reject the null hypothesis; suggesting no serial correlation of order one exists in the panel.

⁴⁵ Under ADLS law, “if a driver is charged with refusing to provide a breath sample or driving with a blood alcohol level over 80 mg%, his or her driver's license is suspended by the Registrar of Motor Vehicles, for a period of 90 days, at the time the charge is laid” (Ontario Ministry of Transportation website, <http://www.mto.gov.on.ca/english/index.html>), Nov. 3, 2008..

measure significantly. This result is a bit unexpected. Ex ante, we expected that the number of bodily-injury accidents would increase after the introduction of no-fault, for two reasons. First, to the extent that care fell (which is consistent with our findings of increased fatal accidents), then we would expect personal injury accidents to increase as well. Second, under no-fault, there is incentive to report a personal injury accident, because of the first-party compensation provisions. Thus, whereas in a tort system a minor injury may be ignored by an at-fault driver, the no-fault system would encourage the reporting of such injuries. The finding that PI accidents did not increase may be explained, at least partly, by offsetting changes in the distribution of the severity of accidents, which could be caused by any economic reasons or for totally orthogonal factors.⁴⁶ The most severe PI accidents became fatal accidents, and some property-damage-only accidents became PI accidents, and that this adjustment at both tails of the distribution cancelled each other out in terms of the total number of all PI accidents, *ceteris paribus*.

The effect of no-fault on property damage-only accidents is positive and significant, under both specifications, i.e., with and without taking account of the endogeneity of implementation of no-fault. Since the minimum reportable levels for property damage-only collisions have risen over time, we also control for that by including dummy variables for those years in which this level has risen in order to capture the changes that have been made into the reporting systems of property damage-only accidents. The dummy variables that have been included to capture increases in the minimum damage necessary before an accident must be reported by province are BC91, Alta91, Sask84, Sask93, Sask2002, Man92, Ont85, Ont98, Que79 and Que98.

⁴⁶ In Chapter Three, which examines the effect of no-fault and choice regimes in Saskatchewan, we find that no-fault is associated with more severe injuries.

We can use the estimated coefficients on the no-fault dummy variables to determine by how much the introduction to no-fault rules influenced accidents. Table 2.8 presents the estimated overall effect of introducing no-fault measures on the number of each type of accidents for the two specifications presented in table 2.6. Overall, the effect seems to be in the 4.24-6.22 percent range for fatal accidents and 5.49-6.79 for property damage-only accidents. In other words, adopting the no-fault regime increases the rate of fatal and property-damage accidents by almost 5 and 6 percent on average, respectively. However, the overall effect of no-fault on personal injury is not significant.⁴⁷

Table 2.8: Percentage change in different types of accidents due to introducing no-fault⁴⁸

Type of accident	Non-endogenous	Endogenous	
		Mill's ratio	IV
Fatality	4.24	6.22	5.65
Personal injury	-	-	-
Property-damage	5.49	6.79	6.32

Average-FatalL=20.68, average-Fatal=465.45, average-PIL=954.88 and average-PI=23912, average-PDL=3254.75 and average-PD=74349.

- =insignificant (because of insignificance of no-fault variable on personal injury for overall effect no percentage effect has been calculated).

Using the IV approach, which is shown in table 2.9, generates very similar results to the Mill's ratio approach. The magnitudes of the coefficients, especially for no-fault, are very close. Comparing the results for the two specifications, with and without taking account of the endogeneity of the implementation of no-fault, shows that even though the magnitudes of

⁴⁷ The elasticity, E, was calculated as: $E = \hat{\beta} \frac{1}{\bar{y}}$, where $\hat{\beta}, \bar{y}$ represents the estimated coefficient on the no-

fault dummy variable and the average of fatal accident/licensed driver. After calculating the elasticities, the numbers are adjusted in order to provide the elasticities based on the absolute number of fatal accidents (and not adjusted by the licensed drivers).

⁴⁸ Using the average number of fatal and property damage accidents just for no-fault provinces instead of average for all provinces, the percentage increases are 3.45, 5.07 for cases of without endogeneity and with endogeneity fatal accidents and 4.67 and 5.77 for property damage accidents, with and without endogeneity of no-fault decision.

some variables do change, the sign and significance level of almost all of the variables remains the same. The magnitudes of the no-fault variable for the various equations are much higher under the no-fault endogenous case as compared to the non-endogenous case (3.09 versus 4.54 and 640 versus 790 for fatal and property-damage-only accidents, respectively).

Table 2.10 presents the range of effects found in the main papers in the literature on the effects of no-fault on fatalities. By and large, the quantitative effects of no-fault insurance on fatality rates of these different studies are comparable with the results reported here. On average, we find that no-fault insurance is associated with a 4.24 to 6.22 percent increase in fatal accidents, which is generally consistent with the estimates found elsewhere.

Table 2.10: Comparing the numerical results of no-fault insurance on fatal accident (%) among different studies

Devlin	Cummins et al.	Cohen and Dehejia	Landes	McEwin	Our results
9.6	2.7-17.3 (median=13.8)	7-10	2-14	16	4.24-6.22*

* The numbers for no-fault insurance that have been used are based on taking into account endogeneity and non-endogeneity of no-fault decision.

2.8.2. Impact of no-fault on accidents across provinces

Rather than including one dummy variable to capture all of the no-fault regimes in Canada, we also run the models with three different no-fault variables, one for pure no-fault provinces, Quebec and Manitoba, one for Saskatchewan's semi-monetary no-fault and one for Ontario verbal no-fault. We have not distinguished the pure no-fault regimes in Quebec and Manitoba separately for two reasons. First, both of these two provinces have pure no-fault regimes in place. Second, separating these two will lead to unreliable results for the Quebec no-fault effect, as only a small number of observations exist for the period before adopting

no-fault in Quebec (1975-1977 i.e. 3 years).⁴⁹ Even though, Saskatchewan's no-fault regime is pure, we separated this province because we believe that the type of the no-fault system in this province is slightly different from the systems implemented in the other two pure no-fault provinces.

Re-estimating the model with these specifications confirms our earlier results and provides some interesting insights into the spectrum of no-fault regimes across the provinces. The estimated results for the fatal accident model when the no-fault regimes are separated are presented in table 2.11. The impact of introducing no-fault rules on fatal accidents remains positive and statistically significant: the impact is highest for the provinces with pure no-fault, Quebec-Manitoba, with 6.29 percent, followed by the semi-monetary threshold province, Saskatchewan, with 4.11 percent. The lowest impact is associated with the verbal threshold no-fault regime, Ontario, which is almost insignificant.

The following table, which is calculated based on table 2.11, shows the percentage effect of the accident rates with respect to no-fault insurance regime across various regimes.

Table 2.12: Percentage change in different types of accidents due to introducing no-fault across provinces

Type of accident	Quebec-Manitoba (pure)	Saskatchewan (semi-monetary)	Ontario (verbal)
Fatality	6.29	4.11	-
Personal injury	4.93	-	-6.71
Property-damage	9.3	-	-

Average-FatalL=20.68, average-Fatal=465.45, average-PIL=954.88 and average-PI=23912, average-PDL=3254.75 and average-PD=74349.

- =insignificant

The percentage effects of no-fault insurance system in table 2.12 show that there is a positive correlation between the strictness of no-fault and its effect on fatal accidents. Pure

⁴⁹ We estimated the model with four no-fault dummy variables, separating Quebec and Manitoba as well, but the result on Quebec is not robust: the standard deviation of Quebec no-fault changes dramatically, which makes inference unreliable.

no-fault provinces, i.e., Quebec and Manitoba have the highest magnitudes, followed by Saskatchewan with the semi-monetary threshold regime and finally Ontario with a verbal threshold.

Regarding the impact on the personal injury measure, running the model while distinguishing among the three different no-fault regimes shows that the effect is not symmetric across the different regimes. A pure no-fault regime shows a positive impact, consistent with Devlin's study (1992) on Quebec, while the effect of Saskatchewan's semi-monetary system is positive as well but insignificant, and the verbal system shows a negative impact of no-fault on personal injuries. This may explain why the overall impact of adopting no-fault on personal injury accidents reported in the previous section was not found to be significant.⁵⁰

Property damage-only accidents have been increased by introducing no-fault just for pure no-fault provinces; Quebec and Manitoba. The impact for the other two regimes, monetary and verbal, is not significant.

In table 2.11, another specification of the model is examined under which two dummy variables are including representing the risk classification system of the province of Quebec and all other provinces. This is because we believe that introducing the bonus-malus system in Quebec on 1992 was a different and more serious change than the changes in the risk-classification system in other provinces. However, this did not lead to any significant changes with respect to the results reported for the base specification.

⁵⁰ In order to see whether or not this statement is true, we re-ran the model excluding Ontario, and we observed a significant impact of no-fault on personal injury.

2.8.3. Determinants of accidents (except no-fault variables)

Based on the results reflected in table 2.6, the estimated coefficient on YOUNG – the percentage of the population aged 16-24 – is consistently positive and statistically significant only for property-damage-only accidents. The sign of this variable for the fatality equation is negative but insignificant, and for the personal injury equation is positive but insignificant as well. The more young people there are on the road, the more accidents, *ceteris paribus*, but not necessarily the more fatal and personal injury accidents. This result for fatal accidents is not consistent with what is found using US data. For instance, Cohen and Dehejia (2005), find an increase of 5.92 fatalities per 10,000 persons as a result of a one percentage increase in the population aged 18-24 and Cummins et al. (2001) find an increase in the range of 39.377-66.632 in the fatal accident rate (total fatal accidents per 10 million vehicle miles) as a result of a one percentage point increase in the percentage of drivers aged 18-24. One possible explanation may be the high correlation of this variable with the other variables in the equation, e.g., 0.64 and 0.55 with the proportion of population of age 65 years and more and POLICE, respectively.

Population65+ has an insignificant effect on fatal accidents, a positive and significant impact on personal injury accidents and a negative and insignificant effect on property-damage accidents. As explained before, the sign of this variable is theoretically ambiguous.

The measure of congestion, i.e., population, has a positive effect on the fatal and property-damage equations, although the effect is not significant for the former one. The effect on personal injuries is mixed, but is generally negative. This variable also is highly correlated with the Ontario province dummy (0.77) and with Income (0.54), which may be part of the reason for not getting the expected sign for this variable.

The results for the income variable are also mixed, which is not unexpected: the higher the per capita income of the population, the more accidents, *ceteris paribus*. However, this effect is insignificant for fatal and personal injury accidents whereas it is statistically significant for property-damage accidents. Cohen and Dehejia (2005) find a statistically significant but mixed (negative and positive) income coefficient while Cummins et al. (2001) find that a one unit increase in income increases the accident rate at the range of 0.010 and 2.03.

The estimated coefficient on the precipitation variable is positive and statistically significant for most of the models. This means that an increase in precipitation – rain and snow – leads to a higher rate of accidents: in other words, the negative impact of high precipitation is outweighing any increase in care brought about by bad weather conditions. This result is at odds with the findings in Cummins et al. (2001) which report a negative effect on accidents from their annual snowfall variable. While the impact of precipitation on fatal accidents is positive for all models, the effects on personal-injury and property-damage-only accidents is positive, and most of the time is significant. However, it does not appear to have as strong effect as it did on fatalities.

The number of criminal code traffic offences per 100,000 is associated with fewer fatal and personal-injury accidents. In general, as mentioned earlier, the expected sign of this variable is ambiguous. Our findings are suggestive of a deterrence-type effect. The results for this variable for the fatalities equation is not consistent with the sign of the violent crime and property crime variable in Cohen and Dehejia (2005); in contrast, Cummins et al. (2001) find ambiguous results when they examined the impact of alcohol consumption on accidents. The effect on property damage is positive but is not significant at the 90 percent confidence

interval. This result suggests that the number of fender-benders is more sensitive to traffic offences, per se, relative to the other, more serious, accidents.

The number of police officers per 100,000 persons may also be interpreted as having either a deterrence effect or as being reflective of badly-behaved drivers. In the fatal accident equation, the estimated coefficient on this variable is negative and statistically significant. This is also true for the personal-injury and property-damage equations, which suggests that, on balance, the deterrence effect dominates.

From table 2.6 we see that the presence of a graduated licensing system (GDL) does not seem to have any statistical impact on fatal accidents. Nor does it affect PI or PD accidents. One explanation for this result is that the GDL program targets young drivers, who make up about 15.6% of the driving population – and hence, its impact is too small to be captured by our aggregate equations.⁵¹ Another complication stems from the fact that the GDL system was introduced around the same time as other policy changes: in Ontario, for instance, the GDL system came into effect in 1994, the same year that some modifications were made to no-fault coverage: whereas the GDL system should presumably reduce accidents, a stronger no-fault regime could have the opposite effect, so we can not isolate the independent effects.

Changes in the risk classification systems appear to have little effect on fatal accidents. The existence of province dummies is a big part of the reason that this variable does not have a significant effect on the fatal accident rate. When I dropped the province effects from the equation (these results are not reported here), the results for the risk-classification system became highly significant and with the expected negative sign (without

⁵¹ For example, in the fatal accident regression, and after including an interaction term for the GDL and the proportion of young drivers in the population as an extra variable, we observed a negative but still insignificant impact of GDL system.

changing the significance of the no-fault coefficient), as is consistent with the results of Cummins et al. (2001).⁵²

The introduction of mandatory seat belt laws across the provinces has been highly effective in reducing fatal accidents: the effects are strongly negative and significant. This result is very consistent with what is reported in other papers (e.g. Sen 2001). In contrast, the impact of this law on personal injuries appears to not be significant. The effect for property-damage-only accidents is positive but not significant; this seems a reasonable result.

The other two policy variables, i.e., short-term and long-term license suspensions, do not have significant impact on the number of fatal accidents. However, they are associated with more personal injury accidents. The results for these two policy variables are inconsistent with the literature. The long-term license suspension (ADLS) has a negative and significant impact on property damage accidents. The effect of short-term suspensions is negative but not significant for property damage accidents.

The interesting point to note about the estimated coefficients on the provincial dummy variables is the consistency of the results across all specifications. The province of Alberta is comparable to the province of New Brunswick once all other variables are taken into account, whereas, *ceteris paribus*, there are fewer fatal accidents in British Columbia, Ontario, Manitoba and Quebec. Saskatchewan, by contrast, appears to have more fatal accidents per licensed driver than any other province once other influences are taken into account. This consistent pattern does not hold for other types of accidents. The fact that

⁵² We re-estimated the model with five separate dummy variables for changing in risk-classification system across the Quebec, Manitoba, Saskatchewan, British Columbia and Alberta. The results for the other variables remain essentially the same, both with respect to sign and significance. The results from the province-specific risk classification suggest that the coefficient differs little across provinces.

fatal accidents are not subject to reporting errors may account for some of the apparent difference across accident types.

The pattern of time effects is also informative. Notice that under both specifications, i.e., with and without endogeneity of the decision to implement no-fault, the estimated coefficients on the year variables are negative and statistically significant for fatal and personal injury accidents, while the opposite is the case for property damage only accidents. Not only are the estimated coefficients on the year dummies negative, but we also see that the overall trend is a decreasing one, which is consistent with what we expected before. The following table compares the estimated signs of the variables and the expected signs.

2.9. Post-estimation tests

2.9.1. Instruments relevancy

In order to check whether the instruments used for calculating the Mills ratio are relevant, we look at the probit equation which estimates the probability of switching to a no-fault regime. As the results in appendix C1 reveal, the most important explanatory variables are significant with the expected signs. For the probit model which generates the Mill's ratio, the estimated coefficient on the insurance premium index variable is positive but not significant at 10% level of confidence. However, using the insurance premium index with one lag provides significant result for this instrument as well. The coefficient on **public** is positive and highly significant, indicating that the provinces which have a public-operated system are more likely to adopt no-fault insurance measures. The Wald test on the overall significance level of the probit model also shows strong significance (Wald tests=27).

2.9.2. Endogeneity of no-fault insurance

In order to test for the endogeneity of the no-fault insurance decision, a variety of specifications were run with and without taking into account endogeneity. The most important point common across the different specifications are that the sign of the coefficient on the no-fault insurance variable does not change. The only difference across the models is the magnitude of the effect of no-fault insurance. This enables us to undertake sensitivity analysis regarding the results.

To test for endogeneity, the most obvious strategy is that discussed in Cummins et al. (2001), i.e., looking at whether inserting the inverse Mill's ratios into the second stage regressions provides significant coefficients for those ratios or not. We find that inverse Mills ratio for no-fault is significant for the fatality equation, is almost significant for property damage-only accidents but not for personal injury accidents. Also, using two different approaches for endogeneity, i.e. IV and Mill's ratio, provides a robustness check for the results.

2.10. Conclusions

This paper examines the relationship between having a no-fault legal system governing automobile accidents and the number of fatal, personal injury and property-damage accidents using an unbalanced panel data set spanning seven Canadian provinces and the period 1975 to 2005. The results reported are largely consistent with the existing literature, which suggests that that adopting no-fault insurance increases the fatal accident rate. As expected, the effects are different across the provinces: the effect under the pure no-fault regimes of

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Table 2.1- Description of variables

Variables	Description
Dependent variables	
Fatall	Number of fatal accidents per 100 000 licensed drivers
PIL	Number of personal injury accidents per 100 000 licensed drivers
PDL	Number of property-damage only accidents per 100 000 licensed drivers
Independent variables	
Nofault	No-fault insurance system, dummy variable, 1 if province adopted no-fault, 0 otherwise
Nofaultmill	Inverse Mills ratio obtained from a probit estimation of no-fault equation, instrument for no-fault in case of endogeneity
Tortmill	Inverse Mills ratio obtained from a probit estimation of no-fault equation, instrument for tort in case of endogeneity
Nofaultpure	Dummy variable, 1 for province of Quebec or Manitoba for the years with no-fault insurance, 0 otherwise
Nofaultsask	Dummy variable, 1 for province of Saskatchewan for the years with no-fault insurance, 0 otherwise
Nofaultont	Dummy variable, 1 for province of Ontario for the years with no-fault insurance, 0 otherwise
No-fault94Ont	Dummy variable for representing the change in no-fault regime on 1994, 1 for 1994-95, 0 for 1978-93 and 1996-04
No-fault96Ont	Dummy variable for representing the change in no-fault regime on Nov. 1996, 1 for 1997-2004, 0 for 1978-1996
Precipitation	Precipitation level
Young	Percentage of population with age between 16 and 24 (percentage)
Population65+	Percentage of population with age 65 and more (percentage)
Offence	Number of traffic criminal code offences per 100 000 population
Income	Real per capita personal disposable income (constant dollars, 1996)
Popn	Size of population (100 000) (person)
GDL	Graduated licensing system, dummy variable, 1 if province adopted the system, 0 otherwise
Risk-classification	Experience rated system, dummy variable, 1 if the province changed the rating variables, 0 otherwise
Police	Number of police officers per 100 000 population
ADLS	Administrative Driver License Suspension, 1 if the province adopted the program, 0 otherwise
SASP	Short-term Administrative Suspension program, 1 if the province adopted the 24 hours suspension program, 0 otherwise
Seatbelt	Dummy variable representing introduction of mandatory seat belt, 1 if the province adopted the law, 0 otherwise
Dum90licQue	Dummy variable representing the change in regulation in Quebec on 1990, 1 for 1990-2005, 0 for 1975-1989 (Dummy variable equal to 1 after the introduction of 15 points instead of 12 before a driving license suspension in Quebec)
Year	Year Dummies
Province	Provinces include new Brunswick, Alberta, British Columbia, Ontario, Saskatchewan, Manitoba and Quebec, and New Brunswick is the reference province
Premium	Premium index of auto insurance (1992=100)
Public	Dummy variable, 1 if the province has public insurance system, 0 if it has private

Table 2.2-Data Comparisons across provinces

Variable	NB			Alberta			British Columbia			Ontario		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Fatal	108.2	61	171	370.2	299	578	441.7	340	567	957.7	718	1316
PI	4135.8*	2920	6269	15139.9	12100	20152	26315.4	19948	35073	62768.9	49948	80432
PD	10681.6*	6090	1654	86351.0	70597	106919	60246.7	20998	122291	151133.0	112632	192952
Fatalv	23.4	11.4	40.7	15.1	9.7	28.8	15.0	10.6	22.5	16.6	9.3	28.3
Fatall	24.0	11.6	47.0	19.0	13.7	33.9	16.8	10.1	25.2	15.4	8.3	27.1
Piv	882*	544	1504	594	504	817	888	570	1257	1070	649	1446
Pil	887*	554	1445	759	633	961	984	577	1330	995	577	1383
Pdv	2298*	1135	3664	3351	282	5202	2102	640	4382	2489	2078	2793
Pdl	2313*	1156	3752	4245	364	6117	2345	640	4638	2300	1936	2672
Pop	739043	706325	752543	2712760	2294198	3277582	3549027	2872920	4203315	10400000	8591725	12400000
Young	15.8	13.4	19.9	16.0	14.1	21.8	14.3	13.1	17.9	15.5	13.1	19.2
Population65+	12	10.05	13.75	9.07	7.16	13.75	12.50	10.8	13.7	11.3	9.3	12.7
Offence	637	372	864	1049	486	1801	746	317	1473	606	262	967
Precipitation	1446	958	2075	470	351	598	1240	864	1581	1015	864	1172
Police	172.2	164.2	183.8	168.3	153.5	188.2	177.0	164.5	197.6	199.5	179.9	221.7
Income	146.75	124	168	183.72	167	220	174.04	163	186	185.48	172	199
Premium	105.9	52.2	214.7	110.8	43.5	234.5	95.3	45.8	145.2	114.1	23.8	248.8
Vehicle	472315	416805	536427	2571022	2006016	3518653	3043419	2331760	3940171	6080382	4496105	7698416
Driver	468623	364041	526667	1990106	1705955	2394917	2723287	2079969	3454879	6620468	4725546	8655597
# obs.	24			25			23			27		

*The data on these variables are not available for 1982 and 1983.

Cont'd table 2.2

Variable	Saskatchewan			Manitoba			Quebec		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Fatal	162.0	105	238	108.2	79	142	946.8	554	1623
PI	5504.3	4719	6397	8230.3	6656	11245	37658.4	30390	44451
PD	27856.6	19284	42096	24722.2	18423	30734	132255.3	92068	172489
Fatalv	23.2	14.2	38.1	13.8	9.9	17.5	26.7	11.1	59.9
Fatall	25.5	15.7	40.2	16.2	11.5	22.0	25.9	12.2	59.5
Piv	783	658	954	1044	867	1373	1007	727	1497
Pil	862	721	1055	1229	937	1671	985	743	1373
Pdv	3971	2730	6416	3147	2270	3893	3597	1933	5844
Pdl	4376	2994	6980	3691	2738	4701	3505	2026	5526
Pop	1001638	944801	1032745	1117053	1046780	1170475	6954260	6330304	7597768
Young	16.2	14.1	19.7	15.2	13.8	18.5	15.8	12.7	20.6
Population65+	13.4	11.14	14.9	13.13	11.9	13.7	10.7	7.4	13.8
Offence	1454	996	2217	547	300	902	590	346	883
Precipitation	460	314	670	596	453	778	1258	826	1679
Police	207.1	183.9	278.6	193.4	168.9	222.2	210.9	186.9	246.3
Income	147.5	137	168	160.78	146	171	160.71	142	184
Premium	95.8	33.4	148.1	103.0	59.9	139.0	87.4	0.8	147.3
Vehicle	704866	621770	740554	786643	706541	855871	3896138	2710747	5306534
Driver	640246	560972	669852	672723	600900	728571	3916513	2727642	4777429
# obs.	28			23			31		

Table 2.3.- Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Nofault	1.00											
(2) Purenofault	0.73	1.00										
(3) Nofaultsask	0.23	-0.13	1.00									
(4) Nofaultont	0.42	-0.16	-0.07	1.00								
(5) Dum94ont	0.15	-0.06	-0.03	0.35	1.00							
(6) Dum96ont	0.30	-0.11	-0.05	0.72	-0.02	1.00						
(7) Dum03sask	-0.08	-0.06	0.44	-0.03	-0.01	-0.02	1.00					
(8) Young	-0.31	-0.14	-0.08	-0.26	-0.10	-0.22	-0.02	1.00				
(9) Pop65+	0.20	0.01	0.39	0.08	0.02	0.10	0.18	-0.64	1.00			
(10) Pop.	0.48	0.21	-0.21	0.64	0.21	0.49	-0.09	-0.12	-0.23	1.00		
(11) Offence	-0.35	-0.33	0.19	-0.25	-0.06	-0.24	0.05	0.50	-0.21	-0.37	1.00	
(12) Police	0.22	0.28	0.01	-0.02	0.00	-0.06	0.05	0.55	-0.18	0.23	0.30	1.00
(13) Income	0.02	-0.15	-0.17	0.40	0.10	0.33	-0.01	-0.35	-0.15	0.54	-0.34	-0.29
(14) Precipitation	0.09	0.17	-0.27	0.08	0.04	0.04	-0.13	0.00	-0.11	0.30	-0.43	-0.02
(15) GDL	0.14	0.02	-0.14	0.30	0.07	0.39	-0.06	-0.46	0.22	0.26	-0.51	-0.36
(16) Riskclass.	0.24	0.28	0.32	-0.23	-0.08	-0.16	0.14	-0.52	0.65	-0.19	-0.19	-0.14
(17) RiskclassQue	0.39	0.53	-0.07	-0.08	-0.03	-0.06	-0.03	-0.29	0.14	0.27	-0.21	0.02
(18) RiskclassxQue	0.03	-0.01	0.38	-0.19	-0.07	-0.14	0.17	-0.38	0.61	-0.36	-0.08	-0.16
(19) Seatbeltdum	0.03	0.12	0.24	-0.30	-0.11	-0.21	0.11	-0.17	0.09	-0.29	0.21	-0.14
(20) Dum90licque	0.43	0.59	-0.08	-0.09	-0.03	-0.07	-0.03	-0.31	0.10	0.30	-0.20	0.06
(21) ADLS	0.16	0.08	-0.13	0.23	-0.06	0.41	-0.06	-0.36	0.26	0.05	-0.48	-0.25
(22) SASP	0.22	-0.11	0.25	0.38	0.13	0.27	0.13	-0.25	0.41	0.07	-0.34	-0.11
(23) Provinces	0.61	0.68	0.11	-0.02	-0.01	-0.01	0.05	0.02	0.16	0.29	-0.08	0.63
(24) Year	0.31	0.13	0.24	0.21	0.04	0.25	0.16	-0.86	0.61	0.02	-0.55	-0.58

Cont'd table 2.3

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(13) Income	1.00											
(14) Precipitation	-0.15	1										
(15) GDL	0.47	0.0935	1									
(16) RiskclassOnt	-0.02	-0.1544	0.0422	1								
(17) RiskclassQue	0.05	0.1476	0.2972	0.3716	1							
(18) RiskclassQue	-0.05	-0.2479	-0.1249	0.8482	-0.1766	1						
(19) Seatbeltdum	-0.28	-0.1372	0.1199	-0.0534	0.2797	-0.2163	1					
(20) Dum90licque	0.02	0.189	0.2377	0.2943	0.8933	-0.1977	0.3131	1				
(21) ADLS	0.39	-0.1774	0.4021	0.308	-0.1458	0.4097	-0.3331	-0.1632	1			
(22) SASP	0.04	0.0418	0.0898	0.0204	-0.2209	0.1477	-0.1317	-0.2473	0.246	1		
(23) Province	-0.14	-0.1297	-0.1625	0.3662	0.3973	0.1616	-0.0545	0.4447	0.0351	-0.1436	1	
(24) Year	0.40	-0.1076	0.6491	0.4857	0.2629	0.365	0.2283	0.2335	0.504	0.3255	-0.1017	1

Table 2.4: Introduction dates of policy variables and no-fault regime in Canadian provinces

GDL=Graduated Driver License program
ADLS=Administrative Driver's License Suspension program
SASP= Short-term Administrative License Suspension

Province	New Brunswick	Alberta	BC	Ontario	Saskatchewan	Manitoba	Quebec
No-fault	-	-	-	1990, 1994, 1996	1995	1994	1978
GDL	1996	1998	1998	1994	2005	2003	1997
Mandatory seat-belt	1985	1987	1977	1976	1978	1977	1982
ADLS	-	1999	1997*	1997**	1977***	1989***	-
SASP	1985	1975	1979	1981	Aug. 1996	April 1988	-
Risk-classification	-	2005****	1988	-	1989	1987	1992

*British Columbia does not have a ADLS system. However, changes made since in 1997 mean that we consider it as a semi-ADLS system. Also, British Columbia introduced Responsible Driver Program in June 2005⁴⁹.

**Since ADLS for Ontario came into effect in November the 29th, 1996, the dummy for this change takes the value on 1 from 1997 onward.

***The Saskatchewan system is called Administrative Suspension. Manitoba introduced its Vehicle Impoundment Program (VIP) at the same time.

****Alberta introduced a grid system in 2005⁵⁰.

Table 2.5: Expected signs of the variables

GDL=Graduated Driver License program
ADLS=Administrative Driver's License Suspension program
SASP= Short-term Administrative License Suspension

Variables	Expected sign
No-fault	+
Income	-
Young	+
Pop65plus	?
Population	+
Traffic criminal code offences	?
Police	?
Precipitation	?
GDL	-
Risk classification	-
ADLS	-
SAS	-
Seat-belt	-

⁴⁹ http://www.icbc.com/Licensing/lic_fines_pen_pro_ADP.asp

⁵⁰ The Grid system introduced in Alberta on October 1, 2004. In this system, insurance companies must compare the premium charged any given driver under their current rating program to the premium indicated on the grid; drivers are then charged the lesser of the two premiums. The premiums levied on experienced drivers with a clean driving record are capped under this new system; those drivers with driving-related criminal code convictions have experienced increases in premiums paid. (<http://www.autoinsurance.gov.ab.ca/questions.html>).

Regression Results:

Table 2.6- FGLS regressions on overall effect of no-fault on fatality, personal injury and property-damage only accidents per 100 000 licensed drivers

Variables	FatalL*		FatalL		PIL*		PIL		PDL*		PDL	
	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.
No-fault	3.09	0.88	4.54	1.11	20.27	41.76	52.64	53.08	640.02	142.88	790.89	205.05
No-fault94Ont	0.73	1.81	0.21	1.83	-41.47	84.50	-49.21	86.95	430.88	241.51	338.38	243.94
No-fault96Ont	-1.88	1.61	-2.54	2.54	-49.48	77.11	-58.75	122.32	1149.82	339.25	178.49	482.46
Choice03Sask	2.58	1.87	0.74	2.08	121.00	89.10	87.19	102.90	1627.98	372.95	1506.73	390.47
Young	-0.18	0.54	-0.04	0.55	13.57	26.22	17.29	27.27	396.68	86.15	403.16	86.05
Population65+	-1.08	0.84	-1.25	0.85	244.24	39.47	242.70	40.45	-332.36	168.23	-398.70	169.78
Population	0.72	0.72	0.57	0.81	-81.79	39.53	-93.96	46.22	247.20	169.01	301.88	206.93
Offence	-0.005	0.001	-0.006	0.001	-0.32	0.06	-0.32	0.06	0.14	0.22	0.15	0.22
Police	-0.040	0.023	-0.040	0.023	-2.12	1.12	-2.19	1.17	-7.84	3.28	-7.10	3.31
Income	0.001	0.038	0.028	0.041	1.90	1.79	2.41	1.96	7.50	5.55	9.87	5.85
Precipitation	0.004	0.001	0.004	0.001	0.09	0.07	0.11	0.07	0.35	0.20	0.42	0.20
GDL	0.272	0.895	0.451	0.923	18.83	42.04	26.26	44.11	44.94	120.80	64.05	125.77
Risk-classification	-0.079	0.818	0.099	0.822	53.13	38.61	54.38	39.33	420.36	116.15	436.90	116.30
Seat belt	-2.462	0.916	-2.127	0.935	1.13	48.28	6.60	49.65	687.76	144.22	712.49	144.49
Dum90licQue**	-0.090	1.251	0.373	1.291	-98.16	58.95	-89.77	61.60	-289.03	174.67	-233.93	183.51
ADLS	0.535	0.790	0.104	0.815	115.65	37.54	109.95	39.79	-525.26	125.81	-577.96	130.09
SASP	0.716	0.910	0.777	0.915	173.96	46.97	173.84	48.74	-195.16	130.03	-164.08	131.14
Mills ratios												
No-fault			1.94	1.01			44.72	48.20			248.80	153.28
Tort			-1.42	1.00			-23.50	48.00			-134.99	149.14
Dum03injNB					-188.80	81.18	-196.57	83.80				
Dum03injONT					9.12	88.25	12.44	93.31				
Province dummies												
Alberta	-3.42	3.74	-3.55	3.83	1018.93	175.09	1035.41	182.91	604.91	801.97	296.96	831.71
BC	-8.34	2.85	-7.92	3.03	330.84	150.31	365.21	166.22	1489.8	587.12	1367	639
Ontario	-19.41	6.96	-19.12	7.70	897.50	352.61	986.67	409.06	-1871	1586	-2439	1863
Saskatchewan	9.40	2.50	10.49	2.56	-50.99	118.46	-26.93	123.44	3672	486	3764	495

Manitoba	-6.51	2.26	-6.02	2.29	90.97	114.47	101.09	117.67	2748	370	2846	375
Quebec	-8.52	4.75	-9.57	5.27	943.39	250.86	982.66	291.11	656	1161	83	1337
Year dummies												
1976	-12.02	2.86	-11.82	2.87	-280.43	133.43	-275.49	135.86	137	379	154	378
1977	-18.21	2.85	-17.84	2.86	-140.57	133.35	-132.91	136.19	174.88	396.15	215.54	397.06
1978	-18.08	2.85	-18.05	2.87	-104.50	133.36	-108.04	136.32	672.19	413.92	716.02	416.52
1979	-15.60	2.98	-15.53	3.00	-81.74	139.04	-85.30	142.48	1611.1	461.90	1669.2	463.95
1980	-19.47	3.04	-19.26	3.06	-103.02	141.98	-103.01	145.23	1759.0	468.44	1825.5	469.77
1981	-21.75	2.91	-21.90	2.92	-360.92	135.94	-366.20	138.66	1361.2	468.91	1407.3	470.40
1982	-26.44	3.00	-26.48	3.01	-517.17	142.53	-522.74	145.59	1095.9	482.28	1157.5	484.27
1983	-31.16	3.17	-31.03	3.19	-594.55	151.65	-596.05	154.85	1000.1	507.04	1085.0	508.99
1984	-31.62	3.26	-31.49	3.27	-595.56	155.57	-596.05	158.73	1276.8	523.35	1372.0	525.12
1985	-30.40	3.41	-30.24	3.42	-618.48	162.43	-617.89	165.61	1805.2	557.10	1919.4	559.35
1986	-32.05	3.66	-31.87	3.66	-659.18	174.35	-658.35	177.68	1867.4	595.60	1999.2	598.07
1987	-29.99	3.95	-29.64	3.96	-746.92	188.54	-741.98	192.31	2226.9	637.96	2380.2	640.92
1988	-32.08	4.23	-31.88	4.25	-869.74	201.73	-866.16	205.80	2641.0	683.93	2783.4	686.45
1989	-32.58	4.52	-32.28	4.54	-918.86	215.62	-912.50	220.14	3078.7	727.30	3233.9	729.94
1990	-35.07	4.72	-34.73	4.76	-1015.85	225.29	-1007.2	230.57	3062.5	762.94	3228.2	766.77
1991	-36.21	4.86	-35.86	4.89	-1053.76	231.90	-1045.7	236.83	3108.8	794.49	3258.7	796.89
1992	-37.93	5.00	-37.76	5.03	-1122.97	238.34	-1117.4	244.01	2896.3	821.05	3042.1	824.03
1993	-38.40	5.16	-38.41	5.21	-1219.30	246.21	-1216.2	252.43	2741.3	846.31	2862.4	848.17
1994	-41.45	5.28	-41.46	5.34	-1291.45	252.40	-1288.9	259.06	2634.7	865.04	2769.0	867.87
1995	-41.90	5.40	-41.41	5.44	-1394.71	257.64	-1383.1	264.00	2548.3	883.42	2748.0	886.66
1996	-44.45	5.53	-44.00	5.57	-1542.72	263.12	-1531.2	269.60	2486.5	903.09	2678.8	906.15
1997	-43.20	5.57	-43.19	5.60	-1617.17	265.17	-1612.0	270.90	2398.1	913.00	2565.7	914.40
1998	-43.60	5.62	-43.66	5.66	-1684.17	267.29	-1684.0	273.59	2426.3	916.02	2552.1	917.44
1999	-43.30	5.68	-43.22	5.72	-1712.12	270.22	-1709.9	276.16	2442.3	929.27	2566.4	930.36
2000	-44.72	5.74	-44.48	5.80	-1751.31	272.91	-1747.4	279.99	2521.9	942.82	2702.6	945.93
2001	-43.99	5.75	-44.00	5.79	-1775.22	272.84	-1782.5	279.50	2543.3	947.91	2702.1	950.94
2002	-43.82	5.78	-43.89	5.83	-1788.48	274.29	-1800.6	280.99	2633.1	960.53	2825.3	964.79
2003	-44.37	5.86	-44.47	5.94	-1811.39	276.64	-1813.1	284.67	2647.2	972.42	2832.4	978.50
2004	-45.88	5.91	-45.60	5.96	-1876.07	278.50	-1869.4	285.06	2618.4	984.56	2892.8	988.78
2005	-43.50	6.43	-43.90	6.48	-1908.48	303.94	-1915.8	311.40	2767	1046	2914	1048
Constant	82.94	17.03	77.64	17.26	-997.88	825.83	-1113.2	849.92	-3248	2853	-3382	2863
Report-changing dummies***												

BC91	-2071	209	-2073	226
Alberta91	-206	192	-149	197
Saskatchewan84	-1474	223	-1445	225
Saskatchewan93	-2374	308	-2241	328
Saskatchewan02	-1419	444	-1459	455
Manitoba92	-415	213	-457	232
Ontario85	-422	226	-528	239
Ontario98	-841	424	****	
Quebec79	-1737	286	-1768	289
Quebec98	-2133	354	-2122	354
Log Likelihood	-378	-1061	-1023	-1197
Wald- chi2 (53)	3399	1087	984	4069
	chi2(54)	chi2(55)	chi2(57)	chi2 (64)
	3158	984	chi2 (63)	3946
	-363			

*FatalL, PIL and PDL are number of fatal accidents, personal injury and property-damage only accidents per 100 000 licensed drivers.

**Raising the limit for a license suspension from twelve to fifteen points for all drivers in January 1990 (Dionne, 2001).

***Dummy variables have been included to capture the changes in reporting systems as follows: 91 for BC and Alberta, 84, 93, and 2002 for Saskatchewan, 92 for Manitoba, 85 and 98 for Ontario, and 79 and 98 for Quebec (have not shown here).

****Dummy98ont dropped because of collinearity

Table 2.7: Expected and estimated signs of the variables
 GDL=Graduated Driver License program
 ADLS=Administrative Driver's License Suspension program
 SASP= Short-term Administrative License Suspension

Variables	Expected sign	Estimated sign
No-fault	+	+
Income	-	+, insig. (0.97)
Young	+	-, insig. (0.98)
Pop65plus	?	-, insig. (0.15)
Population	+	+, insig.(0.74)
Traffic criminal code offences	?	-
Police	?	-
Precipitation	?	+
GDL	-	+, insig. (0.66)
Risk classification	-	-, insig. (0.93)
ADLS	-	+, insig. (0.69)
SAS	-	+, insig. (0.56)
Seat-belt	-	-

Number in parentheses are p-values.

Table 2.9- IV approach: Regressions on overall effect of no-fault on fatality, personal injury and property-damage only accidents per 100 000 licensed drivers

Variables	FatalL (1)*		FatalL (2)*		PIL (1)		PIL (2)		PDL (1)		PDL (2)	
	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.
No-fault	5.81	1.85	4.12	1.37	70	86	64	66	1206	460	737	269
No-fault94Ont	0.89	2.39	1.24	2.33	-22	110	-21	110	642	340	673	326
No-fault96Ont	-0.71	2.15	-0.43	2.09	2.24	100.51	3	100	1089	375	1105	360
Choice03Sask	4.63	2.67	3.17	2.40	155	126	149	116	2155	638	1688	504
Young	-0.17	0.67	-0.07	0.65	16.70	32.26	17	32	419	112	415	107
Population65+	-1.22	1.03	-1.20	1.01	240	48	240	48	-221	231	-308	212
Population	-0.016	0.932	0.14	0.90	-108	50	-108	50	-160	307	64.38	242.98
Offence	-0.007	0.002	-0.006	0.002	-0.35	0.08	-0.35	0.08	-0.03	0.29	0.06	0.27
Police	-0.039	0.029	-0.036	0.028	-2.08	1.38	-2.07	1.38	-7.17	4.26	-7.02	4.09
Income	0.033	0.050	0.013	0.047	2.45	2.30	2.38	2.23	11.49	7.30	10.08	6.93
Precipitation	0.003	0.002	0.003	0.002	0.08	0.08	0.08	0.08	0.35	0.25	0.34	0.24
GDL	1.16	1.18	0.69	1.11	33.66	54.00	32.10	52.17	52.73	176.79	-32.18	157.53
Risk-classification	0.49	1.05	0.15	1.00	65.52	49.36	64.14	47.80	456	152	428	144
Seat belt	-1.72	1.19	-2.15	1.12	18.78	61.24	17.19	59.56	748	191	701	180
Dum90licQue	0.94	1.60	0.51	1.54	-71.86	74.92	-74	73	-77	250	-189	226
ADLS	0.56	0.96	0.40	0.93	115	45	115	45	-350	176	-439	156
SASP	-0.05	1.18	0.31	1.12	-183	99	-183	98	-323	180	-256	165
Dum03injNB					35	108	33	107				
Dum82injONT												
Province dummies:												
Alberta	-3.95	4.63	-3.24	4.50	1021	213	1023	212	1482	1176	869	1033
BC	-7.30	3.47	-6.98	3.39	386	179	387	179	2180	848	1793	761
Ontario	-15.36	8.64	-15.28	8.45	1072	431	1070	430	1333	2693	-489	2200
Saskatchewan	8.78	3.10	9.44	2.99	-61	146	-58	144	3597	629	3661	602
Manitoba	-8.02	2.95	-6.80	2.75	70	146	75	140	2521	486	2637	459
Quebec	-8.95	6.16	-7.09	5.88	1005	313	1011	310	2648	1833	1570	1566
Year dummies:												

1975	48.45	8.88	44.01	8.10	1961	411	1945	386	-2029	1530	-2815	1347
1976	37.15	9.12	32.28	8.23	1694	422	1677	392	-1834	1540	-2633	1354
1977	30.55	8.76	26.03	7.96	1830	405	1814	379	-1870	1475	-2579	1314
1978	28.81	7.92	25.47	7.38	1832	367	1820	352	-1699	1321	-2134	1226
1979	31.80	7.97	28.23	7.39	1866	370	1853	352	-644	1325	-1156	1214
1980	27.87	7.99	24.32	7.40	1844	371	1832	353	-515	1309	-1023	1199
1981	25.52	7.38	22.10	6.80	1587	342	1575	324	-919	1207	-1409	1100
1982	20.57	6.92	17.41	6.39	1423	323	1412	308	-1160	1151	-1649	1043
1983	16.08	6.71	12.86	6.16	1353	312	1341	295	-1218	1115	-1709	1006
1984	15.41	6.23	12.41	5.72	1349	287	1338	272	-957	1032	-1433	925
1985	16.40	5.77	13.62	5.30	1324	266	1315	252	-469	952	-921	850
1986	14.94	5.47	12.16	4.98	1290	252	1280	237	-397	898	-836	798
1987	16.86	5.12	14.26	4.66	1202	236	1193	222	-38	841	-463	743
1988	14.58	4.54	12.19	4.11	1080	209	1071	196	364	755	-46	657
1989	14.00	4.14	11.77	3.74	1032	190	1024	177	778	691	388	596
1990	11.06	3.79	9.15	3.46	928	174	922	164	658	611	356	542
1991	10.16	3.83	8.15	3.47	896	175	889	164	675	583	404	522
1992	8.43	3.73	6.46	3.38	828	171	821	160	514	567	211	496
1993	7.79	3.52	5.95	3.19	729	161	723	151	384	546	63	467
1994	4.27	3.34	2.69	3.08	647	153	642	145	173	506	-84	446
1995	3.21	3.07	2.02	2.88	534	141	530	136	-1	453	-173	416
1996	0.79	3.01	-0.36	2.83	391	138	387	134	-166	441	-332	405
1997	1.62	2.90	0.62	2.75	308	133	304	130	-135	420	-265	392
1998	0.96	2.72	0.12	2.60	237	125	234	123	-212	394	-297	373
1999	0.97	2.56	0.32	2.46	204	118	202	116	-241	369	-292	353
2000	-0.62	2.42	-1.16	2.34	163	112	161	110	-182	347	-222	332
2001	0.01	2.38	-0.45	2.30	137	109	136	108	-163	336	-206	321
2002	0.22	2.33	-0.25	2.26	125	107	124	106	-51	330	-103	314
2003	-0.19	2.30	-0.71	2.22	106	107	104	105	-28	319	-80	304
2004	-1.91	2.20	-2.29	2.14	39	102	37	102	-68	305	-103	291
2005												
Constant	35.96	20.52	37.45	20.05	-2957	968	-2954	967	-2727	4064	-1351	3766
Report-changing dummies												
BC91									-1739	336	-1957	279
Alberta91									-144	251	-184	239

Saskatchewan84	-1559	292	-1514	278
Saskatchewan93	-2729	469	-2451	400
Saskatchewan02	-1889	648	-1556	571
Manitoba92	-751	357	-497	286
Ontario85	-275	299	-338	283
Ontario98	-153	527	-376	478
Quebec79	-1971	415	-1760	366
Quebec98	-2326	498	-2105	449
R-square overall	0.9487			0.9585
Wald- chi2 (53)	2348	0.9464	0.8571	0.8574
		chi2(53)	2248	chi2(55)
			739	740
			chi2(63)	chi2 (64)
			2443	2649

*(1) represent the specification under which public and current level of insurance premium index have been used in reduced probit model, while (2) refers to the case that the first lag of insurance premium and public were added to the reduced probit model.

Table 2.11 - FGLS regressions of no-fault regime-specific effect on fatality, personal injury and property-damage only accidents per 100, 000 licensed drivers

Variables	FatalL, Province-specific		FatalL, two risk-classification measures		PIL, Province-specific		PIL, two risk-classification measures		PDL, Province-specific		PDL, two risk-classification measures	
	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.	Coeff.	STD.
No-fault			3.09	0.88			19.78	41.64			639.45	142.69
Pure (Quebec-Manitoba)	4.59	1.26			184.71	57.38			1084	220.6		
Semi-monetary Saskatchewan	3.00	1.52	2.58	1.87	108.50	71.47	121.36	88.85	272.87	256.22	999.12	1622.14
Choice03Sask	0.05	1.75			157.83	79.39			423.40	337.61		
Verbal (Ontario)	1.23	1.68	0.71	1.81	-251.54	76.24	-49.02	84.59	486.34	237.77	453.70	243.31
No-fault94Ont	1.21	1.82	-1.91	1.64	15.83	81.62	-61.91	77.86	1165.9	332.67	1165.3	339.49
No-fault96Ont	-1.66	1.64	-0.18	0.54	-60.81	74.89	11.94	26.20	394.08	86.72	389.04	86.70
Young	-0.11	0.59	-1.05	0.89	4.15	28.16	257.24	41.40	-255.34	167.25	-357.19	171.60
Population65+	-0.65	0.90	0.74	0.76	277.4	40.58	-72.53	40.46	402.28	207.01	235.55	169.57
Population	1.57	1.00	-0.005	0.001	59.55	50.45	-0.31	0.06	0.07	0.21	0.11	0.22
Offence	-0.006	0.001	-0.040	0.023	-0.34	0.06	-2.14	1.12	-9.22	3.25	-7.85	3.27
Police	-0.047	0.023	0.001	0.038	2.87	1.72	2.05	1.79	9.71	5.49	7.48	5.54
Income	0.007	0.038	0.004	0.001	0.08	0.06	0.09	0.07	0.36	0.19	0.34	0.20
Precipitation	0.004	0.001	0.269	0.896	51.24	41.01	17.20	41.96	42.79	119.53	52.58	121.11
GDL	0.433	0.912			39.99	36.99			416.40	113.74		
Risk-classification	-0.187	0.814										
Risk-classification (Quebec)			-0.223	1.551			-8.93	72.37			559.68	228.14
Risk-classification (except Quebec)			-0.028	0.942			75.58	44.43			371.31	135.05
Seat belt	-2.479	0.911	-2.445	0.928	-14.03	46.19	8.77	48.73	736.03	142.27	668.10	146.67
Dum90licQue	-0.731	1.305	0.000	1.499	-172.45	58.99	-59.20	70.25	-348.27	183.35	-362.80	203.09
ADLS	0.120	0.838	0.531	0.791	82.62	38.92	114.00	37.47	-563.17	123.92	-518.68	125.98
SASP	0.930	0.917	0.72	0.91	193.11	46.33	172.55	46.86	-84.38	134.46	-192.32	129.91
Dum03injNB					-143.82	78.27	-194.82	81.17				

Dum03injONT													
Province dummies													
Alberta	-3.61	4.17	-3.40	3.74	838.04	188.10	1028.41	15.89	88.25	654.79	820.02	562.47	803.08
BC	-10.47	3.63	-8.46	3.06	-82.64	180.03	281.04	157.74	1156.8	659.18	1533.05	1533.05	589.45
Ontario	-26.42	9.30	-19.63	7.25	-306.30	447.35	810.56	361.93	1887.25	-3183	1887.25	-1796.04	1588.31
Saskatchewan	8.97	2.56	9.28	2.71	-142.37	117.68	-102.36	128.55	3595.2	481.18	3756.58	3756.58	499.99
Manitoba	-7.44	2.36	-6.58	2.35	-55.67	115.01	60.59	118.02	2654.5	371.24	2778.59	2778.59	372.13
Quebec	-14.20	6.79	-8.65	4.89	-23.51	335.06	897.22	254.26	-420.22	1409.60	686.69	686.69	1160.91
Year dummies													
1976	-12.07	2.84	-12.02	2.86	-277.35	127.35	-280.93	133.05	144.33	371.42	145.86	145.86	379.01
1977	-18.95	2.87	-18.21	2.85	-222.48	128.95	-140.83	132.97	84.12	389.86	179.87	179.87	395.66
1978	-19.64	2.99	-18.10	2.86	-270.86	134.53	-111.54	133.16	337.60	425.94	691.97	691.97	414.28
1979	-17.27	3.13	-15.62	2.99	-256.63	140.63	-93.58	139.14	1304.8	467.06	1641.6	1641.6	463.26
1980	-21.16	3.19	-19.50	3.06	-286.04	143.74	-118.04	142.35	1451.5	473.68	1794.2	1794.2	470.41
1981	-23.73	3.13	-21.80	2.94	-571.88	140.99	-381.03	137.00	966.34	483.11	1401.0	1401.0	471.60
1982	-28.50	3.24	-26.49	3.04	-730.86	145.79	-541.92	144.20	641.14	504.44	1135.5	1135.5	484.82
1983	-33.28	3.41	-31.21	3.21	-820.46	154.47	-620.71	153.41	527.56	531.35	1037.5	1037.5	509.07
1984	-33.90	3.53	-31.69	3.31	-849.16	159.81	-625.85	157.98	767.16	554.29	1313.9	1313.9	525.22
1985	-32.79	3.72	-30.48	3.48	-894.39	167.74	-654.36	165.80	1251	592.51	1846.3	1846.3	559.33
1986	-34.64	3.99	-32.13	3.74	-957.6	180.26	-699.63	178.39	1266.2	634.73	1913.1	1913.1	598.25
1987	-32.64	4.29	-30.09	4.06	-1062.1	194.32	-796.40	194.25	1597.9	680.47	2283.1	2283.1	641.98
1988	-34.89	4.60	-32.21	4.37	-1212.5	208.55	-926.54	208.83	1953	732.31	2702.6	2702.6	688.46
1989	-35.43	4.91	-32.72	4.69	-1279.6	222.81	-983.38	224.24	1953	778.43	3148.3	3148.3	732.88
1990	-37.65	5.03	-35.23	4.94	-1344.6	228.82	-1089.2	236.04	2360.8	803.23	3144.5	3144.5	770.59
1991	-38.84	5.18	-36.37	5.09	-1391.3	235.57	-1129.8	243.15	2418.7	828.60	3191.8	3191.8	801.97
1992	-40.66	5.33	-38.10	5.23	-1474.3	242.44	-1200.8	249.77	2225	852.16	2977.8	2977.8	827.92
1993	-41.22	5.50	-38.55	5.34	-1582.9	250.46	-1289.2	255.03	2005.7	881.85	2793.8	2793.8	848.36
1994	-44.66	5.70	-41.60	5.46	-1700.0	259.59	-1361.4	260.98	1807.0	913.03	2683.3	2683.3	866.54
1995	-45.23	5.88	-42.05	5.57	-1834.7	267.72	-1465.9	266.35	1747.2	933.54	2596.5	2596.5	884.79
1996	-47.85	6.01	-44.61	5.71	-1991.6	273.05	-1615.4	272.03	1660.1	954.67	2537.8	2537.8	904.73
1997	-46.62	6.06	-43.36	5.75	-2071.2	275.62	-1689.5	273.90	1566.1	965.91	2446.2	2446.2	914.24
1998	-47.16	6.14	-43.76	5.80	-2157.1	279.11	-1758.4	276.43	1588.5	969.0	2480.0	2480.0	917.86
1999	-46.93	6.23	-43.47	5.88	-2196.9	282.85	-1787.2	279.48	1586.6	984.3	2495.2	2495.2	930.96
2000	-48.48	6.31	-44.89	5.94	-2250.8	286.41	-1828.3	282.55	1636.8	1000.9	2576.6	2576.6	944.66
2001	-47.81	6.34	-44.16	5.96	-2286.6	287.54	-1854.7	283.16	1645.2	1008.3	2601.4	2601.4	950.11

2002	-47.72	6.38	-43.99	6.00	-2308.8	289.54	-1869.1	284.86	1706.1	1024.3	2694.0	963.03
2003	-48.44	6.49	-44.55	6.09	-2355.2	293.57	-1892.8	287.33	1702.8	1037.6	2712.0	975.35
2004	-50.07	6.57	-46.06	6.15	-2438.1	297.01	-1959.5	289.69	1649.9	1052.8	2685.3	987.70
2005	-47.81	7.06	-43.72	6.73	-2480.0	319.80	-2007.6	318.50	1761.8	1114.5	2865.1	1054.2
Constant	79.18	18.32	82.66	17.23	-1019.3	873.45	-1099.1	829.52	-3716.8	2860.4	-2831.1	2909.5
Report-changing dummies												
BC91												
Alberta91									-2098	222	-2052	210
Saskatchewan84									-289	199	-208	192
Saskatchewan93									-1419	219	-1486	223
Saskatchewan02									-2051	331	-2331	313
Manitoba92									-990	465	-1381	446
Ontario85									-703	234	-402	213
Ontario98									-469	222	-433	226
Quebec79									-967	422	-851	423
Quebec98									-1862	285	-1734	285
Log Likelihood	-377			-378		-1052	-1061		-1243			-1246
Wald- chi2 (55)	3452		chi2(54)	3399	chi2(57)	1215	chi2(56)	1094	chi2(65)	4253	chi2(64)	4081

Appendix 2.A:

**Table 2.A1-Overview of Reform Initiatives
Canadian Tort Based Insurance System, March 26, 2005**

NL	NS	NB	PEI	ONT	ALTA
<ul style="list-style-type: none"> - \$2,500 deductible on pain and suffering awards - Mandated 15% reduction in premiums overall - Rates frozen March 17, 2004 for one year - Other minor tort reforms - Underwriting guidelines regulated - Rate regulation system changed 	<ul style="list-style-type: none"> - \$2,500 cap on pain and suffering awards for minor injuries as defined - Mandated 20% reduction in premiums - Rate frozen until November 1, 2004 - Other minor tort reforms - Elimination of age and marital status as rating factors - Underwriting guidelines regulated - Introduced rate regulation 	<ul style="list-style-type: none"> - \$2,500 cap on pain and suffering awards for minor injuries as defined - Required insurers to file and justify new rates or face a 20% rollback of their current rates - Elimination of age and marital status as rating factors - Underwriting guidelines regulated - First Chance Discount to provide new drivers with relief from high insurance premiums - Reintroduced rate regulation - No frills option made available - Consumer Advocate created 	<ul style="list-style-type: none"> - \$2,500 cap on pain and suffering awards for minor injuries as defined - Eliminated age of operator and vehicle as rating factors - Underwriting guidelines regulated - Introduced rate regulation 	<ul style="list-style-type: none"> - \$30,000 deductible on pain and suffering awards for minor injuries as defined, increased from \$15,000 (1996), increased from \$10,000 (1991) - Ombudsman position created - Injury assessment centres introduced - Accident Benefits dispute resolution service - Insurance product option being considered 	<ul style="list-style-type: none"> - \$4,000 cap on pain and suffering awards for minor injuries as defined - Grid rating system established - Rating by age, gender and marital status permitted but premium charged cannot exceed grid maximum - Premiums frozen - Freeze to be extended to September, 2005 - Insureds may choose immediate Accident Benefits payments but must follow specific treatment regimen - Tri-level dispute resolution service for rates charged

Source: Completely reproduced from: Public Utilities Board, Automobile Insurance Review, Report to Government, New Found land and Labrador, March 2005, exhibit 6, page 138.

Table 2.A2- Overview of Automobile Insurance in Canada

	NB	Que.	Ont.	Man.	Sask.	Alta.	BC
Governance	Private	Public Private;	hybrid nofault/ tort.	Public	Public; hybrid nofault/tort.	Private	Public
Tort Restrictions	Pain and Suffering awards on minor injury as defined.	No right to sue, pure nofault.	Verbal threshold; \$30K deductible pain and suffering awards.	Modest nofault benefits with appeals process.	\$5,000 deductible on tort recovery.	\$4,000 cap on Pain and Suffering.	Full tort but policy of "nocrash nocash".
Premium/ Rating	Industry standard but banned use of age and marital status in 2004.	Industry standard for property-damage, and flat rate by vehicle class for bodily injury.	Industry standard.	Vehicle, location and driving record. Surcharges for at-fault accidents and convictions.	Vehicle based with surcharges for at-fault accidents and convictions.	Grid system. Surcharges or discounts on base rate due to driver and vehicle characteristics	Vehicle use and location. Surcharges based on penalty points for at-fault accidents and convictions.
Road and Safety Programs	Graduated licensing along with increased enforcement.	Graduated licensing and mandatory driver training.	Graduated licensing, enforcement and driver education.	Education Programs directed at youth, citizen watches and enhanced penalties.	Graduated Licensing pending; education, citizen education, citizen watches and enhanced penalties.	Enforcement, and education. (Red light cameras, etc.)	Graduated licensing, (Red light cameras, education programs etc.)
Regulation	approval all filings.	Use and file for optional. File and use For mandatory.	Prior approval.	Prior approval.	Government Determines rates and coverages.	Benchmark and some prior approval.	Prior approval for ICBC.

* The industry standard according to IBC is where premiums are set by; primary driver's record of offences and at-fault accidents; other drivers who have access to vehicle; the characteristics of the vehicle such as likelihood of being stolen, type and age; use of vehicle such as work or pleasure; and, where and how far you drive. The characteristics of the primary driver in regards to age, gender and marital status are also used.
Source: Reproduced from the following reference with small modifications: Public Utilities Board, Automobile Insurance Review, Report to Government, New Found land and Labrador, March 2005, exhibit 4, page 136.

Table 2.A3- Automobile Insurance in Canada – Mandatory Minimum Benefit Summary*

	NB	Que.	Ont.	Man.	Sask. No-fault	Sask. tort	Alta.	BC
Compulsory Minimum Liability coverage	\$200K	\$50K; \$500K for Off Road Vehicle.	\$200K	\$200K	\$200K	\$200K	\$200K	\$200K
Section "A" Benefits (Third Party Liability)								
1st payer or Last Payer.	Last Payer.	First Payer.	Last Payer.	First Payer.	First Payer.	First Payer.	First Payer.	Last Payer.
Death Benefit (HOH).	\$10K plus \$1K for dependants.	\$55K min. to \$275K max; plus \$26K to \$48K for dependants according to age.	\$25K for spouse; \$10K for dependants.	\$49K - \$325K plus \$23K - \$43K for each dependant according to age.	50% of Benefit received if survived; Min \$56,768.	45% of net earnings; \$45,000 min. \$52,788 max.	\$10K plus \$2K for dependants.	\$5K + modest weekly benefits. 104 week limit.
Medical Benefits	\$50K, 4-year limit.	No Limit.	\$100K per person; \$1M if injury catastrophic.	No Limit.	\$5M per person.	Severe Injury = \$150,000 max. Non-severe injury = \$20,000 max	\$50K per person.	\$150K per person.
Funeral Benefits.	\$2K	\$4K	\$6K	\$6.5K	\$7.7K	\$7.7K	\$2K	\$2.5K
Gross income versus net income	\$50K per person; 4-year limit.	90% of net; max \$52K.	80% of net.	90% of net wages.	90% of net max. \$58K.	45% of net \$45 - \$58K.	80% of gross.	75% of gross
Maximum Disability Benefits.	\$250 week; 104 weeks for Partial disability. Lifetime for total.	3 years for partial disability. Lifetime for total.	\$400 week; 104 weeks Lifetime if suitable employment unavailable.	\$64K per year.	\$680 week max.	\$150 for partial disability. \$300 week for total.	\$300 week.	\$300 week; 104 weeks After which is Reduced by any pension income.

The extra coverage over and above the mandated coverage includes; an increase in the level of mandated coverage such as increasing your liability from \$200,000 to \$1 million; uninsured motorist protection; collision or upset; specified perils; comprehensive; and, all perils. This optional coverage applies in all Canadian jurisdictions unless noted. Uninsured motorist coverage varies widely, from none in Alberta, to \$25,000 in Ontario, and as much as \$2,000 in Manitoba. Some jurisdictions require that the uninsured motorist be identified. In Quebec the Fonds d'indemnisation administered by the SSAQ compensates victims for

property-damage caused by an uninsured motorist or an unidentified third party. There is a \$10,000 limit. In Quebec and Ontario Direct Compensation – Property-damage may apply. (IBC) Last payer means that auto insurance only pays whatever benefits that are not covered by whatever other insurance a claimant may have. For example, if a person has a workplace disability plan, then that plan will pay first leaving the auto insurer to top up benefits if necessary. As a result, for those who are in last payer jurisdictions there is often an overlap between mandatory Section B coverage and employer and individual medical, disability and life insurance coverages. This principle is designed as a cost saving measure.

*Amounts at 2004 levels according to IBC. **Accident Benefits coverage is optional in Newfoundland and Labrador. ***Section “B” benefits are the first payer if claimant follows proscribed treatment plan.

Source: Reproduced from the following reference with small modifications: Public Utilities Board, Automobile Insurance Review, Report to Government, New Found land and Labrador, March 2005, exhibit 5, page 137.

Appendix 2.B:

Table 2.B1: Probit model of Mills ratio (Dependent variable: no-fault regime) (Obs.= 181)

Variables	Coeff.	t-values
Young	-0.777	0.840
Population65+	0.328	1.835
Population	1.901	0.589
Income	-0.004	0.004
Offences	0.025	0.060
Police	-0.280	0.084
Precipitation	-0.003	0.003
GDL	1.503	1.349
Risk-classification	-1.187	3.002
Seat-belt	0.537	3.480
ADLS	-0.568	1.988
SASP	3.769	1.508
Insurance Premium Index ⁵¹	0.039	0.040
Public	6.851	2.730
Constant	35.204	30.170

Log likelihood: -14.34

Wald chi2(14): 27.26

Table 2.B2: Test on serial correlation of first order (no endogeneity included)

FatalL	
Wooldridge test for autocorrelation in panel data	
H0: no first-order autocorrelation	
F (1, 6) =	2.444
Prob > F =	0.1690

APPENDIX 2.C: Data Sources

Except for the general data including real per capita disposable income, population, number of criminal code offences, precipitation, number of police officers, and the proportions of population with age between 16 and 24 and 65 and older which have been collected through the CANSIM and E-STAT, for other data different resources have been used for different

⁵¹ In another specification, we used one lag of the insurance premium instead of current level. The result on lagged-insurance premium was positive and significant. Using the result of this specification to calculate the Mill's ratios, provides a significant coefficient on no-fault, 3.56 as well; however, the effect is much less than the model that we used the current level of insurance premium index (i.e. 4.51), but still is more than the model without any endogeneity (3.06).

provinces. In the first part of the following section a summary of the data sources for each province is presented.

New Brunswick

The data for New Brunswick prior to 1993 has been collected from the “Motor Vehicle Traffic Collision Statistics” annual reports available in Transport Canada library. For the data on 1994-2004 we have contacted the Manager of Driver Safety, Motor Vehicle Branch, Department of Public Safety.

For the information on speed limit changes we have used CanLII (www.canlii.org/nb/laws/) as well as the volumes of *Statutes and Regulations* for 1980-2005 on “*Motor Vehicle Act*” and “*Highway Act*”.

Alberta

Driver safety, Research and Traffic Safety Initiative of Alberta infrastructure and Transportation (of Government of Alberta) publish a report under the name of “Alberta Traffic Collision Statistics” annually. These reports are available on-line (www.inftra.gov.ab.ca) for 1998-2005 and the previous issues are available in the Transport Canada library.

For the information on the insurance system we contacted AIRB (Alberta Automobile Insurance Rate Board) and using (<http://www.autoinsurance.gov.ab.ca/overview.html#transition>), and also for the information on Grid system, we have used (<http://www.autoinsurance.gov.ab.ca/>).

CanLII (www.canlii.org/ab/laws/) as well as Revised Statutes and Regulations of Alberta for years 1970, 1980, and also different volumes of Statutes and Regulations for different years

on “Highway Traffic Act”, “Traffic Safety Act”, and “Traffic Safety Amendment Act” have been used in order to get the information on changes in speed limits.

British Columbia

ICBC, Insurance Corporation of British Columbia prepares and publishes an annual report under the title of “Traffic Collision Statistics” which provides a variety of excellent information and datasets. We have used the different volumes of these reports. Many of the recent volumes for 1995 to 2004 are available on-line (www.icbc.com/library/) and the other issues are available in Transport Canada library.

For more information on the Risk classification system of the BC, we contacted the ICBC, and also BC’s branch of IBC.

The same website CanLII (www.canlii.org/bc/laws/) as other provinces on the Statutes and Regulation on “Motor Vehicle Act” for years 1979, and 1996-04 have been used to get some information on changes in speed limits.

Ontario

The data for this province has been collected from the annual reports of ORSAR (Ontario Road Safety Annual Report) which are available on-line from 1993 onward (www.mto.gov.on.ca/english/safety/orsar/), and also from the Ministry of Transportation library prior to 1993.

Information on speed limit has been gathered from the same source as other provinces, CanLII (www.canlii.org/on/laws/), since 1992, and from the Revised Statutes of 1970, 1980, and 1990, and Statutes and Regulation of year 1991, on the “Highway Traffic Act”.

For year 1978, the data on insurance premium index is available only for the last season of the year.

For the information on “risk classification system” we have looked at Brown (1998) and the “*Insurance Act*” of the Statutes and Regulations of the following years: 1993, c.10,S1-51, and c.27,Sch, 1994, c.11, S.336-348, c.27,s.43(2), 1996, c.21,s.1-49, 1997, c.16,s.10, c.25, Sch.E,s.5, c.28, s.64-147, c.43, Sch. F, s.5, 1999, c.6,s.31,c.12,Sch.I,s.4, 2000, c.26,Sch.G, 2001, c.8,s.43-44, 2002, c.14,Sch-s.10, c.17,Sch.F, Table, c.18,Sch H,s.4, c22, s.114-132, c.24-Sch.B, s.39.

Saskatchewan

The data on Saskatchewan has been collected form the “Saskatchewan Traffic Accident Facts” which has been prepared by SGI (Saskatchewan Government Insurance) and is available on-line just (www.sgi.sk.ca/sgi_pub/road_safety/trafficcollisionstats) for 2003 and 2004 and from the reports available in Transport Canada library for 1979-2002.

The data on speed limit has been collected from the CanLII website (www.canlii.org/sk/laws/) and also different volumes of Statutes and Regulations on Highways Act (the old version), and Highways Traffic Act (the new version) for the following years: 1986, c.H-3.1, s.33, 1986, c.C-15.1, 49, 51, 2002, c.C-11, c.44 and 48, 2003, c.15, 2004, c.L-16, 10 and 13, 2005, c.M-36.1.

Insurance premium data on 1978 just reflects the last season of the year and for the years prior to 1978, the data have been interpolated.

Manitoba

We have collected the data for Manitoba from the provincial Government website on Manitoba Highways and Transportation (www.gov.mb.ca/), the annual reports on “Driver, Vehicle, and Traffic Accident Statistics Report” and also “Traffic Collision Statistics Report” for different years which have been available in Ministry of Transportation Library located in

Ottawa. Also, for information on the speed limit changes we looked at CanLII website (www.canlii.org/mb/laws/) for period of 1992-2005 and *Highway Traffic Act (H60)* of Statutes and Regulation and Revised Statutes and Regulations for different years from 1982-2005. Also for some of the information, we called them directly.

Quebec

Most of the transportation-related-data for province of Quebec has obtained from the report of the “Dossier Statistique” of the “Société de l’Assurance Automobile du Quebec” (which is available in www.saaq.gouv.qc.ca/en/index.php), and some of the previous issues of that institution’s reports under the another name “Accidents, Parc automobile, permis de conduire” of the “Régie de l’Assurance Automobile du Quebec”, that have been available in library of Transport Canada.

For the data on the proportion of population with bachelor degree (one of the explanatory variable) as well as the real income per capita for period of 1975-78, we contacted the Provincial Government of Quebec.

Also for information on the speed limit changes we looked at CanLII website (www.canlii.org/qc/laws/) for period of 1992-2005 and *Highway (Safety) Code Act* of Revised Statutes and Regulations for the following years:

1986, c.91, s.328, 1990, c.83, s.140, 1996, c.22, s.213, 1996, c.56, s.82, 1998, c.40, s.93, 2000, c.64, s.10, 2003, c.8, s.6.

Also since the number of criminal code offences has been available in Canadian Centre for Justice Statistics (Juristat) for 1977-2005, after checking for consistency we have used the data of Devlin’s paper (1992) dataset for 1975-76.

The other data that have been available for prior to 1979, namely premium and real disposable income we used 5 years average to interpolate the data for 1975-78. However, insurance premium data on 1978 reflects the data for the last season of the year.

Data sources common across the provinces

For the data on precipitation we used two different sources, namely AHCCD's (Historical Canadian Climate Data) website (<http://www.cccma.bc.ec.gc.ca/hccd/feedback/>), and also Environment Canada website on weather condition:

(http://www.weatheroffice.ec.gc.ca/canada_e.html).

Also we contacted Traffic Injury Research Foundation (TIRF) for change in speed limits, but we didn't get any information from there. We also contacted the Road Safety department of Transport Canada, but they couldn't help us in that regard.

For the information on the detail of the no-fault insurance for different provinces we contacted the IBC "Insurance Bureau of Canada" of the Alberta, BC, and Ontario, but no information have been provided which we had to use just the information available on IBC website (Facts 2005). Also we looked at "Insurance Act" of the Statutes and Regulations volumes (namely for the year, 1978, 1994, 1994, and 1990, 1994, and 1996 for Quebec, Manitoba, Saskatchewan, and Ontario, respectively).

For the data on proportion of population with bachelor degree we contacted Data Dissemination Officer/Agent de diffusion des données, Statistics Canada, but after a lot of search they couldn't provide us a consistent and enough time series data in that regard.

Transport Canada prepares a summary of casualty rates for all provinces. But we couldn't use those data because the measures have been changed over time. More specifically the data on casualty rates per 100000 Population, per billion Vehicle-Kilometers (VKM), and per

100000 Licensed Drivers have been provided for 2002-04, per billion Vehicle-Kilometers for 2000-01, per 10000 motor vehicle registered for 1987-2000, per 100 million Vehicle-Kilometers for 199-86.

For information on the number of hospitals or health center per 1000 square we contacted the Health Canada, but no information was provided.

The data on “Highest level of schooling for Canada and provinces and territories” is available in Statistics Canada, Catalogue number 93-328 from 1951-1991 for every 5 years apart. We could interpolate the rest of the data for the other years left, but in order to avoiding any inconsistency, we didn’t include data on bachelor degree in our models.

Data description

Fatal: is the number of fatality car accident obtained from “ORSAR” for Ontario, “Dossier-Bilan” for Quebec, “Alberta Traffic Collision Statistics” for Alberta, “Traffic Collision Statistics” for British Columbia, “Driver, Vehicle, and Traffic Accident Statistics Report” for Manitoba, “Motor Vehicle Traffic Collision Statistics” (and also on phone) for New Brunswick, and “Saskatchewan Traffic Accident Facts” for Saskatchewan.

FatalL: is the number of fatality car accident divided by 100,000 licensed drivers.

Personal Injury: is the number of personal injuries happened because of car accident. The references for personal injury accidents are the same as fatal accident above.

PIL: is the number of personal injury accident divided by 100,000 licensed drivers.

Property-damage only: is the number of property-damage only accidents. These data also have been obtained form the same references as fatal and personal injuries.

PDL: is the number of property-damage only accidents divided by 100,000 licensed drivers.

Population: is the size of the population for each seven provinces mentioned in the models. They have been obtained from CANSIM table number 051-0005, “Estimates of population, Canada, provinces and territories, quarterly (100000 persons)”.

Young: is the percentage of the population with the age at the range of 16 to 24 year-old. These data have been obtained from CANSIM table number 510001, “ESTIMATES OF POPULATION, BY AGE GROUP AND SEX, CANADA, PROVINCES AND TERRITORIES”.

Pop65+: is the percentage of the population with the age of 65 years old and more. These data have been obtained from CANSIM table number 510001, “ESTIMATES OF POPULATION, BY AGE GROUP AND SEX, CANADA, PROVINCES AND TERRITORIES”.

Income: is the real personal disposable income which has been calculated by dividing the nominal disposable income in million dollars (CANSIM, table 3800050 prior to 1990 and E-stat, table number 384-0012 for 1991-2005) divided by the population to CPI (table number 326-0002) for each province.

Offence: is the number of criminal code offences per 100 000 population. They have been obtained from the Canadian Centre for Justice Statistics (Juristat), Statistics Canada, Catalogue no. 85-002-XIE, for 1977 to 2005.

Police: is the number of police officer per 100000 populations. The statistics on this variable have been obtained from table number 254-00011 of E-stat.

Driver: is the number of drivers obtained from the same sources as fatal statistics. The dependent variable for all equations has been calculated by dividing the number of fatal, personal injury and property-damage to number of licensed drivers.

Precipitation: is the precipitation data from CIDC website.

Graduation: is the Graduated Driver Licensing System. The information on this variable has been obtained from the “Best Practices for Graduated Driver Licensing in Canada” (IBC), October 2005.

Speed: is a dummy variable to show the changes in speed limit (range of speed). The information for this variable has been obtained from the “Revised Statutes” and also “Statutes and Regulations” from 1975 to 2005. All Canadian provinces switched from miles per hour to kilometer per hour at 1977. Since the dataset for all provinces start after 1977, except Quebec, we didn’t include a dummy variable to capture this change. For Quebec, since no-fault has been adopted at 1978, inclusion of dummy variable for change in speed system make co linearity problem.

No-fault: is a dummy variable equal to 1 for the provinces for the periods that no-fault has been introduced and equal to 0 for the provinces with Tort legal system and also for the periods prior to introducing no-fault in no-fault provinces. The information on this variable has been obtained from many reports and existing documents and papers on no-fault insurance including, but not limited to, IBC website, Devlin (1992), Brown (1998) and the “Report on Alternative Automobile Insurance Compensation Schemes for Atlantic Canada Harmonization Task Force”, September 2003.

Risk-classification: is a dummy variable to represents the changes in different “Risk Classification System” of the different provinces. The information on this variable for Manitoba, Saskatchewan, and BC have been obtained from the “*Report on Alternative Automobile Insurance Compensation Schemes for Atlantic Canada Harmonization Task*

Force”, September 2003, and for Quebec from the George Dionne’s 2001 working paper “*Commitment and Automobile Insurance Regulation in France, Quebec and Japan*”.

For Ontario and New Brunswick the information has been collected from Brown (1998), internet sources and “The Statute and Regulation” reports for different years, as well as the report “*Public Utilities Board, Automobile Insurance Review, Report to Government*” for the Newfoundland and Labrador.

Vehicle: is the number of vehicle registered obtained from the same sources as fatal statistics.

Pure no-fault (Quebec and Manitoba): this variable represents the no-fault regime in Quebec and Manitoba which is 0 prior to 1978 and 1994 for Quebec and Manitoba, respectively, and all other provinces for all years and 1 for 1978-2005 for Quebec and 1994-2004 for Manitoba.

Ontario (Verbal): this variable represents the no-fault regime in Ontario and is 1 for Ontario for 1990-2004 because of verbal threshold system and 0 for 1978-89 for Ontario and all years of all other provinces.

Saskatchewan (semi-monetary): this variable represents the no-fault regime in Saskatchewan and is 1 for Saskatchewan for 1995-2004 because of monetary threshold system and 0 for 1977-94 for Saskatchewan and all years of all other provinces.

TortIM: is the multiplication of tort Mills ratio with one minus no-fault indicator (instrument for tort).

NofaultIM: is the multiplication of no-fault Mills ratio with no-fault indicator (instrument for no-fault).

Vehpop: is the ratio of the total vehicle to the population.

Seatbelt: is a dummy variable representing the time of adopting mandatory seat belt laws in provinces.

ADLS: is Administrative Driver License System adopted by the provinces. The information on this variable has been obtained from the provinces insurance websites and “*AN EVALUATION OF THE SPECIFIC DETERRENT EFFECT OF VEHICLE IMPOUNDMENT ON SUSPENDED, REVOKED AND UNLICENSED DRIVERS IN CALIFORNIA*” and “*Evaluation of the Alberta Administrative License Suspension Program*”.

SAS: is the Short-term (24 hour) Administrative Suspension program. The information on SAS has obtained from “*An assessment of effectiveness in Saskatchewan*” published by Traffic Injury Research Foundation (TIRF).

Premium: is the vehicle insurance premium index obtained from StatCan CANSIM table 326-0020. The data on this variable for the years before 1978 is not available in Statistics Canada dataset. For our case, we backcasted the insurance premium index for Quebec (for 1975-1977) and Saskatchewan (for 1977) using a three year moving average.

Chapter Three

The Effects of No-fault and Choice Systems on Severity in Saskatchewan: A Micro Level Data Analysis

3.1. Introduction

In a seminal paper O'Connell (1965) proposed that recoveries for automobile insurance shift from the traditional liability-based system to a 'no-fault' approach. Starting in the 1970s, an increasing number of jurisdictions shifted from liability to no-fault, prompting a number of researchers to examine the impact of this shift on matters such as driver care. Proponents of no-fault automobile insurance argue that the no-fault regime leads to a more equitable compensation regime, and that the costs of running such a system are lower in comparison with a liability based system. In contrast, the proponents of liability underscore the incentive problems that arise under no-fault, and in particular the problem of moral hazard which arises from the fact that accident victims are compensated irrespective of fault, which may therefore reduce the care taken by drivers.

In 1986 O'Connell proposed yet another insurance compensation system, which he christened "choice". Under 'Choice', drivers may choose to be insured under a no-fault scheme or under a liability-based one; this regime is sometimes called a choice no-fault or mixed-no-fault. Although still relatively rare, a number of jurisdictions have moved to implement 'choice'. In particular, three states in the United States have choice regimes in place: Kentucky moved to choice in 1975, New Jersey in 1989, and Pennsylvania in 1990 (Schmit and Yeh 2003). New Jersey and Pennsylvania offer insured drivers the choice between no fault with a verbal threshold, on the one hand, and pure liability, on the other. In contrast, the no fault regime in Kentucky is monetary.⁵⁴

A number of studies have investigated various aspects of no-fault insurance, including its ability to lead to cost savings (e.g., Cohen and Dehejia 2003), the relationship between the level of driving care and no-fault system (e.g. Devlin 1992; Cummins et al. 1992 and 2001), the speed of compensation under no-fault as compared with liability (e.g. Carroll and Kakalik 1993), and the impact of no-fault on the severity of injuries (e.g. Devlin 2001). Relatively few studies, however, have paid any attention to these same issues in the context of the choice system.

Most of the existing studies on choice focus on the effects of such a system on insurance administration costs and compensation (e.g. Carroll and Abrahams 1998), or attorney usage, settlement duration and payments (e.g. Schmit and Yeh 2003). To our knowledge, there is no empirical study of the effects of a choice system on the level of care taken by drivers. The first contribution of this chapter, therefore, is to undertake such an analysis using a unique data set on Saskatchewan drivers.

⁵⁴ See the Insurance Information Institute website: <http://www.iii.org/media/hottopics/insurance/nofault/>, Nov. 4, 2008.

The second contribution of this chapter is to enrich our understanding of the link between the introduction of no-fault insurance and accident severity by looking at data for Saskatchewan in 1995. Chapter two examines the link between no-fault measures and the number of accidents in seven Canadian provinces. However, as that chapter relies on aggregate data, this precludes an analysis of the relationship between the implementation of no fault coverage and accident severity. In contrast, this chapter uses micro data on individual drivers. The data set used here provides information on the injuries of all drivers involved in accidents from 1988 to 2005, allows us to fill this void in the literature and hence to understand better how the mix of accidents may be influenced by the insurance rules in operation.

The results of this chapter show that the implementation of no-fault rules increases the severity of accidents, i.e., there is a statistically-significant shift toward more serious injuries (including fatal accidents). In contrast, the introduction of choice system does not have a statistically-significant impact on the severity of injuries.

The chapter is organized as follows. In section 2, a short history of the choice system is provided; a literature review is presented in section 3. Section 4 provides a description of the dataset. The empirical approach is discussed in section 5. Section 6 reviews the variables used for modeling in the analysis while section 7 presents the results. The final section concludes.

3.2. A Brief History of the Choice System

Several reasons have been put forth as to why a no-fault regime is desirable relative to a liability-based regime: individuals involved in accidents are compensated in a timelier

manner; less money is spent on lawyers, and court costs are reduced if not eliminated (e.g., see Keeton and O'Connell 1965). It is also claimed that individuals with minor and major injuries are compensated more equitably under no-fault rules: less is paid for minor injuries and more for major injuries relative to a liability-based system (IBC website⁵⁵). Lascher and Powers (2001) argue that a 'choice' regime enables society to take advantage of the cost savings aspect of no-fault, while simultaneously addressing the most important shortcoming of mandatory no-fault, i.e., the restriction on the opportunity of accident victims to seek any recovery through traditional liability system.

Any analysis of the 'choice' system requires an understanding of two fundamental characteristics of the system. The first one is the nature of the no-fault barrier to tort recovery, i.e., is there a monetary or verbal threshold, or is it a pure no-fault regime. The second key issue is the mechanism for the resolution of claims arising from accidents involving drivers who are insured under both tort and no-fault regimes. Regarding the manner in which claims are resolved when accidents involve drivers insured under each of the possible regimes, Powers (1992) describes the three possible systems, 1) "tort-favoring", 2) "no-fault-favoring" and 3) "self-determining". Under "tort-favoring" both parties involving in accident have access to tort rights, without restriction. Under "no-fault-favoring" both parties face restricted tort rights. Under a "self-determining" system the drivers who elected to be insured under a liability-based system have access to tort recovery but the no-fault electors are subject to restricted tort rights.

There are a few examples of choice system. Three states in the United States operate under choice rules: Kentucky, New Jersey and Pennsylvania have implemented "choice" system since 1975, 1989, and 1990, respectively. In New Jersey and Pennsylvania, drivers

⁵⁵ http://www.ibc.ca/en/Car_Insurance/ON/No_Fault.asp. Nov. 4, 2008.

choose between no-fault and tort at the time they purchase insurance. Motorists who choose the no-fault option receive payment for their injuries from their own insurers up to the statutory maximum limit of coverage, as in any no-fault jurisdiction. The statutory requirements are \$15,000 Personal Injury Protection (PIP) covering medical expenses in New Jersey, and \$5,000 PIP covering medical expenses in Pennsylvania. Any economic damages above these limits can be sought from a negligent third party. Non-economic damages are available only if injuries exceed a stated verbal threshold of seriousness. For insureds in either state who select the tort option, there is no limitation on non-economic damages. Both Bodily Injury (BI) liability and PIP coverage, therefore, must be purchased by all New Jersey and Pennsylvania drivers (Schmit and Yeh 2005). Kentucky state law requires minimum Bodily Injury Liability limits of \$25,000 per injured person up to a total of \$50,000 per accident, and Property Damage Liability coverage with a minimum limit of \$10,000 (Kentucky Office of Insurance).⁵⁶

In Canada, the Province of Saskatchewan introduced a no-fault regime in 1995. In January 2003, Saskatchewan began to allow drivers to opt out of most of the provisions of the no-fault plan in favor of a tort system (IBC, Facts book, 2005).⁵⁷ However, even under the liability regime, some no-fault benefits are still available. Table 3.1 compares the choices faced by drivers in Saskatchewan as of 2003. As can be seen, there is a considerable difference in the no-fault amounts that are paid under these two regimes in the event of an accident. The most striking difference is with respect to medical payments, which may go as high as \$5,502,680 under no-fault rules as compared to \$21,506 under liability – the idea being that individuals may sue the at-fault driver under liability rules for the value of their

⁵⁶ <http://www.doi.state.ky.us/kentucky/> Nov. 4, 2008.

⁵⁷ http://www.ibc.ca/en/need_more_info/documents/factsbook2005.pdf, April. 20, 2008.

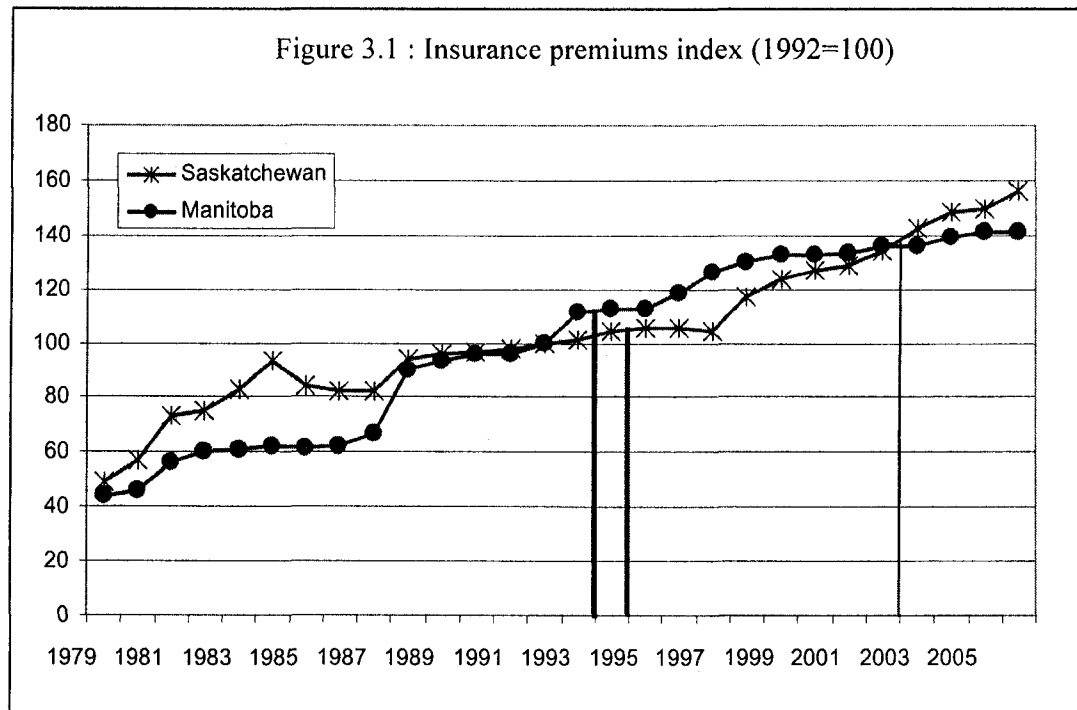
damages not covered by the basic no-fault provisions. The other main difference between the two regimes is that whereas, under liability, the victim may sue the at-fault driver for up to \$200,000 for pain and suffering, there is no compensation awarded for pain and suffering under the no-fault scheme.

One of the interesting features of the Saskatchewan regime is that drivers face the same premiums regardless of which plan they choose. The insurance premiums determined by the Saskatchewan Government Insurance (SGI) agency are calculated using a universal rating program that does not differentiate on the basis of age, gender, or kilometers driven. The main factor used to distinguish between risk classes is the collision history of the driver. The type of vehicle driven is also a factor. The vehicles make and model, along with Canada-wide loss experience and Saskatchewan loss experience, are used to determine an adequate base rate for damage and injury coverage for specific vehicles⁵⁸.

A quick look at the trend of insurance premiums in Saskatchewan provides a clearer idea of how premiums have evolved over time and how changing regimes may have influenced the premiums. As can be observed from figure 3.1, the insurance premium was stable until around 1998; thereafter it began to steadily rise. It is interesting to compare this pattern to what was observed, over the same time period, in Manitoba which, like Saskatchewan, also operates under a public system, and adopted no-fault insurance in 1994, one year before Saskatchewan. Comparing the insurance premium index for these two provinces, shown in figure 3.1, suggests that Manitoba has been more successful in controlling costs as compared to Saskatchewan. As compared to Manitoba, premiums in

⁵⁸ In New Jersey and Pennsylvania, insurers are required by law to charge lower premiums for those who choose no-fault. Furthermore, a "Risk Exchange" facility was established in New Jersey to cover any non-economic damages that have to be paid out by no-fault insurers to tort claimants (Schmit and Yeh 2005). In Kentucky, insurance rates are determined based on driving record, age, area in which you live, and the type of vehicle you drive (Kentucky Office of Insurance, <http://www.doi.state.ky.us/kentucky/>, Nov. 3, 2008).

Saskatchewan increased even more after 2003, perhaps as a result of the introduction of the choice system.



Source: Based on data drawn from Statistics Canada, tables v41694567 and v41694431

3.3. Literature review on choice system

O'Connell and Joost (1986) were the first to propose that drivers should have the option of selecting between coverage provided under either traditional liability rules or under a no-fault regime, thereby giving rise to the choice system. According to O'Connell and Joost (1986, p. 76) "the most practical and politically accepted method of eliminating no-fault's problems while respecting the preferences of advocates of traditional insurance is operating both systems, giving consumers the choice". They argue that the choice system has four advantages over the traditional approach of one regime for all: 1) it transfers the decision

making power from politicians to consumers; 2) it is sensitive to differences in individual's preferences for retaining the right to sue versus obtaining a quick settlement; 3) it enhances efficiency; and 4) it increases competition in the marketplace, by increasing the range of insurance products available to drivers.

Power (1992) describes three different types of optional no-fault including "tort-favoring", "no-fault-favoring" and a "self-determining" system. Powell argues that the "self-determining" system is more equitable than tort, pure no-fault or any other optional no-fault regime. He concludes that a "self-determining" system is both more "tort equitable" - because it does not involuntarily restrict injured parties from using the tort system - and also more "rate equitable" - by offering lower rates to insureds who choose not to use the litigation system - than any other currently observed systems.

The different no-fault regimes - namely, the pure, hybrid and choice regimes - are reviewed by Schwartz (2000), who claims that the choice system will not work as predicted because of problems of adverse selection. However, Schwartz does not explain why he believes adverse selection will be a problem with choice. Carr (1989) and Kabler (1999) also believe that a choice system can lead to adverse selection problems and therefore it is economically inefficient and socially harmful. Carr (1989) argues that in the absence of externalities, a choice system can be superior to other systems. However, in the case of automobile accidents there are externalities, the most important of which is that the choice system will tend to sort high and low risk drivers between the two different regimes, with high-risk drivers tending to opt for the no-fault insurance plan. As a result, the low risk drivers who stay with the no-fault system are the most adversely affected because they will end up cross-subsidizing the high-risk drivers in the pool.

The financial implications of the choice system are examined in Carroll and Abrahams (1998), who look at the effects of choice on automobile insurance administration costs and victim compensation using a simulation methodology of closed claims in the US in 1997. They compare the relative savings and costs for various states under their current system and under a hypothetical choice system. Their results show that the introduction of choice could reduce the costs of insurers by 24 percent (Carroll and Abrahams 1998).

Schmit and Yeh (2003), using claims data from New Jersey and Pennsylvania for 1987 (pre-choice) and 1997 (post-choice), examine the effect of adopting a “choice” system on three dependent variables: attorney usage as proxy for administrative waste, settlement duration as proxy for speed of payment and variability in payments as proxy for equity of payments. The comparison is of interest because New Jersey switched in 1989 from a no-fault to a choice system, while Pennsylvania switched from a tort to a choice system in 1990. The results for New Jersey show that attorney involvement, settlement duration and variability in payments increased as a result of moving to a choice system from a no-fault, while in Pennsylvania case, they found weak evidence of decreased attorney usage, and lower settlement duration, but strong evidence of increased variability in payments relative to loss. Furthermore their results on tort versus no-fault (for post choice) does not provide clear evidence of lower administrative costs, and speedier, more equitable payments for those who chose no-fault in New Jersey and Pennsylvania.

The incentive and efficiency impacts of the three compensation systems (pure tort, choice and pure no-fault) are compared in Liao and White (2003) using simulations. They conclude that none of these systems invariably dominates the others with respect to efficiency (as measured by the level of driving care), but the choice system is the least

efficient outcome because drivers choose pure tort too often; pure no-fault performs the best when the cost of driving care is high and pure tort is best when the cost of driving care is low.

3.4. Data

The econometric analysis undertaken in this chapter exploits an original dataset consisting of 84,555 daily observations on Saskatchewan drivers involved in accidents over the period 1988-2005. Observations are per driver involved in an accident with bodily injuries. If two cars are involved in an accident and both of the drivers are injured then the outcomes for both of the drivers are recorded as separate observations in the dataset. However, if only one of the drivers is injured then the property damages suffered by the non-injured driver are not included in our sample. Also, there is possibility of bias arising from the fact that some drivers may be involved in more than one accident.

After excluding drivers less than 16 years of age, we are left with 81,331 observations.⁵⁹ The dataset includes a wide spectrum of information including the age and sex of the driver, whether there were major contributing factors to the accident, any charges laid by police after the occurrence of the accident, the type of the safety equipment used, whether or not the accident occurred in a rural or urban region, the type of the vehicle involved in accident and the exact day, month and year of the accident.

The dataset distinguishes among four different factors contributing to accidents: the driver's condition, the driver's action, vehicle problems, and environmental conditions. A list

⁵⁹ The minimum age for having a driver's license is 16 years – we believe that the behavior of this group of drivers is not affected by the different legal regimes. This group includes drivers under 10 years of age who are likely cyclists or operators of other unregistered vehicles, drivers with an age of 0 are those whose age is "not stated". This would include hit and run drivers etc.

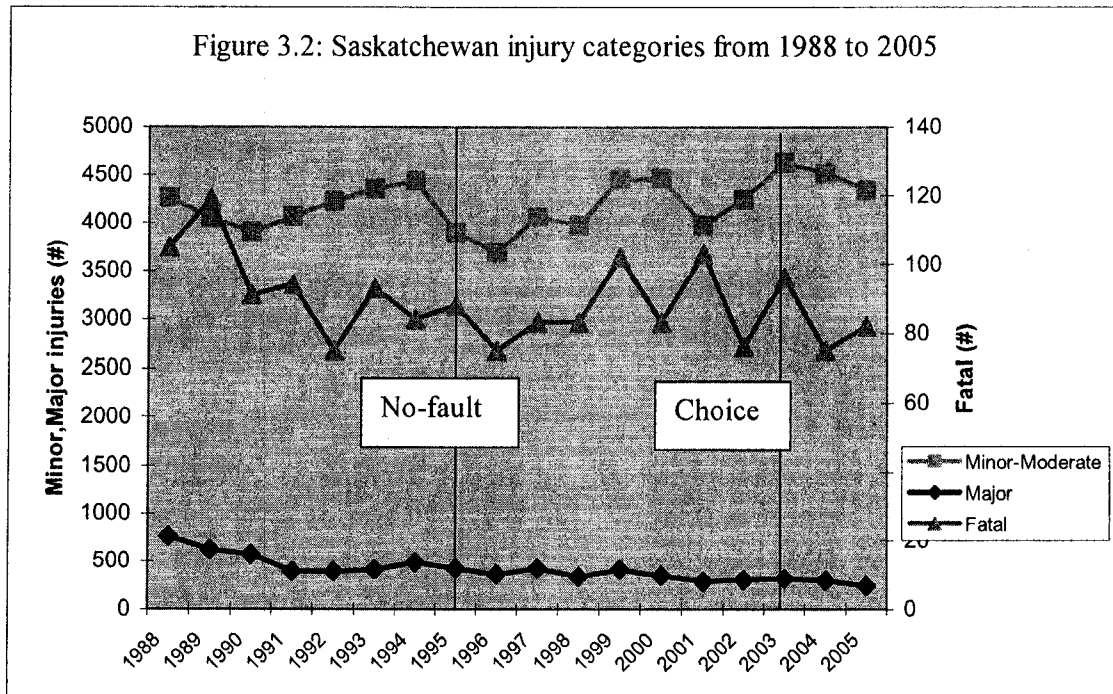
of these factors is provided in table 3.A in the appendix. Table 3.2 describes each of the variables in the dataset, while table 3.3 provides descriptive statistics for each variable.

The information on the severity of the accidents is grouped into five categories: minor injuries, moderate non-capacitating, major incapacitating, major unconsciousness and fatal accidents. On average, based on the data on injury type, 57 percent of total accidents in which there were bodily damages gave rise to minor injuries, 32 percent moderate, 8 percent major incapacitating, almost 1 percent major unconsciousness and 1.9 percent resulted in fatal accidents.

Figure 3.2 depicts changes in the trend for three levels of injuries.⁶⁰ Minor injuries are invariably the most frequent, whereas fatal accidents are the rarest. However, year-to-year variation in the rate of fatal accidents is greater than the volatility in the rate of accidents giving rise to less severe injuries. The fact that there is a clear decrease in the frequency of most of the injury types over time suggests that the possibility of a trend should be included in the estimating equation. Based on the graph, from 1995 to 2003, there is a positive trend for minor injuries and fatal accidents, where the trend of the other types of accidents levels is constant.

⁶⁰ Just for easy comparison purposes, we showed minor and moderate injuries as one category and both major injuries, incapacitating and unconsciousness, as another category and fatal as a third category.

Figure 3.2: Saskatchewan injury categories from 1988 to 2005



Source: Author, produced from dataset.

Among the drivers who were involved in accidents, 44.7 percent were female and 55.3 percent were male. Regarding the level of severity of accident by gender, male drivers were involved in more severe accidents than females. This breakdown is provided in table 3.4. More than 62 percent of accidents occurred in urban areas. However, the accidents that occurred in rural regions appear to be more severe on average than those in urban regions: for instance, 4.3% of rural accidents are fatal ones as opposed to 0.5% of urban accidents. Table 3.4 also provides the breakdown of accident types by driver's age. The highest percentage of drivers involved in accidents is aged 35-54, and they account for 29 percent of all accidents (see the last column of the table). Also, as can be seen from table 3.4, drivers aged 65 and older and aged 55-65 have the highest percentage of fatal accidents, 4.6 and 2.8% respectively, as compared to the other age categories.

The data set provides information regarding the safety equipment employed by drivers at the time of the accident.⁶¹ About 19 percent of the drivers involved in accidents did not wear any safety equipment, or was using it improperly. Cross tabulation of the type of injuries with the wearing safety equipment shows that not using or using such equipment improperly led to the highest percentage of fatal accidents.

Table 3.5 provides information on the traffic infractions levied on the driver at the time of the accident. The data reported by the police categorizes the charges into two possible categories - the main (or first) charge and the secondary one, if applicable. Table 3.5 shows that from among the 32 different first charges laid, “drive without due care”, “failed to yield right of way” and “impaired driving refusing test” are the most prevalent with 21, 14 and 13 percent of total charges, respectfully. But among the second charges, “no driver’s license” and “impaired driving refusing test” are highest with 20 and 15 percent of the total charges. Also, cross tabulating the types of charges with type of injuries in table 3.5 reveals that “drive without due care” and “impaired driving refusing test” are more strongly correlated with fatal accidents and major unconsciousness injury, respectively.

Table 3.6 reveals that the percentage of drivers involved in accidents in urban areas and wearing safety equipment is higher than those involved in accidents in rural area. Also, the percentages of drivers who had accidents, or who committed traffic offences, is higher in rural than in urban areas. One might hypothesize that drivers are more aggressive in rural areas because they believe it less likely that infractions will be detected by the police.

As discussed earlier, the literature suggests that higher risk drivers will choose the no-fault regime, while lower-risk ones will opt to be covered under liability. Table 3.7

⁶¹ Safety equipments includes lap and shoulder belt, lap shoulder belt and airbags, child restraint rear facing, child restraint front tether, child restraint front no tether, child booster seat and helmets.

compares the distribution of the severity of injuries before and after introducing the choice regime with respect to a number of driver characteristics. Before and after refers to the period prior to and after the introduction of choice in January 2003. As can be seen from these two tables, after the introduction of choice system there was a decrease in the severity of injuries, with a shift from major and moderate injuries to minor injuries. However, the percentage of fatal injuries did not change.

3.5. Empirical Framework

One of the main questions motivating our empirical analysis is whether and to what extent the introduction of a choice system affected accident severity. The literature on this topic is quite sparse. However, as previously indicated, some authors have discussed the likely impact of a choice system on the risk distribution of drivers. In effect, one expects that low risk drivers will opt for the liability-based regime, while high-risk drivers would opt for the no-fault provisions. As such, relative to a no-fault only regime, the presence of a liability option may serve to increase the overall care taken by drivers, because those who opt for a liability rule will, at least in principle, drive more carefully.

One challenge associated with trying to examine how the choice system affected drivers in Saskatchewan has to do with the way in which the liability option was priced. As mentioned already, the premiums for the no-fault and liability-based packages were the same. Potentially as a consequence of this, and also because of the generosity of the no-fault provisions vis-à-vis the liability package, not many drivers opted for the tort regime. Based on the information provided by the Saskatchewan Government Insurance agency, the total number of individuals who chose the tort program was 4330, 5022, 5321 and 5426 per year

over the 2003-2006 period, which represented, respectively, only about 0.65, 0.75, 0.79 and 0.81 percent of the driving population.⁶²

Although the data set used in this paper is very good on a number of fronts, providing an extraordinary amount of detail on driver characteristics and the like, it has one main flaw. The data set does not tell us if the driver involved in the accident had opted for the liability or the no-fault system. As such, we have to rely on measures of the overall accident severity in order to judge whether the choice system had an impact on accidents.

An important limitation of our dataset is that it does not include data on drivers who did not have accidents, or who had accidents resulting only in property damage. Consequently, there is a selection bias, and this means that it is extremely important to be very careful about interpreting our findings. If we assume that the number of licensed drivers in the province varied little from year to year (or that the variation in the number of licensed drivers was picked up by our trend variable), then we can make statements to the effect that 'the probability that a Saskatchewan driver will be involved in an accident resulting in severe injuries has increased as a result of the implementation of no-fault insurance'. In contrast, since we do not know whether the number of total accidents increased or decreased during this period, we cannot make statements to the effect that 'the probability that an accident resulted in severe injuries increased as a result of the introduction of no-fault insurance'. In particular, if the introduction of no-fault insurance resulted in a large increase in the number of accidents, it is possible that the probability that a Saskatchewan driver was involved in an accident resulting in a severe injury increased, but that simultaneously the probability that an accident result in severe injuries could have fallen.

⁶² In New Jersey and Pennsylvania, a large majority of insureds opted for default option in which in New Jersey, the default option is no-fault whereas in Pennsylvania it is tort. (Schmit and Yeh 2005). It looks like that there is some stickiness to the default option in both Canadian and American cases.

As discussed above, the literature on choice *per se* is quite small. However, it is evident that more and less risky drivers are likely to react differently to the introduction of choice. *A priori*, it seems more likely that less risky drivers will opt into the tort regime because they can sue the negligent driver, whereas riskier drivers will prefer no-fault. Generally speaking, then, shifting from a no-fault to a ‘choice’ regime should reduce the overall riskiness of the pool of the drivers because, on the one hand, it does not change the incentives facing those drivers who choose to continue to be insured under no-fault while, on the other hand, encouraging drivers who opt into the liability system to take greater care. Moreover, since the remaining pool the drivers covered under the no-fault regime will be riskier, this should lead to higher premiums for no-fault coverage which, as Lascher and Powers (2001) suggest, may in and of itself drive out additional less risky drivers from the no-fault to the liability regime.

This study follows the existing literature with micro-level data on similar topics (e.g. Dionne 2001). Given that the dataset provides information on the severity of the accident, an ordered probit model is used to investigate how the distribution of injury severity was affected by the introduction of no-fault and choice systems.

The model that was used is:

$$y_{it} = \alpha + \lambda(\text{no-fault})_i + \phi(\text{choice})_i + t + (t - \text{square}) + \varepsilon_{it} \quad (1)$$

where y_{it} is the dependent variable for individual i at time t , and measures injury severity on a scale of 1 (minor injury) to 5 (fatal accident); *no-fault* is a binary variable representing the introduction of the no-fault system in 1995; *choice* is a binary variable denoting the introduction of the choice system on January 2003; X_{it} is the matrix of the explanatory variables including the individual characteristics, environmental factors and major factors

contributing in accidents; t and t -square denotes the time trend and the square of the time trend variable (to control for any variation in the data which is not captured by the explanatory variables and which is common across individuals but not over time and affected the severity of the accidents), and ε_{it} is the error term which captures the impact of non-observed variables on the dependent variable.

The ordered probit model is used to model the effect of the switch from no-fault to choice on five types of injuries. The ordered probit model is different from the probit and logit model in the way that it distinguishes between the ordered ranks of the dependent variable. In our model, a bigger number represents a higher accident severity. The ordered probit model takes into consideration this categorization of the dependent variable. Our model is a good example of multinomial choice variables that are “inherently ordered” (Greene 2003), and can be written as follows:

$$y^* = x\beta + \varepsilon ,$$

where y^* is a latent variable and is therefore unobservable. We instead observe y which is:

$$\begin{aligned} y &= 1 \text{ if } y^* < 0, \\ y &= 2 \text{ if } 0 < y^* < \mu_1, \\ y &= 3 \text{ if } \mu_1 < y^* < \mu_2, \\ y &= 4 \text{ if } \mu_2 < y^* < \mu_3, \\ y &= 5 \text{ if } \mu_3 < y^* < \mu_4, \end{aligned}$$

$$\text{Or, more generally, } y = \sum_{j=0}^4 j \cdot 1[\mu_j < y^* < \mu_{j+1}] \quad (2)$$

where the μ 's are unknown parameters (thresholds) that can be recovered after estimating the β 's. There are five different levels of injuries, i.e. $j=5$. y^* and y can be actual accident severity and the type of the injury sustained by the victim of an accident, respectively. The

probability that severity of injury of individual i , given a set of characteristics x_i , falls within bracket j , is:

$$P(y_i = j | x_i) = \Phi\left(\frac{\mu_{j+1} - x_i \beta}{\sigma}\right) - \Phi\left(\frac{\mu_j - x_i \beta}{\sigma}\right) \quad (3)$$

For our case, with five levels of injuries, the probability that an accident is of a specific level of severity is calculated as follows:

$$P(y_i = 1) = \Phi(\mu_1 - x\beta)$$

$$P(y_i = 2) = \Phi(\mu_2 - x\beta) - \Phi(\mu_1 - x\beta)$$

$$P(y_i = 3) = \Phi(\mu_3 - x\beta) - \Phi(\mu_2 - x\beta)$$

$$P(y_i = 4) = \Phi(\mu_4 - x\beta) - \Phi(\mu_3 - x\beta)$$

$$P(y_i = 5) = 1 - \Phi(\mu_4 - x\beta)$$

These relations show how we can estimate the probability changes given a small change in x_i . However, for this type of model, the overall change in the probability for each x_i must add up to zero: in other words, the model measures the redistribution across the (in our case) five classes of variables that arise from a change in any given independent variable. Consequently, if the sign of the estimate for the highest class of injury is positive, then the sign of the estimate must be negative for a lower class of injury. Greene (2003) notes that very large t -ratios should be expected in estimating an ordered probit model.

3.6. Model specification

The variables used in the analysis were chosen based both on previous empirical work on the determinants of accidents (e.g., Dionne 2001) and on the available data. It is generally

argued that the age and gender of the driver matter. Young drivers are generally believed to be less careful than older ones. However, young drivers are also believed to be capable of making faster decisions than can older ones. So although elderly drivers are more cautious in their driving habits, they are also more prone to accidents due to slow reaction time. This means that, *a priori*, the effect of age on severity is ambiguous. Similarly, it is a stylized fact that male drivers are more prone to accidents, which implies that there should be a higher estimated probability of male drivers incurring serious injuries as compared to females. The underlying reasons for the high rate of severe accidents amongst male drivers includes time spent behind the wheel, drinking and driving, and speeding. The location of the accident is another variable which is included in the model. Judging from results reported elsewhere (e.g. Cummins et al. 2001) we expect that driving in a rural area will be associated with more serious injuries.

The data set used in this paper records daily accidents. This means that it is possible to investigate the influence of precipitation on accident severity, by including data on daily rainfall and snow. The precipitation variable is a daily average of precipitation in Saskatchewan over the period under study. The inclusion of daily data on precipitation also allows us to control for the seasonality effect that can affect the seriousness of the accidents. Note that the expected sign on precipitation is ambiguous: difficult weather conditions should lead drivers to drive more carefully, on the one hand, but it can also create uncontrollable situations with more serious accidents, on the other. The actual state of the road (e.g., potholes, requiring re-surfacing) may also affect the severity of accidents. Unfortunately, the data set does not report on such conditions. We thus include a trend variable that can pick up any systematic changes in conditions over time (we also include the square of the trend to pick up non-linear time effects).

The data set indicates if the driver was wearing safety equipment at the time of the accident. The most common piece of equipment is a seatbelt; however, crash helmets are also important for motorcycle drivers. The model includes a dummy variable if the driver was wearing a seatbelt when no airbag deployed, another dummy variable denoting seatbelt usage plus deployed airbag, and a third dummy indicating that the driver was wearing a crash helmet. Wearing safety equipment should lead to less severe injuries because it increases both the probability of surviving a serious accident and also decreases the probability of serious injury. Valuable information on the major contributing factors to the accidents, as identified by the police officers who attended the scene of the incident, is recorded in the dataset. Three of these variables are included in the empirical analysis: alcohol use, speeding and other driving offences. Alcohol and speeding are expected to be associated with more severe injuries

The data set provides detailed information on the types of vehicle involved in the accident; it distinguishes between 20 different possibilities⁶³ Due to the large number of observations in the dataset, it is possible to use dummy variables for each of the different vehicle types. Note that drivers (and passengers) of heavy vehicles are less likely to incur severe injuries when involved in a collision; when a heavy vehicle is in a collision with a passenger vehicle or other light vehicle, the occupants of the passenger vehicle are more likely to incur serious injuries. In contrast, drivers of snowmobile and bicycles are more likely to incur serious injuries when involved in an accident.

⁶³ The types of the vehicles involved in accidents are: 1-automobile(sedan), 2-pick-up truck, 3-panel van, 4-truck over 4500 kg, 5-power units for semi-trailers, 6-urban transit bus, 7-inter-city bus, 8-school bus STD large type, 9-school bus van type, 10-other bus, 11-motorcycle, 12-moped/power bicycle, 13- bicycle, 14- ambulance/police/fire, 15-snowmobile, 16-unregistered maintenance equipment, 17- unregistered farm equipment, 18-off high way vehicles, 19-motor homes, and 99-other vehicles.

A dummy variable is used to capture the impact of the introduction of no-fault measures in January 1995. This variable is predicted to indicate that the shift to no-fault insurance lead to more severe injuries, because it cut the link between the level of care taken by a typical driver and the compensation received in the case of an accident. A second dummy variable is included to capture the introduction of the choice system in January 2003. We expect that the estimated coefficient on this dummy variable should be negative because of the stronger incentives for driver care that are associated with a liability regime. Unfortunately, the effect of the introduction of the choice regime may be confounded by the impact of Saskatchewan's decision to change the speed limit from 100 km/h to 110 km/h on rural 4-lane highways in June, 2003 – only five months after the choice system came into effect. *A priori*, an increase in the speed limit should lead to more accidents and more serious injuries. Fortunately, because the study uses daily data, we are able to disentangle the effects of the increase in the speed limit and of the introduction of the choice regime on the severity of injuries.

Finally, a Graduated Driver Licensing (GDL) system was introduced in January 2005. The population targeted for this system is young and novice drivers. “Under a GLS, driving privileges are gradually phased in to allow early driving experience to be gained in lower-risk situations, and then the restrictions will be lifted gradually to allow driving experience under more-challenging conditions before full licensure” (Senserrick and Whelan 2003, 80). Therefore, the GDL dummy is expected to have a negative coefficient.

3.7. Results

The results from the regression analyses are presented in several tables (collected at the end of this chapter). The results for the main specification of the ordered probit model are reported in table 3.8; the results for a number of alternative specifications are reported in table 3.10. The discussion below separates the analysis into three parts: the impact of the switch to a no-fault regime, the impact of the switch to a choice regime and, finally, the effects of variables other than those describing the liability regime.

3.7.1. Effects of the implementation of a no-fault liability regime

According to the results reported in table 3.8, the implementation of a no-fault insurance regime was associated with more severe accidents; this is consistent with a number of other papers which have studied the effects of no-fault measures on fatal accidents (e.g., Devlin 1992 and 2001, Cummins et al. 1992 and 2001). It also confirms the findings from chapter two of this thesis which found positive and significant effects of no-fault on fatal accidents for most of the no-fault provinces in Canada, including Saskatchewan.

Table 3.9 uses the estimated coefficients from table 3.8 to determine the estimated impact of moving from a liability to a no-fault based insurance regime on the probability that an injured driver falls into any given injury class. From table 3.9 we see that under the liability system (pre-no-fault), a driver involved in an accident is estimated to have a 61.55 percent probability of having a type 1 or minor injury, and 0.89 percent probability of having type 5 or fatal injury. Table 3.9 shows how these probabilities change after no-fault was adopted and represents the difference in probabilities of having an injury of a given level of severity when insurance is provided under liability versus under a no-fault regime. These results show that, after adopting the no-fault system in Saskatchewan, the probability of

having a type 1 injury (small injuries) decreased by 3.5 per cent, while the probability of having a type 2 and 3 injury increased by 3 per cent. The probability that an accident led to fatal injuries increased by 0.024 percent as a result of the introduction of no-fault.

3.7.2. Effects of the introduction of choice

The results from table 3.8 suggest that allowing drivers to choose between liability and no-fault did not have a statistically significant impact on accident severity. Part of the explanation for this result may be that only a small proportion of the driving population, about 0.8 percent, chose to switch to the liability regime. Moreover, while we did not find a significant effect of choice on the entire accident population, it is possible that the introduction of choice affected sub-populations differently. It is therefore useful to note that we have information on the number of males versus females who chose the liability option: over the period 2003-2006, the number of female drivers who opted for the tort regime was 1801, 2104, 2226 and 2251, representing in percentage terms 41.6, 41.9, 41.8 and 41.5 of the total drivers who switched to tort in Saskatchewan.⁶⁴ We therefore estimated another specification of the model in which the choice decision was interacted with the dummy variable denoting male drivers. These results are reported in the last two columns of table 3.8. We observe that the interactive term is positive and statistically significant, suggesting that the introduction of choice is associated with an increase in the likelihood that male drivers are involved in accidents with more severe injuries as compared to the no-fault and, previously, liability regimes. This result is puzzling, as the theoretical analysis suggests that - since the pool of drivers has not changed due to the introduction of choice, and given the pricing of the different insurance packages - only extremely risk averse drivers should have

⁶⁴ Over 2003-2006 period, 48.88, 49.02, 49.07 and 49.13 percent of the total drivers in Saskatchewan were female, respectively.

switched to the liability regime. Given that extremely risk adverse drivers are unlikely to have changed their driving habits substantially (and only to drive more carefully), the implementation of choice should have had no significant impact on male drivers, and should certainly not have increased the likelihood that they be involved in an accident which resulted in injuries. We are, in truth, at a loss to explain this result. However, two possible hypotheses are that this interaction term is in fact picking up the influence of the change in the speed limit on male driving behavior, or that this may be a manifestation of the selection bias (that is, the fact that the data base includes only data on accidents which resulted in injuries, rather than on total licensed drivers and on accidents resulting in property damage only) discussed at the beginning of this chapter.

3.7.3. Effects of other variables

Looking at the other results reported in table 3.8, we find that the signs of the estimated coefficients are mostly consistent with expectations. Getting older leads to a higher probability of being involved in a more severe accident, and the fact that the estimated coefficient on the age squared variable is both positive and statistically significant indicates an increasingly large effect of age on accident severity. This result suggests that the slow reaction time of older drivers is an important factor in determining the severity of an accident. We estimated another specification with six age categories rather than just one age variable, and we obtained very similar results. As noted earlier, the percentage of older drivers involved in severe accidents, especially fatal ones, is much higher than for other age groups. Barancik et al. (1986) report that drivers 75 years of age and over are almost three times more likely to incur severe injuries or fatalities in traffic crashes as compared to all other age groups combined.

Surprisingly, the severity of the accidents in which male drivers are involved is not statistically different from that of female drivers. This result is quite different from what is reported elsewhere in the literature (e.g., Boyer and Dionne 1987). An interpretation of this finding is that while male drivers appear to be more likely to be involved in an accident than are females, they are also more likely to be choosing to drive risky vehicles (e.g., motorcycles, sports cars) or driving behaviours (neglecting to use safety equipment, driving after consuming alcohol) than females. Once these other factors are controlled with, the difference across genders disappears.⁶⁵ Interestingly, this result therefore supports the principle that - as is the case in Saskatchewan - automobile insurance pricing should not be based on gender, but instead there should be greater discrimination based on the type of vehicle driven, or evidence of risky driving behaviours.

Using safety equipment decreases the probability of being in a severe accident, as expected. The use of seatbelts and the deployment of airbags both reduce the severity of accidents. The use of helmets has a positive estimated coefficient – clearly this variable is picking up the fact that a motorcycle or bicycle was involved in a traffic accident, and a helmet does not protect much against the impact of a larger vehicle.

An accident which occurs in a rural area is more likely to be involved severe injuries than is an accident which occurs in an urban area, as expected. This result follows partially because of the nature of rural road conditions – a higher percentage of these roads are four lanes and the speed limit is higher than in urban areas. Also, as observed in our discussion of the data set, driving behavior also seems to be different in urban and rural areas..

⁶⁵ Note that there is a problem with endogeneity: although vehicle type and major contributing factor are treated as exogenous variables in the regression, these are clearly the result of earlier choices by the driver.

We can examine the magnitude of the rural/urban effect by estimating the probability that an accident will fall into one of the five categories under study, and then looking at how this probability changes if the accident took place in a rural setting rather than an urban one. Table 3.9 presents the results of such an exercise for a number of variables used in the analysis. Note from table 3.9 that if an accident takes place in a rural setting as opposed to an urban, it is predicted that there will be 6.84 percent fewer accidents with minor injuries, while the probabilities of all of the other types of accidents increased (albeit by a very small amount for the accident types 4 and 5).

As expected, we find that higher precipitation is associated with more severe accidents. It is associated with a 0.12 percentage shift from minor injuries to moderate and major injuries. The effect is strongest on moderate injuries (table 3.9).

The use of alcohol is associated with more severe accidents. Once again, the analysis reported in table 3.9 gives us an idea of the magnitude of the effect. Given that an accident occurred in which alcohol consumption was identified as a major contributing factor, then the probability of the accident results in more severe injuries is higher than if alcohol were not identified as a major contributing factor. If alcohol is a factor the probability that the accident will result in minor injuries falls by 1.47 percent while the probability of a fatal accident increases by 0.1 percent.

Speed also contributes to more severe accidents. If speeding is a contributing factor to an accident, this reduces the likelihood that the accident results in minor injuries by 0.17 percent while the likelihood of fatalities increases by 0.01 percent. However, the increase in the speed limit that occurred in June 2003 does not seem to have had any significant impact. This is consistent with what Johansson (1996) found in the case of Sweden.

The estimated coefficients on the time trend and trend square variables are negative and positive, respectively, and both are statistically significant. For the time trend variable, this suggests that improvement in technologies over time have led to less severe accidents, consistent with our expectations. The positive estimate on the time trend squared variable suggests that these improvements are having a larger effect over time. The fact that vehicles are safer, drivers are better educated, and the technology for constructing and repairing roads is better, would all contribute to this result.

The inclusion of dummy variables for different types of vehicles allows us to find out how vehicle type affects accident severity. For our analysis, we use sedans as the reference group. As the results in table 3.8 reveal, the severity of accidents differs by vehicle type. In general, drivers of trucks have less severe accidents, while risky vehicles, like snowmobiles and bicycles, are associated with more severe accidents.⁶⁶

The sign of the dummy variable which captures the introduction of the Graduated Driver Licensing system (GDL) in 2005 is negative and significant at 4%. As expected, accident severity is reduced as a result of this measure.

3.7.4. Robustness check

In order to check the robustness of our results, a flexible specification of the model is considered in table 3.10. In this specification, we do not pre-define dummy variables for the different traffic offences; instead we use the exact information that was cited by the police after the accident occurred. This specification results in 56 binary variables representing the different contributing factors to accidents.

⁶⁶ In another specification that is not reported here, we excluded the observations on urban transit bus, inter-city bus, school bus STD large type, school bus van type, other bus, moped/power bicycle, bicycle, ambulance/police/fire, snowmobile, unregistered maintenance equipment, unregistered farm equipment, off high way vehicles, motor homes, and other vehicles. The results were not identical but were similar. There was not any significant change in the magnitude ad significant level of the parameters of the model.

As is reflected by the results reported in table 3.10, this alternative specification does not affect in any significant way our results with respect to the switch to no-fault and choice. These results reinforce our earlier findings: “Impaired”, “Exceeding speed limit”, “Disregarding traffic control” and “Had been drinking” are all associated with more serious injuries.

3.8. Conclusions

Using a unique panel dataset on Saskatchewan drivers involved in accidents, this chapter examines the impacts of adopting no-fault and choice liability regimes on the severity of accidents. It finds that the introduction of no-fault measures in 1995 increased the probability of more serious injuries: the likelihood of minor injuries fell by about 3.5 per cent, while that of moderate and major incapacitating injuries increased by two and one percent respectively. Using a micro-level data set allows us to tease out the effects of this policy – effects which are impossible to measure using aggregated data.

As far as the impact of switching to the choice system is concerned, while this chapter is the first attempt to examine how the choice between no-fault and liability measures may affect the severity of accidents, not much was found. It is clear that the way in which the choice system was implemented in Saskatchewan, notably the generous nature of the no-fault package coupled with the lack of price differentiation between the no-fault and liability regimes, meant that few people availed themselves of the liability option. Interestingly, it looks like there is a small effect arising when gender is interacted with the presence of the choice system. In this case, it would appear that fewer females, but more male drivers, were involved in more serious accidents after the introduction of choice. By

and large, however, we are left to conclude that the choice system currently in effect in Saskatchewan has had little impact on the severity of accidents in that province.

One avenue for future research would be to model more explicitly the types of drivers that would opt for one regime over another. This exercise coupled with better data would permit a more rigorous analysis of the choice system.

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Table 3.1: comparing PIPP/No-fault and Liability systems

	PIPP/No-fault	Liability
Minimum third party liability	\$200,000*	\$200,000*
Medical payment	\$5,502,680 per person including rehabilitation	\$21,506 per person, unless catastrophically injured, then up to \$161,369
Funeral expense benefits	\$8,254	\$5,379
Disability income benefits	90% of net wages, max. income gross \$63043/year	\$16,796/year for total disability from employment, \$8,398 for partial disability from the employment up to 104 weeks
Death benefits	\$56,767 to spouse/dependants**	50% of income disability benefits to spouse, 5% of income disability benefits to each dependant child
Impairment benefits	Max. \$157,687 for non-catastrophic, \$187,531 for catastrophic injury	Scheduled up to \$10,758, unless catastrophic, then up to \$139,853
Right to sue for pain and suffering***	No	Yes, deductible of \$5,000
Right to sue for economic loss in excess of no-fault benefits	Yes; injured persons may sue for economic losses that exceed no-fault benefits. However, award above no-fault benefit based on net income after deductions for income tax, Canada pension plan and employment insurance.	Yes. Any benefit amount received from other insurance plan to be deducted from the court award or settlement
Administration****	Government	Government

*However if a claim involving both bodily injury and property damage reaches this figure, payment for property damage will be capped at \$10,000.

** If no spouse \$12,283 per person to a maximum of \$55,275 for five or more dependants.

*** The maximum amount of sue is \$200,000.

**** Government and private insurers compete for optional and excess coverage.

Source: reproduced from the Facts about property and causality insurance in Canada 2006, IBC.

Table 3.2- Description of Variables used in the Analysis

Variables	Description
Dependent variables	
Injury-code	Type of injury taking the values on 1 to 5, where 1, 2, 3, 4 are minor, moderate non-incapacitating, major incapacitating, major unconsciousness injuries, respectively and 5 is fatal accident
Independent variables	
GDL	Graduated Driver Licensing system, dummy variable, 1 for 2005, 0 other years
No-fault	No-fault insurance system, dummy variable, 1 for 1995-2005, 0 other years
Choice	Presenting the introduction of choice system, binary variable, 1 for 2003-2005, 0 other years
Speed-limit	Change in speed limit, 1 from June 1 st 2003, 0 otherwise
Weather	Weather condition, binary variable, 1 if any snow drift or weather condition has been reported as a contributing factor of the accident, 0 otherwise
Age	Driver's age (in years)
Male	Binary variable which takes the value 1 if driver is male, 0 if female
Precipitation (mm)	Level of daily precipitation defined as the sum of the total rainfall and the water equivalent of the total snowfall observed average across province of Saskatchewan during the daily-average precipitation
Lap and shoulder seatbelt	Binary variable, 1 if the driver wore lap and shoulder belt, 0 otherwise
Lap shoulder belt and airbag	Binary variable, 1 if the driver wore lap shoulder belt and airbags deployed, 0 otherwise
Helmet	Binary variable, 1 if the driver wore helmet at the time of the accident, 0 otherwise
Rural	Binary variable which takes the value 1 if accident occurred in rural area, 0 for urban area
Alcohol	Binary variable which takes the value 1 if alcohol related charges were levied ("has been drinking" or "impaired"), 0 otherwise
Speed	Binary variable which takes the value 1 if any charges were laid regarding "exceeding speed limit", 0 otherwise
Trend	Representing the trend from 1988 to 2005
Trend-sq	Representing the square of the trend from 1988 to 2005
Vehicle-involved	The type of the car involved in accident

Table 3.3-Data Statistics (n=81,331)

	Mean	Std. Dev.	Min	Max
Injury-code	1.57	0.82	1	5
Age (year)	35.71	16.84	16	100
Age-square	1559	1494	256	10000
Age 16-19	0.18	0.38	0	1
Age 20-24	0.16	0.36	0	1
Age 25-34	0.22	0.41	0	1
Age35-54	0.30	0.46	0	1
Age 55-65	0.07	0.26	0	1
Age 65 plus	0.08	0.27	0	1
Male	0.55	0.50	0	1
Rural	0.38	0.49	0	1
Lap and shoulder seatbelt	0.73	0.44	0	1
Lap shoulder belt and airbag	0.052	0.22	0	1
Helmet	0.028	0.164647	0	1
Speed limit change (June 2003)	0.15	0.36	0	1
Speed	0.02	0.14	0	1
Alcohol	0.09	0.29	0	1
GDL	0.06	0.23	0	1
No-fault	0.61	0.49	0	1
Choice	0.18	0.38	0	1
Trend	9.54	5.25	1	18
Trend-square	118.57	102.51	1	324
Road	0.12	0.33	0	1
Weather	0.05	0.22	0	1
Precipitation (mm)	1.079	3.52	0	59
Sedan	0.63	0.48	0	1
Pick up truck	0.18	0.39	0	1
Panel van	0.0864	0.281	0	1
Truck over 4500 kg	0.0107	0.103	0	1
Power units for semi-trailers	0.0173	0.130	0	1
Urban transit bus	0.0003	0.018	0	1
Inter-city bus	0.0002	0.015	0	1
School bus STD large type	0.0006	0.025	0	1
School bus van type	0.0002	0.013	0	1
Other bus	0.0002	0.014	0	1
Motorcycle	0.0294	0.169	0	1
Moped/Power bicycle	0.0003	0.018	0	1
Bicycle	0.0236	0.152	0	1
Ambulance/Police/Fire	0.0015	0.039	0	1
Snowmobile	0.0061	0.078	0	1
Unregistered maintenance equipment	0.0010	0.032	0	1
Unregistered farm equipment	0.0011	0.033	0	1
Off high way vehicles	0.0014	0.038	0	1
Motor homes	0.0004	0.020	0	1

Table 3.4: Individual characteristics and types of injuries (%)

Variables	Minor	Moderate non-incapacitating	Major incapacitating	Major unconsciousness	Fatal	% of total
Male	55	32	9.5	1.1	2.7	55.3
Female	61	31.5	5.9	0.4	1	44.7
Urban	64	30	4.6	0.5	0.5	62
Rural	47	34	13.2	1.3	4.3	38
Wearing safety equipment	60	32	6.4	0.5	1.1	80.9
Not-wearing safety equipment*	46	32	14.2	2	5.4	19.1
Sedan	60	31	6.5	0.6	1.5	63
Other vehicles	54	32	10	1.1	2.6	37
Age 16-19	59	32	7	1	1.4	18
Age 20-24	57	33	8	1	1.6	16
Age 25-34	57	33	7.8	0.7	1.7	21
Age 35-54	59	31	7.6	0.7	1.7	29
Age 55-64	57	31	8.6	0.7	2.8	7
65 and older	52	31	11	0.8	4.6	8

The numbers in 2nd to 6th columns are percentage of each category in total. However, the last column shows the percentage of each row in total (e.g. male accidents form 55.8 percent of total accident).

* It also includes wearing improperly.

Table 3.5: Percentage of Accidents of Different Severities in which the Driver was charged with a Violation

Charges	Minor	Moderate non-incapacitating	Major incapacitating	Major unconsciousness	Fatal
Drive without due care	20.1	21.9	23.4	18.6	22.2
Fail to yield right of way	15.3	12.9	9.2	8.4	18.5
Disobey stop sign	6.8	7.3	6.3	6.2	14.8
Other offense	7.5	7.3	7.7	6.2	7.4
Impaired driving refusing test	10.6	13.2	18.3	25.2	3.7
No driver's license	5.2	5.5	5.5	7.5	3.7
Dangerous driving	1.3	1.8	3.5	7.1	3.7
Speed too fast for conditions	9.9	9.4	8	3.1	3.7
Not using seat belts	1.3	1.9	3.3	1.8	3.7
Unregistered vehicle	2.8	3.2	5	4.4	0
Drive while disqualified	1.7	2.1	2.1	4.4	0
Fail to report	2.4	1.4	0.3	2.2	0
Disobey traffic signal	4.6	4.5	2	1.3	0
Driving left of centre	0.5	0.7	1.2	0.9	0
Passing when unsafe	0.6	0.4	0.6	0.4	0
Fail to signal	0.2	0	0.2	0.4	0
Improper turn	1.8	1.4	0.8	0	0
Follow too closely	3.9	2.3	0.7	0	0
Criminal negligence	0.1	0.2	0.7	0	0
Improper lane change	0.7	0.7	0.3	0	0
Defective unauthorized parts	0.2	0.1	0.2	0	0
24 hour suspension	0.8	0.5	0.2	0	0
Driving wrong way on one way	0.1	0.1	0.1	0	0
Inadequate brakes	0.1	0.2	0.1	0	0
Stunting	0.2	0	0.1	0	0
Passing on right	0.1	0.1	0	0	0
Fail to yield to pedestrian	0	0	0	0	0
Improper parking	0	0	0	0	0
Passing school bus	0	0	0	0	0
Fail to remain	0.7	0.8	0	0	0
Unsafe backing	0.4	0.1	0	0	0
Speeding past highway worker	0	0	0	0	0
	100	100	100	100	100

Table 3.6: The Percentage of Drivers Wearing Safety Equipment and Engaging in Criminal Code Offences for Rural and Urban Accidents (%)

	Urban	Rural
Wearing	83	78
Not-wearing	17	22
Committing offences	3	6
Not-committing offences	97	94
Violating speed limit	1.6	2.9
Not-Violating speed limit	98.4	97.1

Table 3.7: Individual characteristics and types of injuries **before** and **after** the introduction of choice (%)

Variables	Choice	Minor	Moderate non-incapacitating	Major incapacitating	Major unconsciousness	Fatal	% of total
Male	Before	54	33	10	1.1	2.7	56.4
	After	63	27	6.7	1.1	2.7	49.8
Female	Before	59	33	6.5	0.4	1	43.6
	After	70	25	3.5	0.5	0.8	50.2
Urban	Before	62	32	5.1	0.5	0.5	61.6
	After	72	25	2.8	0.5	0.5	64.1
Rural	Before	45	35	14	1.3	4.3	38.4
	After	57	28	9.2	1.4	4.1	35.9
Wearing safety equipment	Before	59	33	6.9	0.5	1.1	79.9
	After	68	26	4.3	0.5	1.1	85.8
Not-wearing safety equipment	Before	45	33	15	1.9	5.4	20.1
	After	57	25	9.6	2.7	6	14.3
Sedan	Before	58	33	7	0.6	1.6	63.7
	After	69	25	4	0.6	1.3	61.5
Other vehicles	Before	52	33	11.2	1.1	2.7	36.3
	After	63	27	6.8	1.1	2.5	38.5
Age 16-19	Before	57	33	7.4	0.9	1.3	18.5
	After	70	23	4.4	1	1.9	15.8
Age 20-24	Before	55	34	8	0.8	1.6	15.9
	After	68	24	4.8	1.3	1.5	15
Age 25-34	Before	55	34	8.3	0.7	1.7	22
	After	68	26	4.8	0.7	1.3	19.1
Age 35-54	Before	58	31	8.2	0.7	1.7	28.8
	After	65	28	5	0.6	1.5	33.7
Age 55-64	Before	55	32	9.5	0.7	2.9	6.7
	After	64	28	5.1	0.6	2.3	8.2
65 and older	Before	50	32	12	0.9	4.8	7.9
	After	63	26	7.6	0.5	3.6	8.2

The numbers in 3rd to 7th columns are percentage of each category in total. The last column shows the percentage of each row in total (e.g. male accidents form 56.4 and 49.8 percent of total accident before and after choice introduction). "Before" and "after" refer to the average of each related category before and after January 2003, when the choice system came into effect. Not wearing safety also includes wearing improperly.

Table 3.8: The Impact of No-Fault and Choice Rules on Accident Severity
 Ordered Probit Regression Results: Dependent variable: five categories of injuries (n=81,254)

Variables	Base model		Model with interaction term between choice and male	
	Coefficient	P-values	Coefficient	P-values
No-fault	0.149	0.00	0.149	0.00
Choice (January 2003)	-0.006	0.86	-0.048	0.18
GDL	-0.045	0.07	-0.044	0.07
Speed limit change (June 2003)	0.042	0.20	0.042	0.21
Age	-0.001	0.67	-0.001	0.67
Age-square	0.00007	0.00	0.00007	0.00
Choice-male			0.082	0.00
Male	0.0026	0.78	-0.011	0.27
Precipitation	0.0027	0.02	0.0027	0.02
Lap and shoulder seatbelt	-0.362	0.00	-0.363	0.00
Lap shoulder belt and airbag	-0.265	0.00	-0.264	0.00
Helmet	0.179	0.00	0.177	0.00
Rural	0.472	0.00	0.471	0.00
Alcohol	0.417	0.00	0.417	0.00
Speed	0.201	0.00	0.200	0.00
Trend	-0.123	0.00	-0.123	0.00
Trend-sq	0.0039	0.00	0.0038	0.00
Vehicles involved				
Sedan			Omitted category	
Pick up truck	-0.022	0.06	-0.022	0.06
Panel van	-0.027	0.08	-0.026	0.09
Truck over 4500 kg	-0.106	0.01	-0.105	0.01
Power units for semi-trailers	0.005	0.88	0.004	0.91
Urban transit bus	-0.026	0.91	-0.027	0.91
Inter-city bus	0.644	0.02	0.646	0.01
School bus STD large type	-0.032	0.84	-0.033	0.84

School bus van type	-0.478	0.16	-0.483	0.16
Other bus	-0.051	0.86	-0.049	0.87
Motorcycle	0.148	0.00	0.148	0.00
Moped/Power bicycle	0.299	0.18	0.299	0.18
Bicycle	-0.036	0.22	-0.037	0.22
Ambulance/Police/Fire	0.241	0.02	0.241	0.02
Snowmobile	0.224	0.00	0.227	0.00
Unregistered maintenance equipment	-0.068	0.59	-0.065	0.61
Unregistered farm equipment	0.186	0.11	0.185	0.12
Off high way vehicles	0.481	0.00	0.479	0.00
Motor homes	0.138	0.47	0.139	0.46
Other vehicles	0.166	0.35	0.168	0.34
_cut1	-0.3779		-0.38703	
_cut2	0.781062		0.772027	
_cut3	1.53865		1.529658	
_cut4	1.699882		1.690918	
Log Likelihood	-75693		-75686	

* Reference group for involved vehicles is sedan.

Table 3.9: Measuring the Impact of Selected Variables on the Probability of an Accident Occurring of Severity i ($i=1-5$) Based on the Regression Results from Table 3.7

	Prob.(y=1)	Prob.(y=2)	Prob.(y=3)	Prob.(y=4)	Prob.(y=5)
No-fault=0	0.6155	0.3114	0.0596	0.0047	0.0089
No-fault=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	-0.0350	0.0216	0.0099	0.0011	0.0024
Choice&Male=1	0.5769	0.3351	0.0706	0.0059	0.0115
Choice&Male=0	0.5741	0.3367	0.0715	0.0059	0.0118
Change	-0.0028	0.0017	0.0008	0.0001	0.0002
Rural=0	0.6489	0.2895	0.0509	0.0038	0.0069
Rural=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	-0.0684	0.0434	0.0187	0.0019	0.0043
Precipitation*=0	0.5816	0.3323	0.0692	0.0057	0.0112
Precipitation=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	-0.0012	0.0007	0.0003	0.0000	0.0001
Average precipitation*=0	0.5816	0.3323	0.0692	0.0057	0.0112
Average precipitation=0	0.5516	0.3496	0.0784	0.0067	0.0136
Change	-0.0300	0.0174	0.0091	0.0010	0.0024
Heavy precipitation*=0	0.5816	0.3323	0.0692	0.0057	0.0112
Heavy precipitation=0	0.5305	0.3612	0.0852	0.0075	0.0156
Change	-0.0511	0.0289	0.0160	0.0018	0.0044
Seatbelt=0	0.4756	0.3883	0.1044	0.0099	0.0219
Seatbelt=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	0.1049	-0.0553	-0.0348	-0.0042	-0.0106
Seatbelt&Airbag=0	0.5751	0.3361	0.0712	0.0059	0.0117
Seatbelt&Airbag=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	0.0054	-0.0032	-0.0016	-0.0002	-0.0004
GDL=0	0.5795	0.3335	0.0699	0.0058	0.0114
GDL=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	0.0010	-0.0006	-0.0003	0.0000	-0.0001
Alcohol=0	0.5952	0.3240	0.0653	0.0053	0.0102
Alcohol=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	-0.0147	0.0089	0.0043	0.0005	0.0011
Speed=0	0.5821	0.3320	0.0691	0.0057	0.0112
Speed=1	0.5805	0.3329	0.0696	0.0057	0.0113
Change	-0.0017	0.0010	0.0005	0.0001	0.0001

1= minor, 2= moderate, 3= major incapacitating, 4= major unconsciousness, 5=fatal.

*Precipitation, average precipitation and heavy precipitation represent three levels of precipitation, 5, 27 and 47 mm, respectively.

Table 3.10: The Impact of No-Fault and Choice Rules on Accident Severity (Robustness check model with no pre-defined the alcohol and speed variables)
 Ordered Probit Regression Results: Dependent variable: five categories of injuries
 (n=81,254)

Variables	Coefficient	P-values
No-fault	0.13	0.00
Choice (January 2003)	0.0127	0.71
GDL	-0.0388	0.11
Speed limit change (June 2003)	0.0435	0.19
Age	0.0023	0.06
Age-square	0.00003	0.02
Male	-0.0043	0.65
Precipitation	0.0027	0.02
Lap and shoulder seatbelt	-0.36	0.00
Lap shoulder belt and airbag	-0.26	0.00
Helmet	0.18	0.00
Rural	0.53	0.00
Trend	-0.11	0.00
Trend-sq	0.003	0.00
Vehicles involved		
Sedan	Omitted category	
Pick up truck	-0.017	0.14
Panel van	-0.024	0.13
Truck over 4500 kg	-0.12	0.00
Power units for semi-trailers	-0.02	0.47
Urban transit bus	-0.01	0.96
Inter-city bus	0.65	0.01
School bus STD large type	-0.08	0.62
School bus van type	-0.50	0.14
Other bus	-0.06	0.83
Motorcycle	0.18	0.00
Moped/Power bicycle	0.32	0.16
Bicycle	-0.08	0.01
Ambulance/Police/Fire	0.22	0.03
Snowmobile	0.25	0.00
Unregistered maintenance equipment	-0.05	0.69
Unregistered farm equipment	0.17	0.15
Off high way vehicles	0.51	0.00
Motor homes	0.11	0.55
Other vehicles	0.19	0.27
Major Contributing Factors		
Human condition		
Inattentive	0.06	0.00
Distracted	-0.09	0.02
Had been drinking	0.19	0.00
Impaired	0.46	0.00
Extreme fatigue	0.17	0.02

Fell asleep	0.13	0.00
Driver inexperience confusion	-0.19	0.00
Lost consciousness illness	0.45	0.00
Physical medical disability	0.34	0.00
Drugs prescription or illegal	0.52	0.00
Defective eyesight hearing	-0.11	0.71
Other human conditions	0.11	0.05
Human Actions		
Fail to yield	0.11	0.00
Traffic control disregarded	0.30	0.00
Following too closely	-0.26	0.00
Driving too fast for conditions	-0.04	0.21
Exceeding speed limit	0.47	0.00
Turning improper	-0.05	0.52
Passing or lane usage improper	0.13	0.01
Backing unsafely	-0.49	0.01
Fail to signal	-0.36	0.11
Driving wrong way	0.18	0.21
Taking evasive action	-0.12	0.00
Careless driving stunting	0.16	0.04
Pedestrian action contributed	-0.30	0.25
Other human action	0.06	0.24
Vehicle condition		
Defective brakes	-0.16	0.06
Defective lights	-0.06	0.64
Defective exhaust system	-0.13	0.87
Load shifted spilled	-0.33	0.01
Vehicle over or improperly loaded	0.29	0.38
Defective steering	-0.16	0.14
Defective suspension wheel failure	-0.14	0.25
Defective tires or blowout	-0.13	0.04
Defective engine or power train	-0.20	0.08
Jackknife trailer swing	-0.29	0.03
View obscured from vehicle	-0.11	0.29
Lights not on	-0.12	0.21
Other vehicle condition	0.37	0.03
Environmental condition		
Animal act (wild)	-0.47	0.00
Animal action (domestic)	-0.37	0.00
Road condition surface or structure	-0.19	0.00
Excessive loose gravel	-0.19	0.00
Snow drift	-0.27	0.00
Obstruction debris on roadway	-0.22	0.02
View obstructed limited outside vehicle	-0.02	0.74
Sun glare	-0.10	0.27
Construction zone	-0.15	0.20
Soft or Defective shoulders	-0.31	0.00
Lane marking inadequate	0.00	0.99
Traffic control not working	0.30	0.11
Weather condition	-0.15	0.00
Uninvolved vehicle	-0.23	0.00

Uninvolved pedestrian	-0.13	0.27
Other environment condition	-0.19	0.03
_cut1	-0.35209	
_cut2	0.814424	
_cut3	1.580201	
_cut4	1.743727	
Log Likelihood	-75788	

* Reference group for involved vehicles is sedan, for age group is 65 years old and older.

HA=Human Action, HC=Human Condition, VC=Vehicle Condition and EC=Environmental Condition (see table Appendix 3.A).

Appendix 3.A:

Various Factors Contributing to Accidents

Driver's condition	Driver's action	Vehicle condition	Environmental condition
Inattentive	Fail to yield	Defective brakes	Animal act (wild)
Distracted	Traffic control disregarded	Defective lights	Animal action (domestic)
Had been drinking	Following too closely	Defective exhaust system	Road condition surface or structure
Impaired	Driving too fast for conditions	Load shifted spilled	Excessive loose gravel
Extreme fatigue	Exceeding speed limit	Vehicle over or improperly loaded	Snow drift
Fell asleep	Turning improper	Defective steering	Obstruction debris on roadway
Driver inexperience	Passing or lane usage improper	Defective suspension wheel failure	View obstructed limited outside vehicle
Lost consciousness illness	Backing unsafely	Defective tires or blowout	Sun glare
Physical medical disability	Fail to signal	Defective engine or power train	Construction zone
Drugs prescription or illegal	Driving wrong way	Jackknife trailer swing	Soft or Defective shoulders
Defective eyesight hearing	Taking evasive action	View obscured from vehicle	Lane marking inadequate
Other human conditions	Careless driving stunting	Lights not on	Traffic control not working
	Pedestrian action contributed	Other vehicle condition	Weather condition
	Other human action		Uninvolved vehicle
			Uninvolved pedestrian
			Other environment condition