The Role of Memory in Long-Term Contracting with Moral Hazard : Empirical Evidence in Automobile Insurance

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Abstract

This paper tests the efficiency associated with the role of memory in long-term contracting. Bonus-malus schemes in automobile insurance are examples of contracts that use memory. During the eighties different contributors (Lambert, 1983, Rogerson, 1985, Boyer, and Dionne, 1989) showed how multi-period contracting under moral hazard improves resource allocation. In particular, it was demonstrated that multi-period contracts with memory outperform those without memory under full commitment. However, Allen (1985), Fudenberg et al. (1990), Rey and Salanié (1990) and Chiappori et al. (1994) stressed the fact that the above models did not consider the possibility of savings. Indeed it can be shown that the optimal level of action (or safety in automobile insurance) can be a function of the agent's saving activity. In the absence of full commitment, the presence of savings can eliminate all the potential gains of multi-period contracting with memory when wealth effects are significant. Consequently, it is not clear that introducing a bonus-malus scheme in automobile insurance will work efficiently to reduce moral hazard. Our empirical results show, however, that the introduction of the new bonus-malus scheme in the Quebec automobile insurance industry reduced accidents and traffic violations. This structural change was a transition from a contract regime without memory to a regime with memory and can be interpreted as a laboratory experiment to test for the efficiency of the role of memory in reducing moral hazard.

Keywords: memory, long-term contracting, moral hazard, empirical evidence, automobile insurance, bonus-malus, savings, Quebec automobile insurance industry.

JEL Classification: D80, G22.

Résumé

Ce texte propose un test sur l'efficacité reliée au rôle de la mémoire dans les relations contractuelles de long terme. Les systèmes bonus-malus sont des exemples de contrats qui utilisent la mémoire. Durant les années 1980, plusieurs auteurs (Lambert, 1983, Rogerson, 1985, Boyer et Dionne, 1989) ont montré comment les contrats de long terme en présence de risque moral augmentent l'allocation des ressources. En particulier, il a été démontré que

les contrats à plusieurs périodes avec mémoire et plein engagement dominent ceux sans mémoire. Par contre, Allen (1985), Fudenberg et al. (1990), Rey et Salanié (1990) et Chiappori et al. (1994) ont insisté sur le fait que ces types d'analyse ne tenaient pas compte des possibilités d'épargne des agents ou des assurés. En effet, il peut être démontré que les actions optimales des agents peuvent être affectées par leur épargne. En absence de plein engagement, la présence de l'épargne peut éliminer tous les gains potentiels associés à des contrats à long terme lorsque les effets de richesse sont importants. Conséquemment, il n'est pas clair que l'introduction d'un système bonus-malus en assurance automobile va réduire le risque moral. Nos résultats empiriques indiquent, par contre, que l'introduction d'un nouveau système bonus-malus dans l'industrie de l'assurance automobile du Québec a réduit les accidents et les infractions routières. Ce changement structurel fut une transition d'un régime d'assurance sans mémoire à un régime avec mémoire et peut être interprété comme une expérience de laboratoire visant à tester l'efficacité du rôle de la mémoire dans la réduction du risque moral.

Mots clés : mémoire, contrat à long terme, risque moral, évidence empirique, assurance automobile, bonus-malus, épargne, industrie de l'assurance automobile au Québec.

Classification JEL : D80, G22.

1. Introduction

Over the past twenty years, many contributions have studied the dynamic aspect of moral hazard (for recent surveys, see Chiappori et al., 1994, and Winter, 2000). Radner (1981) and Rubinstein and Yaari (1983) have examined infinite horizon models with full commitment while Lambert (1983) and Rogerson (1985) have considered relationships that last a finite number of periods.

Particularly, Lambert (1983) and Rogerson (1985) studied how the role of memory under full commitment can be useful in controlling moral hazard problems. They obtained that the agent's payoff in one period will depend on his performance in that period as well as in previous periods, a result that may justify experience rating in insurance contracting, for example. Moreover, the optimal long-term contract will outperform a sequence of optimal static contracts in their framework. However, as pointed out by Allen (1985), this strong result was obtained without including savings in the analysis.

More recently, Fudenberg et al. (1990), Malcomson and Spinnewyn (1988) and Rey and Salanié (1990) focused on the role of commitment and spot contracting when the agent has access to perfect credit markets. An important finding of these studies, is that spot contracting can provide just as much long-run efficiency as long-term contracting when the principal can monitor the access to savings. As pointed out by Chiappori et al. (1994), the control of savings introduces memory in spot contracts since it affects the agent's reservation utility in periods following the first period. Two ingredients are then important for either spot or long-term contracts to gain any advantage over repeated optimal static contract: memory and savings. Without the control of savings, repeated optimal spot contracts are identical to repeated optimal static contracts, whereas the long-term contract with commitment and memory will outperform both of them. This is the polar case where transaction costs in credit markets are very high or access to savings is not allowed.

When memory is absent, the optimal long-term contract is itself limited to the repeated optimal static contract. Consequently, with the control of savings, memory is necessary to improve welfare. Without control of savings, the efficiency effects of memory may be less strong. First, the full commitment optimum is not renegotiation-proof (or sequentially efficient) in private markets and spot implementability cannot be obtained. Second, if we limit the analysis to non-random savings, renegotiation-proof long term contracts may yield the minimizing effort level. Randomized saving seems to have a less negative effect on effort, but characterization of the optimal long term contract is still an open question under non-constant risk aversion (Chiappori et al., 1994). When the utility function is CARA (constant absolute risk aversion), all negative effects of non-monitored savings on effort disappear, but long-term contracts are not necessary (Fudenberg et al., 1990). Finally, one important issue we must stress before discussing empirical matters, is that credit markets are assumed costless in this literature. Intuitively, imperfect credit markets should temper the negative effects of savings on effort, since transaction costs reduce the flexibility of savings over time.

The object of this paper is to test the role of memory in optimal contracting under moral hazard. This test is important when savings is not monitored by the principal as in many real economic situations. Our environment can be interpreted as one where savings is random and where credit markets are not costless. Consequently, the net effect of introducing memory in the market studied will not necessarily have a positive effect on effort. However, contract renegotiation is not possible in the market studied, since the public insurer is committed to the long-term contract by law. (It should be emphasized that a similar situation may also be observed in a private market with many insurers where the bonus-malus scheme is defined by law.)

Our data set is a panel covering eight periods of automobile insurance contracting. Insurance for bodily injuries is offered by a public monopoly in Quebec, while coverage of property damages is offered by the private sector. We had access to the accident data for both markets, since the public insurer has information on all accidents filed on police reports. Since savings is not monitored, the issue of contract renegotiation and savings on moral hazard is related to both the significance of the wealth effects and the imperfections in the credit markets that may reduce the negative effect of savings on safe behaviour under full commitment.

A structural change was introduced in the automobile insurance market in 1992, when the public insurer proposed a new pricing scheme for bodily injuries insurance based on accumulated driving demerit points during the previous period only. The number of demerit points accumulated can be interpreted as an adequate sufficient statistics of safe driving behaviour activities. Although the public insurer had this information prior to 1992, this memory was not used in pricing and insureds were not rated according to their driving record (past accidents were not used either). Consequently, the 1992 structural change is a transition from a contract regime without memory to one with memory. It can be interpreted as a laboratory experiment to test whether an exogenous change in the use of memory reduces accidents and traffic violations. No structural changes were introduced in the private market during the same period.

The paper is organized as follows. In Section 2, a theoretical model is presented in order to isolate the main empirical hypothesis. Section 3 discusses the two empirical propositions of the article. Section 4 presents data and variables while Section 5 introduces the econometric model for panel data. Section 6 discusses the results and Section 7 concludes.

2. The model

Our economic environment is an insurance market for automobile accidents where insurance coverage for bodily injuries is offered by a public monopoly to a large population of clients. Insurance for property damages is managed by the private sector. Insurance is compulsory which reduces adverse selection effects in the sense that policy-holders include all risks types (Dionne, Doherty, and Fombaron, 2000). However, risk classification remains important to screen for exogenous factors that affect accident distributions and to isolate moral hazard effects (see Crocker and Snow, 1986, 2000, Dionne, Gouriéroux and Vanasse, 1998, 2001, Pinquet, 2000). As usual in moral hazard situations, driving safety activities are not observable by the principal, which is sufficient to introduce an ex-ante moral hazard problem (Pauly, 1974, Holmstrom, 1979, Shavell, 1979; see Winter, 2000, for a recent survey).

Following Lambert (1983), Rogerson (1985) and Chiappori et al. (1994), we consider a two-period model $(i = 1,2)$ – two-state model ($j = A,N$ where A stands for accident and N for non-accident) which can be extended easily to a finite number of periods and a finite number of states. However, for our empirical test, two periods are enough since the insurer does not use the past information for more than one period. In each period, the agent selects an action (a_i) that affects his chances of having an accident $p_{ij}(a_i)$. However, a_2 is selected after claims in period 1 have been observed by both parties. We use l_{1j} for claims in period 1. The effect of a_i on p_{ij} shifts the accident distribution such that a first-order stochastic dominance is obtained $(p'_{iA}(a_i) < 0$ and $p'_{iN}(a_i) > 0)$. We assume that all the technical conditions that are necessary to obtain reliable results are satisfied (Holmstrom, 1979, Rogerson, 1985 and Jewitt, 1988).

In each period, the policy-holder pays a premium P_i to obtain a coverage q_i. In the second period, this premium can be a function of past accidents l_{1j}. Consequently, ex-ante in period 1, $P_2(\tilde{l}_{1j})$ is a random variable. Our goal is to determine endogenously the function $P_2(\tilde{l}_{1j})$. To be more general, we can also suppose that the second-period insurance coverage is a function of l_{1j}, but no such insurance scheme is observed in any insurance market. Consequently, we limit our analysis to the function $P_2(\tilde{l}_{1j})$.

Under full commitment and without savings, the optimal contract solves :

Problem 1

$$\max_{P_1,q_1,P_2,q_2,a_1,a_{2j}} P_1-p_{1A}(a_1)q_1+\delta\left[\sum_j p_{1j}(a_1)\left[P_2\left(\tilde{l}_{1j}\right)-p_{2A}\left(a_{2j}\right)q_2\right]\right]$$

$$+\lambda\{p_{1N}(a_1)U(W-P_1)+p_{1A}(a_1)U(W-P_1-l_1+q_1)-c(a_1)$$

$$+\delta\left[\sum_j p_{1j}(a_1)\left[p_{2N}\left(a_{2j}\right)U\left(W-P_2\left(\tilde{l}_{1j}\right)\right)+p_{2A}\left(a_{2j}\right)U\left(W-P_2\left(\tilde{l}_{1j}\right)-l_2+q_2\right)\right]-c\left(a_{2j}\right)\right]-\overline{U}\}$$

$$+\mu_1\left\{-p'_{1A}(a_1)\left[U(W-P_1-l_1+q_1)-U(W-P_1)\right]-c'(a_1)\right.$$

$$\left.+\delta\sum_j p'_{1j}(a_1)\left[p_{2N}\left(a_{2j}\right)U\left(W-P_2\left(\tilde{l}_{1j}\right)\right)+p_{2A}\left(a_{2j}\right)U\left(W-P_2\left(\tilde{l}_{1j}\right)-l_2+q_2\right)\right]\right\}$$

$$+\delta\left\{\sum_j \mu_{2j}\,p_{1j}(a_1)\left[p'_{2A}\left(a_{2j}\right)\left[U\left(W-P_2\left(\tilde{l}_{1j}\right)-l_2+q_2\right)-U\left(W-P_2\left(\tilde{l}_{1j}\right)\right)\right]-c'\left(a_{2j}\right)\right]\right\}$$

where $U(\cdot)$ is the von Neumann-Morgenstern utility function of final wealth. It is implicitly assumed that the principal is risk neutral and the insured is risk adverse $(U'(\cdot) > 0$ *and* $U''(\cdot) < 0)$. The principal maximizes his profits under the constraint that the agent accepts the contract (participation constraint with multiplier λ) and is efficient in action (three incentive constraints with multipliers μ_1 and μ_{2j}). It is important to mention that the optimal a_1 takes into account of the anticipated effects of $\tilde{l}_{1j}$ (accident, non accident) on P_2 in order to evaluate the total benefits of prevention. For the moment, Problem 1 supposes that savings have no effect on the production of either a_1 or a_{2j}. To complete the notation :

δ is a discount factor used by both the principal and the agent;

$\overline{U}$ is the two-period welfare corresponding to the best alternative for the agent;

$c(a)$ is the cost function of effort; it is strictly increasing and strictly convex.

First order conditions for q_1 and P_1 yield :

$$\frac{1}{U'(A_1)} = \lambda + \mu_1 \frac{p'_{1A}(a_1)}{p_{1A}(a_1)}$$
$$\frac{1}{U'(N_1)} = \lambda + \mu_1 \frac{p'_{1N}(a_1)}{p_{1N}(a_1)}$$

with $U'(A_1) \equiv U'(W - l_1 + q_1 - P_1)$ *and* $U'(N_1) \equiv U'(W - P_1)$. Under MLRP (the Monotonic Likelihood Ratio Property), we obtain that $U'(A_1) > U'(N_1)$ which implies that $q_1^* < l_1$. Optimal values of q_2 and $P_2(l_{1j})$ solve for first order conditions of the type :

$$\frac{1}{U'(A_{2j})} = \lambda + \mu_{2j} \frac{p'_{2A}(a_{2j})}{p_{2A}(a_{2j})} + \mu_1 \frac{p'_{1j}(a_1)}{p_{1j}(a_1)}$$
$$\frac{1}{U'(N_{2j})} = \lambda + \mu_{2j} \frac{p'_{2N}(a_{2j})}{p_{2N}(a_{2j})} + \mu_1 \frac{p'_{1j}(a_1)}{p_{1j}(a_1)}$$

for $j = A, N$ where $A_{2A} \equiv W - l_2 + q_2 - P_2(l_{1A})$, $N_{2N} \equiv W - P_2(l_{1N})$,
$N_{2A} \equiv W - P_2(l_{1A})$ and $A_{2N} = W - l_2 + q_2 - P_2(l_{1N})$.

From these conditions, it is clear that :

$$A_{2A} < A_1 < N_{2A} \quad and \quad A_{2N} < N_1 < N_{2N}.$$

Consequently, we obtain :

<u>Result 1</u>

a) $P_2(l_{1N}) < P_1 < P_2(l_{1A})$

b) $q_i^* < l_i, \;\; i = 1,2$

Proof : From a direct application of Lambert (1983). Available upon request.

Result 1b) is a direct consequence of the two first-order conditions and is the standard result verified under MRLP. Here, to simplify the presentation, we were limited to two states of the world. In a more general model, one can show that, when self-protection activities only affect accident frequencies, a deductible contract is optimal (Winter, 2000).

More generally, if self-protection activities also affect the seriousness of the accident (as with speed for automobile insurance) then coinsurance (above the deductible) is the optimal contract. The public insurer in Quebec offers a coinsurance rate equal to 90% of income loss with a maximum for those having incomes higher than a certain threshold. However complementary private insurance is available.

Result 1a) comes from the second group of first-order conditions and is a direct consequence of the fact that the insurer uses his memory. It shows that the optimal second-period premium corresponds to a bonus-malus insurance scheme. When the insurer does not use his memory, it is easily shown that $P_2\left(l_{1N}\right) = P_1 = P_2\left(l_{1A}\right)$. From the first-order conditions on a_1 and a_2 we can also verify that $\mu_1 > 0$ and $\mu_{2j} > 0$ for all j, which implies that more traffic safety activities are produced in period 1 than in a single-period contract (see Lambert, 1983, for details).

Since a_1 is not observable, it is difficult to test directly whether or not the use of memory increases effort. However, we can test whether or not the new pricing scheme introduced in 1992 has reduced both the number of demerit points and the number of accidents, since both distributions are a function of insured's behaviour. In the above model, we used accident probabilities but we can rewrite the model by considering distributions of demerit points.

Before going to the empirical part of the study, let us discuss the issue of savings. The natural case is the one where the agent's saving activities are not observable by the principal. Consequently, the agent will choose his private level of savings in the first period as for any other action level. This decision can be represented by a first-order condition. Then, in choosing the optimal insurance contract, the agent will adjust his savings in function of the insurance contract. But optimal savings can also be affected by the agent's behaviour when the utility function is not CARA.

In order to simplify the extension of the previous model, let us rewrite the two-period expected utility of the agent as follows :

$$
\begin{aligned}
& p_{1N}(a_1)\, U\,(W - P_1 - S_N) + p_{1A}(a_1)\, U\,(W - P_1 - l_1 + q_1 - S_A) - c(a_1) \\
& + \delta \sum_j p_{1j}\ (a_1) \left[p_{2N}\ (a_{2j})\, U\,(W - P_2(\tilde{l}_{1j}) + S_j) \right. \\
& \left. + \ p_{2A}\ (a_{2j})\, U\,(W - P_2(\tilde{l}_{1j}) + S_j - l_2 + q_2) - c(a_{2j}) \right] - \overline{U}
\end{aligned}
$$

where S_A and S_N stand for savings in accident and non-accident states respectively. The first order condition for S_N is equal to :

$$
-U'(W - P_1 - S_N) + \delta \left[p_{2N}(a_{2N}) U'(N_{2N}) + p_{2A}(a_{2N})\, U'(A_{2N}) \right] = 0\,,
$$

and a similar condition can be derived for S_A. Introducing these first order conditions in Problem 1 yields parameters q_1 and P_1 for the first period:

$$
\begin{aligned}
\frac{1}{U'(A_1)} &= \lambda + \mu_1 \frac{p'_{1A}(a_1)}{p_{1A}(a_1)} - \gamma_A \frac{U''(A_1)}{U'(A_1)} \\
\frac{1}{U'(N_1)} &= \lambda + \mu_1 \frac{p'_{1N}(a_1)}{p_{1N}(a_1)} - \gamma_N \frac{U''(N_1)}{U'(N_1)}
\end{aligned}
$$

The above conditions clearly show that savings affects the contract parameters. From the above first order conditions for savings, we also observe that the level of savings depends on the agent's effort. Under full commitment, when the principal can monitor savings activities the same results as in Problem 1 can be obtained. However this full-commitment program is usually not renegotiation-proof in private markets when savings is not monitored. Since the level of savings is predetermined at the end of period 1, both parties can improve their welfare by signing a new contract at the beginning of the second period which would reduce the incentive effects of the initial contract.

It is usually shown that the effect of memory on effort is less significant, particularly when the savings activity is not random and cannot be monitored. In real life, savings activities are random and not monitored. In this case, the net result of memory on effort or traffic safety is not well documented in the literature, with the exception of utility functions that are CARA. Consequently, an empirical test is necessary to verify whether the introduction of memory in 1992 had a beneficial effect on driving safety. We suspect that any negative effect associated with savings should be low, since the insurance contract is regulated by a law which, in some sense, precludes renegotiation of the initial insurance contract in subsequent periods. Moreover, savings is not costless. Consequently, we are in a world of commitment where random savings is not monitored in an imperfect capital market.

3. Empirical Propositions

The goal of this paper is to test the following empirical propositions.

Proposition 1 Is the new bonus-malus scheme (with memory), introduced in the Quebec automobile insurance market in 1992, efficient to reduce the number of accidents and the number of violations to the Road Safety Code ?

It is clear that this new scheme introduces a larger use of memory than the preceding one. However, it is not clear that it is more efficient because of the potential savings effects on efforts.

Proposition 2 Does the observed reduction in accidents and violations reflect a reduction in moral hazard ?

This question is also very important because the main motivation for bonus-malus schemes is to reduce moral hazard, since risk classification is used for adverse selection (Crocker and Snow, 2000, and Dionne, Gouriéroux and Vanasse, 2001). (For another test on moral hazard, see Dionne and St-Michel, 1991.)

4. Data and variables

4.1 Data

In order to realize the empirical part of our study, we built up a data set with intertemporal individual data. Our panel covers the period January 1, 1983 to December 31, 1996. The panel is unbalanced since individuals can enter or leave the panel when they enter or leave the market.

A first sample of 40,000 license holders was randomly selected on April 1, 1983. Then, in order to keep an age structure including sufficient young drivers, a new random sample of young drivers was added each following year.

For each driver, we have information from four data bases : information on individuals' characteristics available on the driving license for the current year and information on accidents, demerit points associated to violations to the Road Safety Code, number of violations to the Road Safety Code, and license suspensions for the current year and the two previous years. Demerit points are penalties associated to violations of the Road Safety Code.

In order to monitor the operations of the public insurer which renews insurance policies and driving licenses each two years on the client's birthday, our current observation period for accidents and other variables is a period of two years beginning on the client's birthday and our period for past observation extends back two years preceding that birth date. The maximal number of periods for an individual in the sample is 8. Consequently, one standard observation is equal to a two-year period starting on the policy-holder's birthday and ending the day before his birthday two years later (days of driving permit suspension are subtracted). When individuals enter or leave, the two-year period is shorter, but we control for the number of exposure days in each year.

This procedure yielded a sample of 295,600 observations: 42,863 license holders are present for at least a period of two years ; 41,842 are present for a period of more than two years. The average number of periods is 6.90.

Consequently, we have a panel data-set where the beginnings and endings of periods vary from one observation to another with random exits and systematic entrances in each period.

4.2 Variables

The parameters of two conditional distributions are estimated: the distribution of accidents and violations to the Road Safety Code. They are conditional on the explanatory variables. Both are characterized by a dependent variable which is a count with the values 0, 1, 2, ... The different explanatory variables are the following (detailed interpretations and predictions for Tables 2 to Table 5 are given only for the variables that are directly related to the subject of the article) :

<u>Driving license variables</u>

Sex of the license holder : dummy variable equal to 1 for a male. A positive sign is predicted in both regressions.

Age at the beginning of each period : 7 classes of age ranging from 16 to 65 years old with the 17-to-19 class as the reference group. Young drivers are expected to have more accidents and demerit points.

Place of residence : 16 administrative regions in Quebec, with Montreal as the reference group. We do not make predictions for this class of variables.

Experience : Number of years since the first driving license, with class 3-to-5 years as the reference group. More experience, for any given age, should generate fewer accidents and fewer demerit points.

Driving license class : Eleven driving classes. Driving classes define the type of vehicle the individual is allowed to drive. This is an indirect measure of individual driving exposure.

Variables for regulatory changes and pricing

January 1990 : Dummy variable equal to 1 after the introduction of a new regulation for all drivers in Quebec : 15 points instead of 12 before a driving license suspension. Since this regulation is less severe after that date, a positive sign is expected.

New drivers (1991) : Dummy variable equal to 1 after the introduction of a new regulation for new drivers in Quebec in November 14, 1991. The effect of this variable is ambiguous: the new law was a little more severe for the new drivers but it increased their access to driving licenses.

Law : Dummy variable equal to 1 for those who renew their driving license in periods after application of the new pricing scheme that uses memory. (After December 1, 1992). A negative sign in the two regressions will indicate that the new incentive scheme with memory is beneficial in terms of traffic safety: clearly, if the new law increases incentives for traffic safety, a negative sign is predicted for the distribution of accidents. Moreover, since offences to the Road Safety Code can serve as sufficient statistics for safe driving activities, a negative sign is also predicted in the corresponding regression.

Table 1 presents the pricing scheme introduced in 1992. Before that date, all premia where the same whatever the license holder's record of accidents and demerit points. Here we observe that it increases rapidly in period *t* when demerit points increased in period *(t–1)*.

(Table 1 here)

Cyclical and risk-exposure variables

Number of days : Total number of days the driving license is valid during a year : this variable controls for two effects : individual risk exposure and aggregate characteristics of the year.

Unemployment rate in Quebec according to sex, age group, and periods : Less economic activity should generate fewer accidents and fewer demerit points (Statistics Canada SDDS 3701 STC [71-001]).

Aggregate gas sold in litres each year in Quebec according to periods : A positive sign is predicted in both regressions. (Statistics Canada SDDS 2150 STC [45-004]).

Time trend : Trend variable that takes into account possible reductions in the distributions of both accidents and offences to the Road Safety Code for reasons that are not controlled by the variables in the model. A negative sign is predicted since it is documented that road accidents and offences decreased over time in Quebec during the period studied.

Law trend : An interaction variable to isolate the effect of the change in law from the time trend. If the trend variable is significant in the regression, this law trend variable will indicate how the new pricing scheme, with its use of memory, affects the time trend variable. This variable is more accurate than using only a dummy variable for the change in law because it isolates the effect of the change in law from that of the other non-observable variables measured by the time trend variable.

Past experience variables

Demerit points accumulated: This variable is to test the predictive power of the demerit points accumulated in period *(t-1)* on the distribution of accidents in period *t*. The insurer does not use information on accumulated demerit points for periods *(t–2)* and for higher periods. In other words, the past experience variable starts at zero in each period. Different classes of demerit points corresponding to those in Table 1 are used and class 0-3 is the reference group. Consequently, the different parameters will allow verification of the predictive power of the new pricing scheme: Do drivers who accumulate more demerit points have more accidents ? The result can also test the fairness of the new pricing scheme.

Driving license suspensions : The number of driving license suspensions accumulated due to a driver's criminal offenses during period *(t-1)* is used as an explanatory variable for accidents in period *t*. Most of the suspensions are alcohol related.

Moral hazard variable

In order to isolate the moral hazard interpretation of the change-in-law variable from other possible interpretations, we introduce an additional variable in the accident equation (Table 5) that measures the effect of the change in law on the relationship between past experience and accidents. Before December 1992, demerit points were not used for insurance pricing. After that date, they became a pricing variable. Although they should be correlated with accidents both before and after December 1992, their predictive power under moral hazard should be greater after that date, because drivers would then know that the cost of accumulating demerit points is higher. In other words, we should observe fewer demerit points for each accident after 1992 or a positive coefficient for an interaction variable between the law variable and classes of demerit points higher than class 0-3. This positive coefficient will indicate that the predictive power of each demerit points on accidents is higher after December 1992, because the former become fewer in relative terms. A second test for the moral-hazard interpretation of the results is presented at the end of Section 6.

5. Econometric Models for Panels with Count data

Data come from an incomplete panel and the dependent variables of both regressions are count variables. We must then consider count data econometric models for the panel.

The natural starting point for count data is the Poisson distribution where the probability that the relevant count $\gamma_{it} = k$ is given by $P(\gamma_{it} = k) = exp\ (-\ \lambda_{it})\ \frac{\lambda_{it}^{k}}{k!}$ with $k = 0, 1, 2, ...$ and where $\lambda_{it} = exp\ (\beta_0 + x_{it}\beta)$. γ_{it} is either the number of accidents or demerit points, β_0 is a constant term, x_{it} is the vector of explanatory variables and β is the vector of parameters. By definition, $E(\gamma_{it}) = Var(\gamma_{it}) = \lambda_{it}$ (equidispersion).

Equidispersion is rarely observed with accident data (Dionne and Vanasse, 1992, Dionne et al., 1998, Pinquet, 2000). Some heterogeneity between individuals may not be observable and, consequently, cannot be introduced in the vector x_{it}. The unobserved heterogeneity can be taken into account by assuming that the Poisson parameter is itself a random variable following, for example, a gamma distribution with parameters (λ_{it}, ω) such that $E(\lambda_{it}) = exp(\beta_0 + x_{it}\beta)/\omega$ and $Var(\lambda_{it}) = exp(\beta_0 + x_{it}\beta)/\omega^2$. It can be shown that γ_{it} will then follow a negative binomial distribution with mean λ_{it}/ω and variance $\lambda_{it}\ (1 + \omega)/\omega^2$. Different parametrizations were proposed by Gouriéroux, Monfort, and Trognon (1984), Cameron and Trivedi (1986), Hausman, Hall, and Griliches (1984), Gurmu and Trivedi (1992) and Winkelmann (1994).

We can estimate (β_0, β, ω) by using the method of maximum likelihood. With panel data, we may have time-specific effects or individual-specific effects (Hausman, Hall and

Griliches, 1984). In our case, the number of individuals is large and the number of periods is small. Consequently, an explicit modelization of the time-specific effects is possible while individual-specific effects cannot be fully modelized.

Methods with fixed or random effects must then be considered for this individual effect. In this paper, we concentrate the analysis on random effects. Suppose now that ω is no longer the same for all individuals over all periods and is distributed randomly between individuals. Therefore, we assume, as in Hausman et al (1984), that $\omega_i /(1+\omega_i)$ is distributed between individuals as a Beta distribution with parameter *(a, b)* such that :

$$f\left(\frac{\omega_i}{1+\omega_i}\right) = \left[B(a,b)\right]^{-1}\left(\frac{\omega_i}{1+\omega_i}\right)^{a-1}\left(\frac{1}{\omega_i+1}\right)^{b-1},$$

then,

$$P\left(Y_{i1},Y_{i2},\ldots,Y_{it}\right) = \int_0^1 \prod_t \left[\frac{\Gamma\left(\lambda_{it}+\lambda_i\right)}{\Gamma\left(\lambda_{it}\right)Y_{it}\,!}\left(\frac{\omega_i}{1+\omega_i}\right)^{\lambda_{it}}\left(1+\omega_i\right)^{-Y_{it}}\right] f\left(\frac{\omega_i}{1+\omega_i}\right) d\left(\frac{\omega_i}{1+\omega_i}\right)$$

$$= \frac{\Gamma(a+b)\Gamma\left(a+\sum_t \lambda_{it}\right)\Gamma\left(b+\sum_t Y_{it}\right)}{\Gamma(a)\Gamma(b)\Gamma\left(a+b+\sum \lambda_{it}+\sum Y_{it}\right)} \cdot \prod_t \left[\frac{\Gamma\left(\lambda_{it}+Y_{it}\right)}{\Gamma\left(\lambda_{it}\right)Y_{it}\,!}\right]$$

which is a "negative binomial distribution with random effects". Parameters (β_0, β, *a*, *b)* can be estimated by the method of maximum likelihood. These estimators are limited to the assumption that ω_i is independent of x_{it}.

6. Econometric Results

Let us start with the results for the demerit-point distribution in Table 2. We observe that the introduction of the law (12-1992) has a significant negative coefficient which implies that the memory in the insurance pricing scheme reduces the number of offences to the Road Safety Code. The same result applies to the accident equation in Table 3.

We also observe from Table 3 that demerit points accumulated in period *(t-1)* are good predictors for accidents in period *t*, which seems to confirm that demerit points are indeed an adequate sufficient statistics for traffic safety behavior. Moreover, the coefficients increase with the number of points accumulated which confirms the pricing schedule of Table 1.

Other interesting results in Table 3 show that sex and age variables have the usual effects observed in many automobile insurance data sets (Dionne, Gouriéroux, and Vanasse, 1998, Dionne and Vanasse, 1992). We also observe that many control variables do not have the same effect on accidents as on offences to the Road Safety Code. This is particularly true for regional variables and driving license classes. Unemployment rates and aggregate gas sold are significant, as well as, the trend variable. Finally, the change of regulation for new drivers has a positive effect on the number of accidents, while the change in 1990 has no effect.

The coefficient for the 1992 change in law may be too high and may still capture a trend effect. Table 4 presents the same specification as in Table 3 but introduces one new variable for the analysis of the change in law: we still have a trend variable but an additional interaction variable between the trend and the change in law is added. We observe that the trend variable has still a negative effect on accidents and that introduction of the new law (Law* trend) also reduces the number of accidents, by changing the slope of the trend variable.

These coefficients are more plausible since they indicate that accidents have decreased (on average) by about 5% a year since 1984 (Trend) and that the change in law has reduced accidents by about 1% each year since 1992, so it accelerated the decreasing trend as Figure 1 shows. The value of the coefficient is reliable; as documented by Gagnon (1998), the number of accidents decreased by an average of 5% between 1980 and 1992 in Quebec. We obtained a similar result for offences to the Road Safety Code. Details are available from the authors.

(Figure 1 here)

The above results show clearly that by adding memory to its pricing strategy the public insurer reduced both accidents and offences. Two interpretations of these results are possible. The first one is that the new pricing scheme may have eliminated bad risks from the market. However, this interpretation is not very plausible since insurance is compulsory in the market studied. Moreover, offences to the Road Safety Code measure the drivers' violations directly and are consequently associated with ex-ante moral hazard.

The second interpretation is related to moral hazard. As documented in the theoretical model, the change in the pricing scheme introduced memory in the management of the insurance rates under commitment, since the insurer is constrained to be fully committed to the pricing scheme by law and drivers cannot leave the public insurer, unless if they decide to stop driving.

In order to add interpretation in that direction, we did reestimate the model for distribution of accidents in Table 4 by adding an interaction variable between the change in law and the past-demerit-point variables. This regression was done with fewer observations because we did the test for careless drivers who accumulated at least four demerit points in one period.

As we can observe from Table 5, all the results for the other variables remain stable as well as the Trend and Law* trend variables. Moreover, we observe that the new variable "Law* 4 and more accumulated demerit points" is significant with a positive sign. This means that a bad driving record is better at explaining the current distribution of accidents after the change in the insurance pricing scheme that introduced memory.

(Figure 2 here)

In fact, as shown in Figure 2, the ratio of demerit points to accidents increased during the period before the change in the scheme and then decreased after 1992: before 1992, accidents decreased more rapidly than demerit points since there was less incentive to reduce the latter in that period than after 1992 when the new pricing of insurance increased the benefits of safe driving.

In summary, by using memory, the public insurer introduced more incentives for driving safety thereby reducing both demerit points and accidents. Moreover, it increased the effect of past experience (measured by demerit points) on accidents and consequently reduced moral hazard in this market.

We now consider a supplementary test for interpreting the results in terms of moral hazard. This test uses the correlogram of the random effects or the autocorrelation coefficients between the different periods (Pinquet et al, 2000). A correlogram measures the nature of memory in the data. Usually, the decreasing shape of the correlogram indicates that the predictive power of past observations decrease with time. Of course, this shape is endogenous. It considers all the effects that may affect the memory.

Here we analyze how the 1992 change in regulation affected the shape of the correlogram. If the new pricing scheme with memory introduced more incentives for safety and reduced moral hazard, this means that short-term memory (period *t-1* as used in the pricing scheme of the public insurer) should have a higher predictive power after 1992 then before. For example, drivers that start accumulating demerit points will have more incentives to change their behaviour after 1992 than before (and so will have fewer demerit points) because the new insurance scheme introduced financial incentives to encourage such behaviour. The results are presented in Table 6. They indicate clearly that the correlation between accidents in period *t (U(t))* and demerit points in period *t-1 (V(t-1))* is higher after 1992 than before. This confirms that the use of memory after 1992 increases the incentives for road safety.

7. Conclusion

The purpose of this research was to test the role of memory on optimal contracting when saving activity is potentially present. To our knowledge, no previous study was able to isolate this net incentive effect from real data. Our methodology can be interpreted as using a laboratory experiment since no other significant structural change concerning memory was introduced during the period studied. Our econometric results indicate clearly that the use of memory introduced more incentives for driving safety in our data set. We did also verify that with the new pricing scheme, insurance rates vary according to the individual's risk which is endogenously chosen by their driving record. Some readers may want to interpret our results as a the combined effects of moral-hazard and those of asymmetrical-information on individual characteristics.

It is clear that separating moral hazard effects from asymmetrical information ones on accidents rates is not an easy task. However, our results do clearly separate exogenous from endogenous effects which represent the main difference between the two information problems. Our risk-classification variables (age, sex, driving permit, place of residence) were introduced to screen for asymmetrical information while the action variable was approximated by demerit points which was interpreted as an adequate sufficient statistics of safe driving behaviour. We are confident that demerit points accumulated are mainly a measure of moral hazard since these points are given for traffic violations (low effort) and decreased significantly after 1992 while the drivers remained in the portfolio.

Table 1

Insurance Premiums as Function of Demerit Points

Demerit Points	Premium
0, 1, 2, 3	$50
4, 5, 6, 7	$100
8, 9, 10, 11	$174
12, 13, 14	$286
15 and more	$398

Table 2
Maximum Likelihood Negative Binomial with Random Effects
Number of offences to the Road Safety Code

Variable	Coefficient	t-statistic
Intercept	-1.268637	-7.945
Sex (M=1)	1.10207	78.362
16 years old	-0.00166	-0.024
17-to-19 years old (omitted)		
20-to-24 years old	-0.17852	-4.972
25-to-34 years old	-0.39224	-8.326
35-to-54 years old	-0.69514	-14.139
55-to-64 years old	-1.29102	-24.284
65 years old and more	-1.88021	-32.401
Bas St-Laurent	-0.35255	-8.673
Saguenay Lac Saint-Jean	-0.08399	-2.545
Québec	-0.05272	-2.183
Mauricie Bois-Francs	-0.11581	-4.446
Estrie	-0.11008	-3.346
Montréal (omitted)		
Outaouais	-0.13088	-3.846
Abitibi-Témiscamingue	-0.16980	-3.991
Côte-Nord	-0.07747	-1.472
Nord-du-Québec	-0.23561	-2.007
Gaspé, Îles-de-la-Madeleine	-0.17366	-3.110
Chaudière-Appalaches	-0.24735	-8.478
Laval	0.12087	3.943
Lanaudière	0.01556	0.553
Laurentides	0.03748	1.392
Montérégie	0.03382	1.736
Driving class		
1 Heavy truck	0.08705	1.869
2 Bus with more than 24 passengers	0.13085	2.386
3 Truck< 4500 kg	0.47923	7.428
4a Emergency vehicle	-0.71855	-7.835
4b Bus with less than 24 passengers	0.02606	0.273

Variable	Coefficient	t-statistic
4c Taxi	0.23950	3.870
5 Car (omitted)		
6A Moto without restriction	0.00560	0.311
6B Moto 400cc and less	0.31970	2.615
6C Moto 125cc and less	-0.01460	-0.065
6D Moped	-1.13393	-4.899
Less than 1 year of experience	-0.62100	-9.144
1-to-3 years of experience	-0.09832	-2.944
3-to-5 years of experience (omitted)		
5-to-10 years of experience	-0.02734	-1.505
10 years and more of experience	-0.12118	-5.247
Days 1983	0.00392	26.566
Days 1984	0.00150	18.324
Days 1985	0.00337	23.140
Days 1986	0.00215	20.022
Days 1987	0.00332	24.009
Days 1988	0.00219	17.363
Days 1989	0.00278	20.412
Days 1990	0.00250	17.478
Days 1991	0.00257	20.899
Days 1992	0.00250	16.684
Days 1993	0.00215	18.652
Days 1994	0.00299	18.872
Days 1995	0.00210	24.433
Days 1996	0.00312	19.352
Unemployment rate (% annual)	0.00770	2.264
Aggregate gaz sold (10e6 liters)	0.46664	7.056
Law (12/1992)	-0.16382	-4.028
January 1990 (15pts)	0.01909	0.536
New drivers (1991)	0.07322	1.460
Trend	-0.07134	-4.152
Parameter a (Beta Distribution)	25.72788	21.907
Parameter b (Beta Distribution)	1.26827	67.298
Log-Likelihood	-175482.7248	
Number of individuals	42863	

Variable	Coefficient	t-statistic
Number of observations	295600	

Table 3
Maximum Likelihood Negative Binomial with Random Effects
Number of accidents

Variables	Coefficient	t-statistic
Intercept	-0.85492	-3.798
Sex (M=1)	0.67993	42.218
16 years old	0.15292	1.943
17-to-19 years old (omitted)		
20-to-24 years old	-0.14315	-2.982
25-to-34 years old	-0.46543	-7.333
35-to-54 years old	-0.66408	-9.983
55-to-64 years old	-0.77018	-10.772
65 years old and more	-0.83169	-11.199
Bas St-Laurent	-0.02468	-0.559
Saguenay Lac Saint-Jean	0.25058	7.094
Québec	0.21617	8.181
Mauricie Bois-Francs	0.15029	5.254
Estrie	0.14328	3.997
Montréal (omitted)		
Outaouais	0.22437	6.176
Abitibi-Témiscamingue	0.18030	3.978
Côte-Nord	0.32916	6.054
Nord-du-Québec	0.03628	0.284
Gaspé, Îles-de-la-Madeleine	-0.04441	-0.702
Chaudière-Appalaches	0.04397	1.374
Laval	-0.03561	-0.981
Lanaudière	0.10198	3.216
Laurentides	0.10564	3.481
Montérégie	0.11064	4.991
Driving class		
1 Heavy truck	-0.00802	-0.170
2 Bus with more than 24	0.21584	3.955
3 Truck < 4500 kg	-0.01173	-0.200

Variables	Coefficient	t-statistic
4a Emergency vehicle	0.16017	1.809
4b Bus with less than 24	-0.67755	-7.286
4c Taxi	0.93328	16.265
5 Car (omitted)		
6A Moto without restriction	-0.00287	-0.134
6B Moto 400cc and less	0.34580	2.900
6C Moto 125cc and less	0.22679	1.017
6D Moped	-0.62698	-2.648
Less than 1 year of experience	-0.04006	-0.522
1-to-3 years of experience	0.04623	1.043
3-to-5 years of experience		
5-to-10 years of experience	-0.09713	-3.400
10 years and more of experience	-0.18391	-5.265
Days 1983	0.00338	15.849
Days 1984	0.00225	18.824
Days 1985	0.00339	16.127
Days 1986	0.00224	14.265
Days 1987	0.00307	14.992
Days 1988	0.00229	11.959
Days 1989	0.00253	12.305
Days 1990	0.00223	9.941
Days 1991	0.00259	13.234
Days 1992	0.00214	9.108
Days 1993	0.00242	12.793
Days 1994	0.00247	9.683
Days 1995	0.00227	15.502
Days 1996	0.00234	9.052
Unemployment rate (% annual)	-0.00908	-1.880
Aggregate gaz sold (10e6 liters)	0.31001	3.701
Law (12/1992)	-0.16410	-2.568
January 1990 (15pts)	-0.01871	-0.332
New drivers (1991)	0.18013	2.719
Driving permit suspensions	0.27886	6.694
0-to-3 accumulated demerit points		

Variables	Coefficient	t-statistic
(omitted)		
4-to-7 accumulated demerit points	0.38194	8.210
8-to-12 accumulated demerit points	0.34935	3.817
12-to-14 accumulated demerit	0.87161	5.158
15 and more accumulated demerit points	0.67072	2.234
Trend	-0.05437	-2.524
Parameter a (Beta Distribution)	73.35447	11.198
Parameter b (Beta Distribution)	2.07681	33.494
Log-Likelihood	-101773.7422	
Number of individuals	42863	
Number of observations	295600	

Table 4
Maximum Likelihood Negative Binomial with Random Effects
Number of accidents

Variables	Coefficient	t-statistic
Intercept	-0.86841	-3.855
Sex (M=1)	0.67986	42.215
16 years old	0.15155	1.926
17-to-19 years old (omitted)		
20-to-24 years old	-0.14283	-2.976
25-to-34 years old	-0.46517	-7.329
35-to-54 years old	-0.66377	-9.979
55-to-64 years old	-0.76985	-10.767
65 years old and more	-0.83142	-11.195
Bas St-Laurent	-0.02468	-0.559
Saguenay Lac Saint-Jean	0.25058	7.094
Québec	0.21620	8.183
Mauricie Bois-Francs	0.15031	5.254
Estrie	0.14333	3.999
Montréal (omitted)		
Outaouais	0.22433	6.175
Abitibi-Témiscamingue	0.18037	3.980
Côte-Nord	0.32926	6.056
Nord-du-Québec	0.03641	0.285
Gaspé, Îles-de-la-Madeleine	-0.04439	-0.701
Chaudière-Appalaches	0.04407	1.377
Laval	-0.03561	-0.980
Lanaudière	0.10201	3.217
Laurentides	0.10567	3.482
Montérégie	0.11066	4.992
Driving class		
1 Heavy truck	-0.00805	-0.171
2 Bus with more than 24	0.21586	3.956
3 Truck < 4500 kg	-0.01185	-0.202
4a Emergency vehicle	0.16025	1.810
4b Bus with less than 24	-0.67748	-7.285

Variables	Coefficient	t-statistic
4c Taxi	0.93323	16.266
5 Car (omitted)		
6A Moto without restriction	-0.00287	-0.134
6B Moto 400cc and less	0.34558	2.898
6C Moto 125cc and less	0.22673	1.017
6D Moped	-0.62757	-2.651
Less than 1 year of experience	-0.04006	-0.522
1-to-3 years of experience	0.04610	1.040
3-to-5 years of experience		
5-to-10 years of experience	-0.09693	-3.393
10 years and more of experience	-0.18378	-5.262
Days 1983	0.00339	15.900
Days 1984	0.00224	18.763
Days 1985	0.00339	16.126
Days 1986	0.00222	14.124
Days 1987	0.00305	14.909
Days 1988	0.00226	11.750
Days 1989	0.00249	12.113
Days 1990	0.00218	9.676
Days 1991	0.00255	12.933
Days 1992	0.00209	8.827
Days 1993	0.00235	12.074
Days 1994	0.00247	9.763
Days 1995	0.00225	15.369
Days 1996	0.00237	9.142
Unemployment rate (% annual)	-0.00901	-1.865
Aggregate gaz sold (10e6 liters)	0.31184	3.725
January 1990 (15pts)	-0.02102	-0.372
New drivers (1991)	0.18259	2.755
Driving permit suspensions	0.27839	6.682
0-to-3 accumulated demerit points (omitted)		
4-to-7 accumulated demerit points	0.38363	8.246
8-to-12 accumulated demerit points	0.35130	3.838

Variables	Coefficient	t-statistic
12-to-14 accumulated demerit	0.87341	5.169
15 and more accumulated demerit points	0.67115	2.235
Trend	-0.04992	-2.299
Law*trend	-0.01644	-3.020
Parameter a (Beta Distribution) Parameter b (Beta Distribution)	73.37666 2.07713	11.195 33.490
Log-Likelihood	-101772.4918	
Number of individuals	42863	
Number of observations	295600	

Table 5
Maximum Likelihood Negative Binomial with Random Effects
Number of accidents

Variables	Coefficient	t-statistic
Intercept	-0.55306	-1.678
Sex (M=1)	0.37999	12.285
16 years old	0.07309	0.673
17-to-19 years old (omitted)		
20-to-24 years old	0.03371	0.520
25-to-34 years old	-0.33932	-3.740
35-to-54 years old	-0.45014	-4.711
55-to-64 years old	-0.39879	-3.734
65 years old and more	-0.41037	-3.397
Bas St-Laurent	-0.11814	-1.528
Saguenay Lac Saint-Jean	0.22584	4.247
Québec	0.21016	5.419
Mauricie Bois-Francs	0.09516	2.160
Estrie	0.04307	0.769
Montréal (omitted)		
Outaouais	0.20467	3.768
Abitibi-Témiscamingue	0.13328	1.931
Côte-Nord	0.16652	2.020
Nord-du-Québec	-0.04043	-0.187
Gaspé, Îles-de-la-Madeleine	0.04076	0.418
Chaudière-Appalaches	0.11155	2.209
Laval	-0.07254	-1.460
Lanaudière	-0.03614	-0.789
Laurentides	0.02645	0.615
Montérégie	0.07330	2.294
Driving class		
1 Heavy truck	-0.02913	-0.432
2 Bus with more than 24	0.16534	2.198
3 Truck < 4500 kg	0.15563	1.779
4a Emergency vehicle	0.22943	1.754
4b Bus with less than 24	-0.84690	-6.397

Variables	Coefficient	t-statistic
4c Taxi	0.85819	12.200
5 Car (omitted)		
6A Moto without restriction	0.00791	0.273
6B Moto 400cc and less	0.19986	1.491
6C-6D Moto 125cc and less or Moped	-0.29085	-0.897
Less than 1 year of experience	0.18381	1.656
1-to-3 years of experience	0.16406	2.721
3-to-5 years of experience (omitted)		
5-to-10 years of experience	-0.16666	-4.493
10 years and more of experience	-0.32378	-6.815
Days 1983	0.00307	9.834
Days 1984	0.00221	12.779
Days 1985	0.00319	10.487
Days 1986	0.00198	8.893
Days 1987	0.00281	9.581
Days 1988	0.00201	7.440
Days 1989	0.00229	7.817
Days 1990	0.00191	6.086
Days 1991	0.00250	8.887
Days 1992	0.00179	5.365
Days 1993	0.00234	8.299
Days 1994	0.00225	6.262
Days 1995	0.00239	11.076
Days 1996	0.00203	5.453
Unemployment rate (% annual)	-0.02486	-3.408
Aggregate gaz sold (10e6 liters)	0.35704	2.903
January 1990 (15pts)	-0.02362	-0.296
New drivers (1991)	0.28073	2.318
Driving permit suspensions	0.22931	4.628

Variables	Coefficient	t-statistic
0-to-3 accumulated demerit points (omitted)		
4 and more accumulated demerit points	0.17804	8.904
Law*4 and more accumulated demerit points	0.13307	2.692
Trend	-0.06969	-2.194
Law*trend	-0.01862	-2.280
Parameter a (Beta Distribution)	66.62471	8.989
Parameter b (Beta Distribution)	3.02096	20.546
Log-Likelihood	-41527.27464	
Number of individuals	11366	
Number of observations	82883	

Table 6
Correlogram Between Demerit Points and Accidents
for the Periods 88-92 and 92-96

88-92			92-96		
Period	**Observations**	**COV**	**Period**	**Observations**	**COV**
U(t), V(t)	70902	0.491	*U(t), V(t)*	69191	0.485
V(t-1), U(t)	34009	0.315	*V(t-1), U(t)*	33327	0.373

Figure 1
Trend and Trend* Law for the number of accidents (1983=100)

Figure 1
Ratio demerit points(t-1)/accidents(t) for years 1984 to 1995

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