Point-record incentives, road safety and dynamic data

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Outline of the presentation

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1. Introduction: Facts and figures about road safety
2. The SAAQ database, with first empirical results
3. Incentive effects of point-record mechanisms
4. Empirical results on the incentive effects
5. Conclusive remarks

Introduction: Facts and figures about road safety

- A wide discrepancy is observed between economic regions with respect to the social costs of road traffic accidents.
- On one hand, fatality rates due to road-traffic accidents have decreased steadily in developed countries, although risk exposure increased at the same time.
- On the other hand, fatality rates increased faster than risk exposure in emerging economies.
- For example, the road fatality rate decreased of forty percent in France during the last ten years, whereas it was multiplied by five in Vietnam.
- Road-traffic accidents should be the third cause of disability-adjusted life years lost from disease or injury in 2020 world-wide. The corresponding rank was equal to nine in 1990.

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Incentive mechanisms to careful driving

- An important cause of the improvement of the situation in the OECD is the development of incentives to careful driving.
- They can be monetary (fines, experience rated premiums) or non-monetary (point-record driving licenses).
- The two latter incentives schemes can be based on the history of traffic violations. In Quebec, an experience rated premium enforced in 1992 and based on a two year history supplemented fines and a point-record driving license.
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Objective of the paper

- Analyze the incentive properties of the two point-record mechanisms (point-record driving license and experience rated premium).
- Compare theoretical results to empirical findings obtained from SAAQ policies observed from 1983 to 1996.
- Eliminate unobserved heterogeneity on risk distributions, in order to estimate the incentive effects.
- Obtain overall results on the incentive efficiency of each mechanism.

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The SAAQ database, with first empirical results

- Our working sample represents roughly one percent of the SAAQ motor insurance portfolio.
- The data base include events (traffic violations, accidents), spells (license suspensions), risk exposure data (contract birthday, individuals' characteristics).
- The frequencies per year of accidents with bodily injury, accidents of all types and traffic violations are equal respectively to 1.4%, 6.7% and 16.9% on average between 1985 and 1996.
- Figure 1 represents the relative frequencies derived from a one year moving average.

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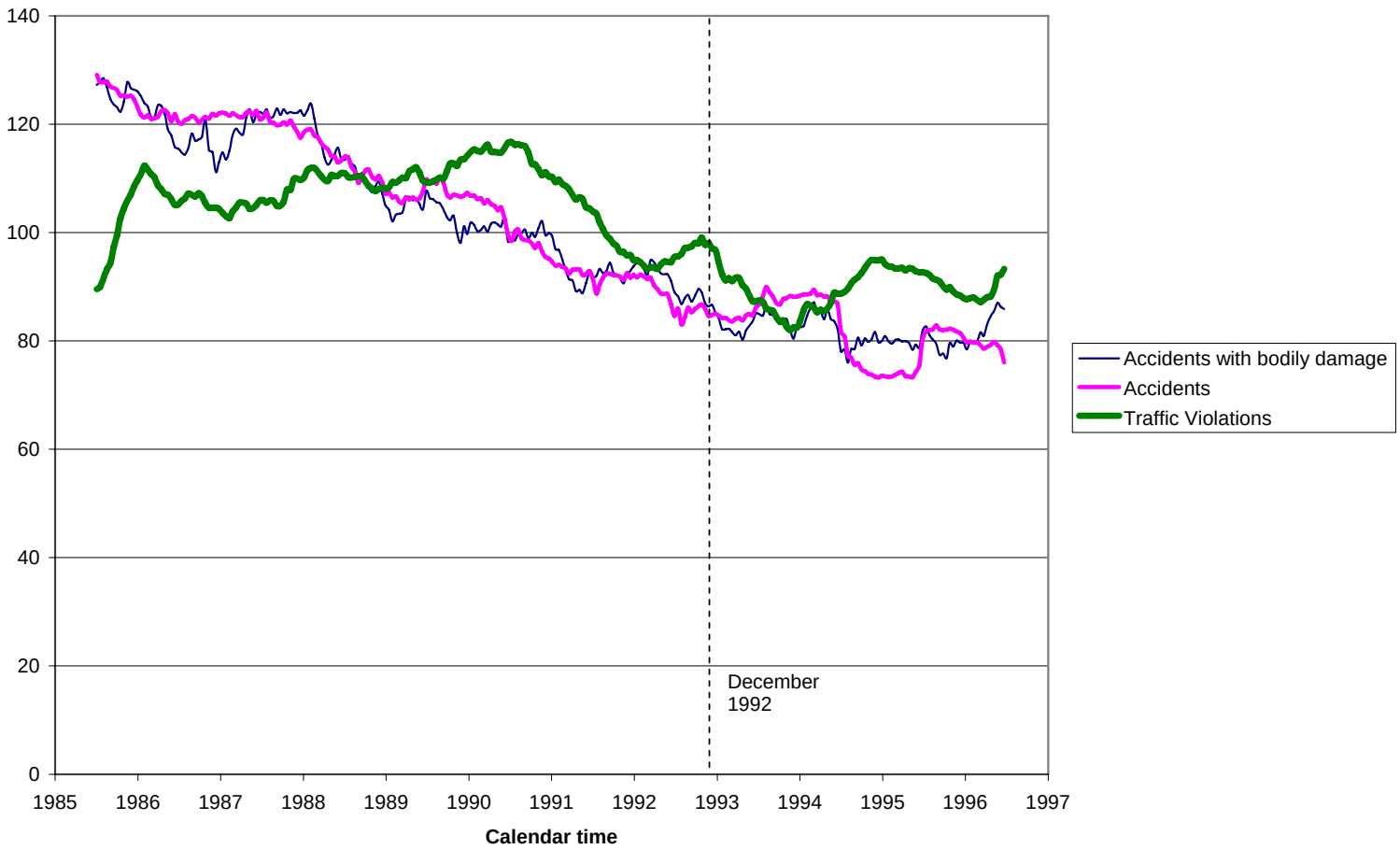
Trends for accidents and traffic violations

Figure 1.-- Relative frequencies (in percentage) for traffic violations and accidents



Point-record driving licenses

- A cumulated number of demerit points triggers licence deprivation if a given threshold is reached or exceeded. The driver is reinstated with a zero point fresh record once the suspension spell is over.
- In order to mitigate the social cost of driving license deprivation, redemptive systems exist in real-world point-record driving licenses. In Quebec, the demerit points related to a given driving offence are redeemed after two years.
- Redemption of demerit points are either performed for each traffic offense after a given seniority (Quebec, France, NY State), or all the demerit points are redeemed after a violation-free driving of a given duration (Spain, Utah).

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A model of optimal driving behavior

- A rational driver is supposed here to maximize a lifetime utility.
- Two parameters of the model are: a) a driving utility flow d_u; b)an instantaneous discount factor r. Hence the private lifetime utility is $u_{max} = d_u/r$ in the absence of any incentive mechanism.
- We suppose that the disutility of driving license deprivation is only the loss of driving utility during the suspension spell.
- Bellman equation on lifetime utility: the loss of private lifetime utility due to the different incentives is due to cost of effort, immediate payments after a traffic violation (fines), and expected variation of lifetime utility between the current state and those reached after a traffic offense.

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$$d_u - ru(S) + \left(\frac{d}{dt}\left[u(S_t)\right]\right)_{t=0^+} = \lambda_*(\overline{fa} + u(S) - E\left[u(TR(S))\right]). \quad (1)$$

S: state which determines the lifetime utility $u(S)$;
S_t: state reached from S after an event-free history of duration t.
$\lambda_*(\Delta u) = \min_{e \geq 0} e + [\lambda(e) \times \Delta u]$: λ_* is the dual of the hazard function $\lambda : e \to \lambda(e)$, which links effort and traffic violation risk.
If λ is convex, λ_* is concave.
$\overline{fa}$ is the average fine amount for a given traffic violation.
$E\left[u(TR(S))\right]$ is the average lifetime utility related to states reached from the current state S after a traffic offense.
The argument of λ_* in the equation determines the optimal effort level.

A model of optimal driving behavior

- Continuity equations on utility before and after a redemption or a birthday (in the latter case, the increase in lifetime utility is equal to the disutility of the premium) and the equation linking the utility of a beginner and just after a license suspension define the solution together with the Bellman equation.
- If all the traffic violations are redeemed after a violation-free record of a given duration (Spain, Utah): effort increases with time and decreases on average after a traffic violation.
- If redemption occurs at the offense level (as in Quebec): effort increases after a traffic violation and globally decreases with time.

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Point-record driving license

- The revelation of unobserved heterogeneity counteracts the incentive effects in this setting.
- An actuarial predictor is plugged into the hazard function of the traffic violations in order to offset the effect of unobserved heterogeneity.
- We observe that effort increases with the cumulated demerit points, which confirms the economic findings.
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- Interestingly, the behavior of risky drivers improves when they go close to or beyond the license deprivation threshold.
- For drivers close to the license deprivation threshold, traffic violation risk increases after a redemption, but not accident risk.
- This modification of behavior is also observed for drivers who experienced a license deprivation. Both accident and traffic violation risk decrease after a suspension spell.
- The time effect of incentives also confirms the economic theory (i.e. effort increases since the last modification of cumulated demerit points, if any).

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Experience rated premium

- For each number of demerit points since the last birthday, the incentive level of this mechanism depends on expected variation of the utilities between the current state and those reached after a traffic offense.
- On average, the argument of λ_* (which determines the incentive level), is equal to 11.65 Canadian dollars for this mechanism.
- This result can be compared to the average value of a fine (130 Canadian dollars), also plugged into the argument of λ_*.
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Overall comparisons between incentive schemes

- The efficiency of incentives can be assessed from the elasticity between the optimal risk level (i.e. $\lambda(e_{opt})$, with e_{opt} the optimal effort level) and the argument of λ_*.
- When the incentives are effective, it can be shown that this elasticity is greater than -1 if and only if $\log(\lambda)$ is a convex function of effort.
- Hence we can compare a 12.5% (or 15%) decrease in the frequency of traffic violations and a 9% increase in the argument of λ_*.
- This also suggests an elasticity less than -1 for the traffic violation hazard function with respect to the argument of λ_*, which means a concave shape for $\log(\lambda)$. However we could not control for external effects since the reform was applied on the whole sample.

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Conclusive remarks

- Fines are the most efficient incentive mechanism on average, but the absence of memory entails a uniform effect for given characteristics of the policyholder.
- The incentive effects of the point-record driving license increase with the number of non-redeemed traffic violations. This mechanism also acts as an incapacitating device for reckless drivers.
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