Speed choice on congested road: traffic safety under oligopolistic insurance

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Abstract:

Accident externalities are among the most important external costs of road transport, see for example Parry et al. [2007]. The social cost of road accidents is a multiple of that of congestion externalities (Steimetz [2008] provides an overview of the literature on accident externalities). Both drivers’ behaviour (such as speeding, distance to the next car, attention paid towards the other road users) and technical characteristics (such as safety belts, advanced breaking systems, window shields, lights, weight, etc.) of vehicles heavily influence the safety of the car driver and passengers, as well as of others on the road. This conclusion has been drawn from both empirical (see, for example, Lave [1985], Cohen and Einav [2003], Aarts and van Schagen [2006], Steimetz [2008], Hultkrantz and Lindberg [2011], Hultkrantz et al. [2012]) and theoretical works (e.g., Jansson [1994], Verhoef and Rouwendal [2004], Nitzsche and Tscharaktschiew [2013], Wang [2013]).

Furthermore, Delhaye [2007], Rizzi [2008], and Hultkrantz et al. [2012], suggest that incentives stemming from insurances can change drivers’ strategic behaviour. However, the effect of insurance companies, efforts and incentives to affect driver behaviour remain under-investigated in the economic literature. For instance, based on Steimetz [2004], and Gossner and Picard [2005], Rizzi [2008] considers a rational driver who optimally chooses risk-reducing efforts (care), such as speed, distance between the cars etc., in a model where car insurance is available. Rizzi clearly shows that insurance influences driver’s efforts to drive safely. However, in his work insurance agents do not play an active role controlling drivers’ choice, and only drivers’ utility functions are maximized.

We study the regulation of road safety, when insurance companies have market power, and can influence road users’ choices in terms of aggregate traffic flow, and speed as a function of flow. The latter may benefit the driver as well as a possible “partner” in a collision. A social regulator, in turn, has instruments to affect both insurance providers and thus indirectly the drivers.

Our model describes a two-stage game between car insurance providers and road users. First, insurance companies maximize their profit by optimizing the level of insurance premiums, and how these depend on behavioral speed-flow relationship, subject to equilibrium constraints. Then, each atomistic road user opts for speed, in order to minimize its generalized price. Next, an aggregate kilometrage results from the inverse demand function for
trips, given this minimized generalized price. This price includes time costs, insurance premiums, and a (possibly immaterial) part of the expected accident costs not covered by the insurance. We assume that an individual’s speed choice does affect both one’s own and other road users’ safety, and depends on aggregate kilometrage as well as insurance-specific traffic flow.

Following and extending the reasoning provided in papers Verhoef and Rouwendal [2004] and Dementyeva and Verhoef [2015], we obtain marginal conditions for the first- and second-best premiums. In our model we assume that companies can influence drivers’ behavior via insurance programs. A social regulator can then impose taxes or subsidies on companies and/or road users, fines for speeding over a certain speed limit, and other regulations. We consider social welfare-maximizing and private profit-maximizing monopolies, and duopoly markets of firms playing Nash in a Cournot fashion.

A number of conclusions stand out: For each type of market structure, the insurance premium (function) drivers face is defined by an insurance premium level in the equilibrium point, and marginal dependence of that premium function on speed, given by what we will call optimal “slope” of the premium function with respect to the individual driver’s choice of speed.

The insurance premiums we derive reflect that monopolists fully internalize the accident externalities imposed by their drivers upon one another, while competing firms provide only partial internalization. The same is true for the optimal “slopes” of the premium with respect to the speed of the road users. The speed choice increases the risk to cause a collision and therewith other drivers’ risks, and this fact is reflected in the control over the marginal change of the premium.

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References


